THE WORLD'S FOOD RESOURCES

BY

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PREFACE

In the preparation of this book the problem of statistical illustration has been peculiarly unsatisfactory. It is an attempt to consider things as they will be in the world of peace that we hope is to come. Conditions during the period 1914-18 were so disturbed that production figures would not serve as good illustrations. For this reason we had to go back to the period before the war, hence the frequent references to figures of 1911-13. In most cases they were the last normal figures available.

It is a pleasure to acknowledge the assistance I have received in the preparation of this book from my wife, Henrietta Stewart Smith, and also from my secretary, Miss Anna Y. Satterthwaite, and Mr. C. Raymond Michener. Our combined labors kept idleness far away from a mountain camp in the summer and autumn of 1918. It is to the diligent aid of these assistants that the prompt completion of this book is due, and by many facts, compilations, and suggestions have they enriched it. I am also indebted to Dr. Louis N. Robinson of Swarthmore, Pennsylvania, for valuable counsel with regard to the plan of the book, and to Mr. Robert Atkinson of Wrightstown, Pa., for material in connection with the chapter on Dairy Products.

For that great kindness, critical reading of galley proofs, I am indebted to Professors C. J. Posey of the University of Minnesota and N. A. Bengston of the University of Nebraska, and to Mr. O. E. Baker and Miss Helen M. Strong of the Bureau of Farm Management, United States Department of Agriculture.

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J. Russell Smith.

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INTRODUCTION

For two years the people of Europe and America have been reading about diet, studying nutrition, practising cookery, talking about food, and wondering about the food supply as never before.

Has food shortage come to stay, or is there a bounteous future ahead of us? The answer to that question depends on how man behaves. The injunction of Jehovah to Adam and Eve in the Garden of Eden still holds good. The earth is still a potential Eden with room (food possibilities) for many, many more of the children of men. We have subdued the earth far more extensively than Adam dreamed of doing. It is more completely ours than Eden was Adam's. Now as then, man's greatest enemy is himself. Food we can have in great abundance if we devote our time to the continued conquest of the earth, and to the utilization of nature, rather than to the conquest of each other. But there can be only death and starvation for millions of men if we continue to indulge in war. Nations are no longer independent. We have become dependent on a great fabric of trade; when it is destroyed, we die.

It is the object of this book to present some of the facts concerning the world's food supply and the possibilities of food supply, and to discuss the outlook for the future. The war has made us think about food—a little.

Did you ever figure out just what you would do if your food supply failed? You probably have not, but a good observer who has seen men in all stages of starvation in the Yukon wilderness has it worked out in this way: "If a man misses his meals one day, he will lie. If he misses his meals two days, he will steal. If he misses his meals three days, he will kill."

This may sound far-fetched, but in reality it is just an everyday fact that has not hitherto come up for our consideration. Having had an abundant food supply, we have never had to consider possibilities of famine. Our world commerce, which is very new, has run so smoothly for a while that we do not understand the troubles of the past, nor as yet the vital problems of the present. Tens of millions of us depend upon a great worldwide mechanism daily to bring us food. So far as food is concerned, modern man has the independence of a bird in a cage, no more. He depends upon the continuance of world trade.

We in America have been peculiarly free from anxiety about food shortage. With us it was at worst merely the question which food we should buy. We have lived on a continent that was secure and rich—the richest in all the history of man. We have been a whole world to ourselves. Suddenly we found ourselves only a part of a bigger world—and a hungry one.

We have been lulled and dulled by the comfort and security of far-reaching trade. The world market is excellent, when it is well supplied.

For two generations we have all known that if we had the price or the credit, goods and food were ours. They came mysteriously by night from places about which we neither knew nor cared. What difference did it make to the housewife of England, or of New England, whether her flour came from the grain that waved in the fields of the next county or of another hemisphere? But in war its source determined the lives of nations.

Where does the world's food come from?

The Great War with its starvation made nations see, really see, what a century of world trade had done for them by giving them the whole world from which to feed themselves. In the matter of food supply there has been far more change since the days of George Washington than there was in all the time between George Washington and Caesar or Nebuchadnezzar, or Cheops, who built the pyramids of Egypt. In 1786 a Massachusetts farmer wrote a pamphlet telling just how he supported his family.* With the wheat and corn and buckwheat that grew in his fields he furnished the family bread. The chickens, pigs, sheep, and an occasional beef that he slaughtered furnished the meat. His garden furnished all the vegetables and his orchard all the fruits, many of which, along with garden vegetables, were

* See MacMaster, J. B.: *History of the People of the United States,* Vol. I.

dried for winter use. Thus the farm produced the family food. For clothing, his wife spun the wool which he sheared from the sheep; and the flax that grew in the corner of a field was made into linen. The skin of the meat animals was tanned and made into the family's shoes, and thus were they clothed. The trees from his wood lot furnished the boards to build his house, and the logs for his fire, and the rails for such fences as were not of stone. He himself, like most farmers of that time, was a fairly good worker in wood, and had a little blacksmith shop, so that he made practically all of his own tools on rainy days and in

FIG. 1.—The distribution of people is remarkable in its unevenness. (Finch and Baker, *Atlas of the World's Agriculture.*)

snowy winter weather. Only a few things were needed from the outside world, such as salt, pepper, a little lead and gunpowder, and iron for his little forge. These outside products cost him altogether \$10 a year, permitting him to save \$150 out of the \$160 received for the wheat and cattle that he sold.

In that day trade was confined to luxuries. The countries of the world like the colonial farmer tended to be economically independent. They had to be so. The locality that could not furnish most of the materials for man's food, clothes, shelter, and fire, remained unused. Men clustered along the shores of the sea and navigable rivers in that comparatively small part of the world where resources were reasonably complete. If crops were short, men went hungry. If crops failed, men starved, as they did in England in Shakespeare's time. For many centuries the month of May was called in England the starving time, because it was the last month before the beginning of the first new food crop, and therefore the period of greatest scarcity. Most of the central parts of all the continents save Europe were empty, because of the absence of even the small trade that went in the sailing vessel and the river boats of those days.

In the United States, only in the last few decades have Iowa, Kansas, and the Dakotas become important granaries of the world. Canada is but beginning; and in South America the plains of the Argentine were the possession of savages and wild animals when man invented the locomotive and the steamship, although the white man had been in possession of the shores of both Americas for at least three centuries. He could go far inland only on rare and venturesome exploring trips, such as the journey of Lewis and Clark to Oregon in the first decade of the last century.

It is only in the last hundred years, the century of steam and a sea clear of pirates, that man has begun to possess and utilize the earth to any great extent, and we are yet only at the beginning of the possibilities of such utilization. It is largely sea trade that has made this new epoch of comfort, and it is by sea trade that an enriched future must be fed. Sea trade, the great sea trade, is new. It has made population increase greatly and suddenly, the result of ships and a safe sea. This century of steam, a free sea, world trade, and abundant food, has enabled the struggling settlements along the shores of America to increase their numbers twenty-fold within a little more than a century. Europe has also gained enormously in population, as have South America, Africa, Asia, and Australia. Because of this world-wide ship business connecting with the railways and permitting a world-wide food supply, men have clustered in places where it was good to live. No longer dependent on their own garden spots, they could eat and increase, regardless of local harvests. During this golden age of the larder, food always came from some far place if it was not produced at home. Men have been able to cluster so closely that they could no longer live upon the produce of the land in which they dwelt, so that England and Scotland, Holland and Norway, Italy, the Rhine-land, in fact all of western Europe from Norway to Greece, became dependent upon the sea trade. Without it they would not have enough to eat. Even their cows depended partly upon antipodean hay; witness the export of baled alfalfa from Chile to Britain, and of corn, bran, and oil-cake from America to Holland and Scandinavia.

America and Japan have also entered into the world's trade and are becoming increasingly dependent upon sea trade. New England could no more feed herself than could old England, and the United States finds itself using each year more and more products from overseas.

Compare the food and clothes of the Massachusetts farmer of 1786 with those of the American reader of this book. The man of today starts his breakfast with an orange from California or Florida, or a banana from Central America, or an apple from Oregon, Virginia, or New York. He takes a shredded wheat biscuit made in Niagara Falls from Dakota wheat. He sugars it with the extract of Cuban cane. He puts Wisconsin butter on bread baked of Minneapolis wheat flour mixed with Illinois corn flour. He has a potato. In June it comes from Virginia, in July from New Jersey, in November from New York, Maine, or Michigan. If he indulges in meat, it is a lamb chop from a frisky little beast born on the high plains near the Rocky Mountains, and fattened in an Illinois feed lot before going up to Chicago to be inspected, slaughtered, and refrigerated. He warms and wakes himself up with a cup of coffee from Brazil (called Mocha perhaps) or tea from Ceylon or Japan, or cocoa from Ecuador or the coast of Guinea.

So much for the breakfast of today. Our other meals are equally far-reaching, and our clothing also is a collection of stuffs from the far ends of the world.

This development of *dependence* had gone so far before the war that England produced but a fifth of the food she ate, Italy two-thirds, and Germany four-fifths.

In both Europe and North America there is, facing the Atlantic, a region of dense populations—city dwellers and manufacturers in districts that cannot raise enough food for local needs. Inland from this region, still farther from the Atlantic, is the zone of food surplus and export.

In America the chief region of food surplus is the Corn Belt and the Great Plains. In Europe it is chiefly the East, including Russia, Rumania, Serbia, Hungary, and also Denmark and Sweden.

On both continents there have for years been heavy shipments of food from the agricultural back-country to the cities on the Atlantic. New England furnishes an illustration.

Massachusetts produces two and one-half pecks of corn per person, and not enough wheat to feed the hens of the chicken fanciers. She has but four cows and three hogs per hundred people. In Wisconsin there are, per hundred people, 67 cows; in Iowa 453 hogs; and in Kansas 106 beef cattle.

Massachusetts spreads the butter of Wisconsin on the bread of Dakota, eats the meat of Kansas, and feeds the horse, born in Iowa, with the corn of Illinois. She would starve more quickly, far more quickly, than Belgium; so would New York, so would eastern Pennsylvania and New Jersey, but for the supplies that continuously roll in from the West.

Then came the war, in which Germany sought to win world dominion by the simple plan of throwing the commerce of a part of Europe back a hundred years. She would use the submarine blockade and destroy this nineteenth century world trade in food for Britain and France. The world would then be hers. If the German plan had worked as quickly as they hoped, England might now be a German vassal. Nor was America left entirely out of the plan. New England shares with old England the possibility of conquest by starvation, and such was a part of the reported German plan for the conquest of America. This plan provides for bisecting this country along the easily held line that nature has made by the Potomac River, the Blue Ridge Mountains, the Susquehanna and Hudson rivers, with the addition of Lake George and Lake Champlain. The map shows how easy it seems.

In Europe we have seen the continent cut in two and the starvation process working. In the prosperous times of recent peace, England and Belgium, and to a lesser extent France and Italy, lived like Massachusetts and New York. A steady pro-

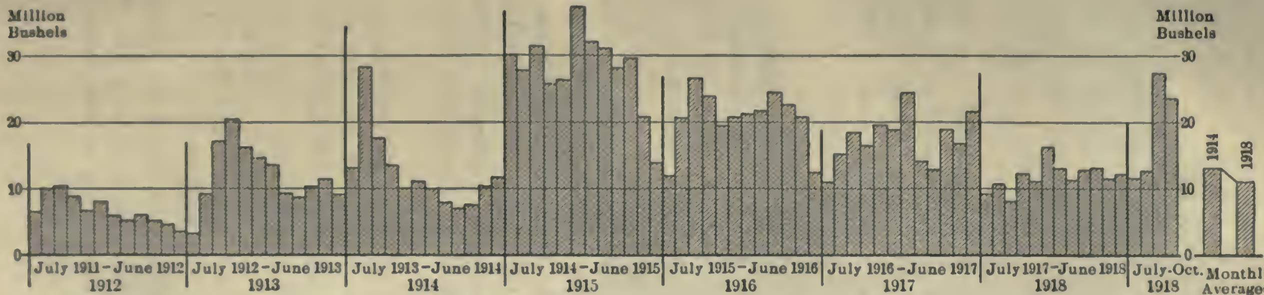

FIG. 2.—United States exports of wheat and wheat flour by months. The influence of the great crops of 1914 and 1915 followed by normal crops is plainly to be seen. (*The American Trade Balance and Probable Tendencies, National Foreign Trade Council.*)

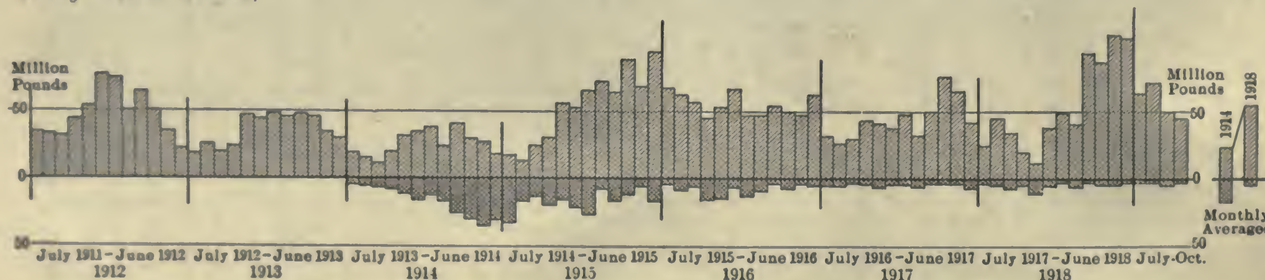

FIG. 3.—United States exports of beef and beef products and cottonseed oil shown above the 0 line. Imports of beef and veal shown below the 0 line. Note the reduction in import and comparatively small increase in export when compared to pork. Fig. 4. (*National Foreign Trade Council.*)

cession of ships and trains with wood, wheat, oats, rye, barley, corn, butter, eggs, and meat streamed westward from north Europe and the White Sea, from middle Europe and the Baltic Sea, from southeastern Europe and the Black Sea.

Suddenly Germany stopped it all. She controlled the Baltic, and when she got Turkey into the conflict the Black Sea was closed and Russia and Rumania were shut up as tightly as the United States and Canada would be if every Atlantic port were closed, every Gulf port closed, and every Pacific port closed except San Diego, California.

The conspicuous thing about America's foreign trade for ten years before the war was the decline in the export of food-stuffs. Then suddenly the countries of western Europe were cut off from their other great source of supply in eastern Europe. Next, the war reduced Allied home production. Consequently America had the bag to fill.

Another biting fact in the early part of 1918 was that supplies of wheat and corn in Argentina and of wheat in Australia, although paid for and lying in the warehouses, might as well have been in the moon. There were great piles of wheat lying in Australia, one report put it at two hundred million bushels; but from England to Australia by sea is three times as far as to America. Ships to carry the Australian wheat did not exist. Such ships as could be found had to be supplied almost exclusively from the short-journey place—the United States, 3,000 miles—rather than Argentina, 6,000 miles, or Australia, 10,000 miles away. For several years the fate of the Great War hung on the Allies' oversea food supply.

If the issue of this war hung on the question of food supply, what about the past? If it is a key to present history, is it not also a key to the past? History is like a Punch and Judy show. The real things are the forces that work the puppets. An empty stomach is not the least of these, and one to which historians have given too little heed. Huntington * claims that the fall of Rome was due to vast droughts in central Asia. The droughts diminished the grass supply. This shortage cut down the flocks and the food supply of pastoral peoples. Should they sit at home and starve, or go forth and fight their way to new lands,

* Huntington, Ellsworth: *Climate and Civilization.*

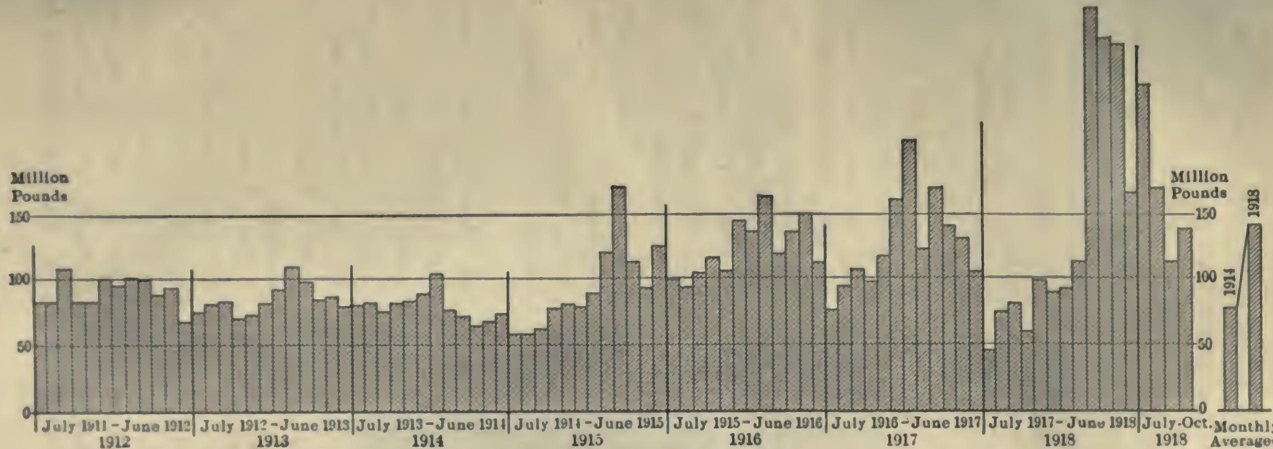

FIG. 4.—United States exports of pork and pork products. The increase in export shows the result of the remarkable ability of swine to increase. (*National Foreign Trade Council.*)

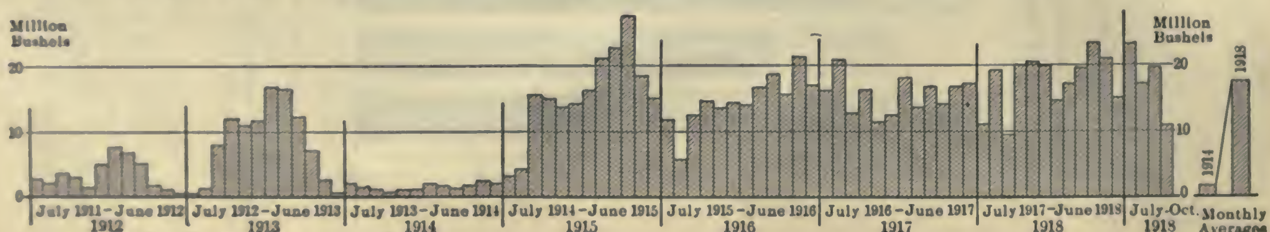

FIG. 5.—United States exports of corn, oats, buckwheat, barley, rye, and meal of. This chart shows combined exports of wheat substitutes and forage grains—great increase. (*National Foreign Trade Council.*)

to fresh pastures—the only things they knew as a source of food? Of course they chose action rather than death, and so they broke into Europe with a power that could not be stayed. Rome fell before them.

A well-known economist has called the French Revolution a bread-riot, and the fall of the Russian Empire and of Kerensky's government had many of the marks of being another. For months the Czar's government had been handing out bread every day to the hungry people in Petrograd. One day the bread-line waited in vain, and the people went hungry to bed. The next morning they started to riot. The soldiers of the Petrograd garrison were ordered to fire on the mob. These soldiers happened to be Petrograd men, and they did not think well of firing on their own kin. Instead of shooting the people, their people, they fraternized with them. The mob and the army became one, and Nicholas was no longer Czar of all the Russias.

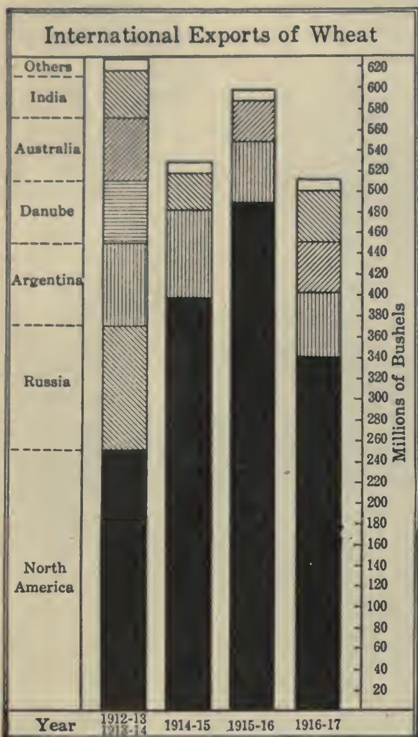

FIG. 6.—The total wheat trade shows the important part played by North America in supplying food for the war. (*United States Crop Reporter.*)

Then Kerensky ruled in Petrograd as long as his bread held out. The soldiers liked Kerensky, they wanted to stand by him, but man must have food. One morning the bread did not come. All day the soldiers waited for their breakfasts. They held a meeting and sent word to Kerensky that they would give him until 7 P.M. to deliver the bread. This he could not do, and the army went over to the Reds. Kerensky followed the Czar.

The food supply is the first necessity of mankind; and a satisfactory food supply is a necessity of advancing civilization: for, as President Wilson recently put it, "Hunger does not breed reform."

CHAPTER I

WHEAT: REGIONS AND PRODUCTION

THE IMPORTANCE OF CEREAL FOODS

Most of the energy made in the human machine comes from starches and sugars (carbohydrates)—mainly from starch, the chief element in the cereal foods. Bread is the most desired of all the cereal products. Long ago it was called the staff of life.

Wheat is the most highly prized of all the breadstuffs, not because it is the most nutritious, but because wheat bread tastes a little better to most people than other breads; consequently, as people become richer, they turn from cheaper and less palatable breads to wheat bread. Thus the negro of the South turns from corn pone to the wheaten loaf; the German and Russian peasants turn from the black rye bread to the white wheat bread, and the scantily clad West Indian leaves his yams and cassava cake for the produce of the Minneapolis mills.

Even the Chinese and Japanese are increasing their use of wheat as a luxury to replace partially their cheaper foods of barley, rye, millet, and the more expensive rice.

All the cereals are furnished by the grass family. We get these foods by taking the legacies that the plants leave for their children. The plants pack starch, gluten, fats, and other elements of nutrition into their seeds to provide for the nourishment of the young plant before it gets its roots well into the earth. Cultivation has greatly increased the number of seeds to each plant, and we take and eat the surplus. Cereals are equally acceptable to man and to many beasts, and they are furnished to man in various lands by a much greater variety of plants than a wheat-eating nation would at first surmise.

Professor Sylvanus Thompson estimated a few years ago that the number of wheat eaters in the world was 585,000,000, or more than one-third of the human race, and there is little doubt that our wide-reaching world trade and increasing wealth have steadily increased their number. The year 1918 saw wheat become a subject of more intense human interest than it had ever been before. Most of these hundreds of millions of wheat-eaters had taken their diet as a matter of course before the war; but, as country after country faced a reduced wheat supply and formal or informal rationing, tens of millons of people found a new interest in the prospects for wheat. This emphasis continued until, when the reduced rations were applied to the United States and Canada, wheat became a world interest. The new conditions applied to all except those few scattered groups of humanity who lived beyond the reach of world trade in some far interior location, such as the oases where mountain streams run out into the arid plains of Afghanistan, or Turkestan, or Mongolia, and help to produce wheat that could not be carried to a seaport for several times its value.

While important in every locality where it is used, wheat bread is of varying importance in the diet of different people. To many Americans it is merely a supplementary food. In much of Europe, particularly France and parts of the Mediterranean countries, it is the mainstay of the diet.

THE WHEAT PLANT AND ITS REQUIREMENTS

Wheat was grown by man before the dawn of recorded history, so long ago in fact that for centuries the wild plant was thought to be extinct, like the wild sugar-cane. Botanists are still in doubt as to the claim that it was found growing wild a few years ago by Mr. Aaronson on the slopes of Mt. Hermon in Palestine. It is certain, however, that wheat belongs in the Palestine climate. Wheat is primarily, throughout the world, a crop of lands of little rain. Most of the world's crop is grown in regions having less than thirty inches of rain; some indeed is grown in lands where the rainfall is only ten inches a year.

For soils wheat grows best on silts and clays, and does so poorly on sand that little of the world's supply is grown on sandy soils.

During the first stage of its growth, the wheat plant, being a grass, consists of a tuft of green blades. Later it sends up stalks of straw that support the grain-bearing heads. The number of stalks and heads depends on the size and vigor of the plant, and these are greatly dependent upon the duration of cool,

FIG. 7.—Rainfall, June, July, and August. (Mark S. W. Jefferson, *Teachers' Geography.*)

Heavy—more than 10 inches of rain and melted snow in the three months.
Light—from 6 to 10 inches in the three months.
Scant—less than 6 inches in the three months.

All the great wheat regions are in or along the margins of the regions of scant summer rain. It should be noted that in the southern hemisphere this map shows summer rain.

moist weather. If the cool, moist season of grass growth is long, the grass-like development is good, the roots are full of nutrition, and the heads many. Early sunshine and heat that shorten the damp period shorten the grain yield also. This formative period is therefore important. In milder climates it may include the winter, for, like most grasses, wheat is not harmed by mere freezing; but where the winter is too severe the wheat-growing period falls wholly in the spring and summer. The wheat of warmer regions, called winter wheat, is sown in the autumn and

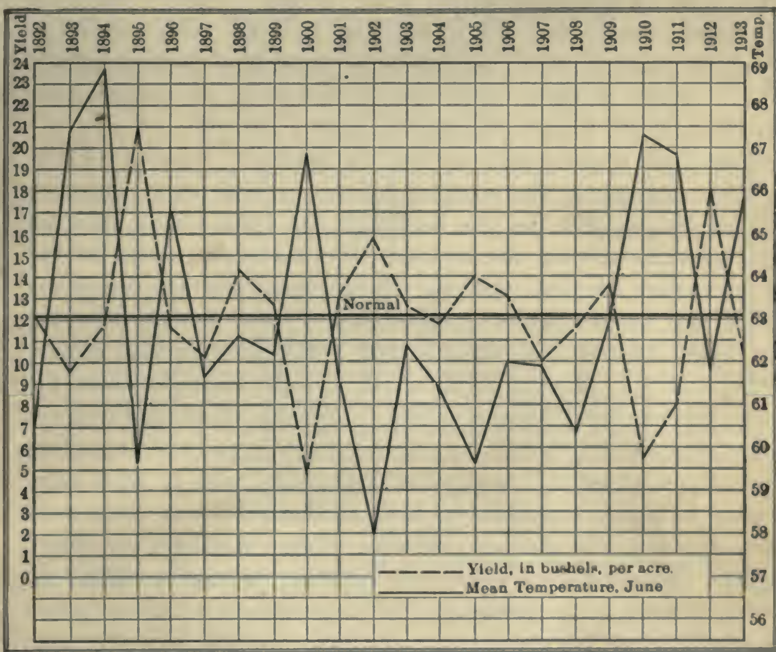

FIG. 8.—Note striking relationship between excessive temperature and low yield, and low temperature and high yield, in the Dakotas, 1891–1913. This clearly explains why Nebraska, farther to the south, is not a spring wheat region. (*Data* from United States *Monthly Weather Review*, January, 1915.)

harvested early in the next summer. Spring wheat, the wheat of the lands of dry cold winter, is sown in the spring and harvested at the end of the summer. Although wheat grows in many and widely scattered lands and different climates, it should have for the period of its early growth moderate rainfall * with rather cool, moist weather, long-continued if possible. This

* The moisture left from a period of seasonal rainfall is sufficient in some parts of the Pacific slope to mature a crop of wheat upon which no rain falls.

should then be followed by warm, bright, and preferably dry weather. Much summer rain is bad for wheat. It causes the plant to make straw rather than grain, and also favors rust and other fungous diseases. If excessive, it causes the grain to shrivel before harvest, and often causes it to mold or decay after harvest. Consequently, wheat growing cannot be tried in warm regions of heavy summer rainfall with assurance of good harvest, and its southward progress in the eastern United States is almost completely stopped by an average temperature of 68° for the two months before harvest.

There is a wheat region on every continent. Despite its proverbial uncertainty the weather follows certain laws. On each side of the equator lies the region of the trade winds, blowing very steadily toward the equator: the northeast trades in the West Indies, Mexico, and the Philippines, and the southeast trades in North Australia, Madagascar, and Brazil. In the temperate latitudes of Oregon and Ohio, France and Japan, Chile and New Zealand, the winds are prevailingly from the west, disturbed by days of storm. Between these zones of the trade winds which deluge the coasts with rain, and the prevailing west winds which also bring good rains, are belts of little rain, giving to every continent a belt of desert—lower California and Arizona, the Sahara, Arabia, Chile, Kalahari in South Africa, and the great wastes that, blighting its center, make Australia a shell of a continent. In the transition land between the trade wind deserts having very little rainfall and the zones of the west winds with their much rain on the other side, there is a place for wheat, so that each one of the six continents, Europe, Asia, Africa, Australia, North America, and South America, has one or more wheat regions. They vary greatly in extent on the different continents because of the accidents of land form and land surface. There are also wheat regions in the zone of the west winds and in continental interiors, as in central North America and central Eurasia. The map shows eight important and distinct wheat regions:

1. The plains of southern Russia and the Danube Valley.
2. The country bordering the Mediterranean.
3. Northwestern Europe.
4. The central plains of the United States and Canada.

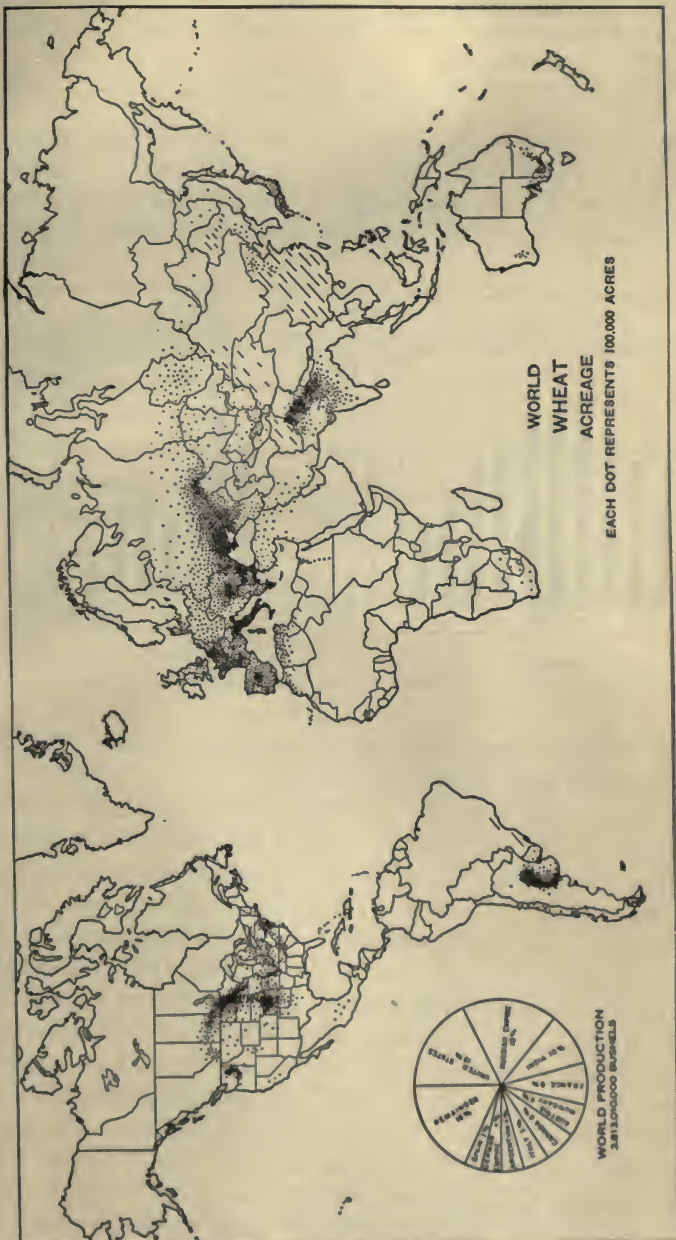

FIG. 9.—Note wheat region in every continent. Compare with Figures 10, 11, and 12. (Finch and Baker.)

5. Columbia Basin of the United States.
6. Northwestern India.
7. Eastern Argentina.
8. Southern Australia.

These wheat regions are located in both hemispheres and in climates that range from the tropics of India to the very cold temperature of Alberta and Finland, where a little wheat grows at 65° N. As a result of this wide distribution wheat is being

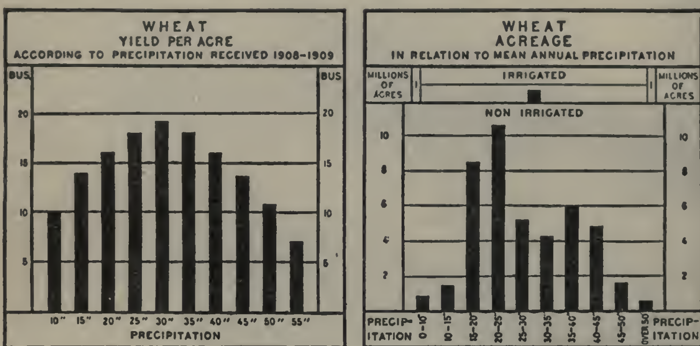

FIG. 10.—An admirable illustration of the fact that lands can have too much rain for wheat. United States, 1909. (Finch and Baker.)

planted and harvested every month in the year and tends to flow constantly into the world's granary.

The wheat plant's double requirement of a cool, moist formative period and a warm, sunny but not hot, period of ripening, explains the importance of wheat in regions of rainy winter and dry summer, like California, Spain, and Australia; and its absence from lands of heavy summer rainfall, like the coasts of the Gulf of Mexico and most tropic lands. The rainfall of the eastern and southern United States promotes heavy vegetation, permits a rich and luxuriant agriculture, and is especially adapted to the moisture-loving cotton and corn, but is quite unsuitable for wheat. A ten-year average for Georgia shows 7.9 bushels per acre, while Wisconsin made in the same ten years 15.7 bushels per acre. Even the corn-belt of the Ohio and Mississippi valleys has sufficient moisture at times to injure the wheat crop to some extent, although some wheat is grown in almost every county in that region. It is often the case that a good corn season makes a poor wheat season. In the cotton-belt with its still greater summer rainfall, so favorable for cotton, wheat becomes less and less profitable, and the little that is grown on the northern margins of the eastern Gulf States and in Carolina has the lowest yield per acre found anywhere among English-speaking peoples. Early ripening varieties must be used to avoid rust. A week's difference in time of harvest sometimes reduces the yield ten or twelve bushels. The whole tropic and sub-tropic region with its tendency toward summer rain is, therefore, practically debarred from wheat growing, except here and there where some climatic exception holds sway, as in Egypt, arid, but having enough river water for the two needed irrigations, or again, where high elevation, as in Mexico and Colombia, gives temperate conditions to plateaus and mountain regions, where a little wheat is grown. The most important of these tropic exceptions is India, where the summer rains, brought from the Indian Ocean by a great summer sea breeze, the monsoon, arrive after the winter wheat has been ripened by the heat and droughts of early summer, thus permitting India to be one of the world's important wheat countries.

FREEZING AND THAWING OF AN OPEN WINTER

In addition to the handicap of summer rain, parts of the corn-belt of the United States have another difficulty in the alternate freezing and thawing unaccompanied by snow cover in winter and early spring. This condition is much worse than solid and continuous freezing. The expansion and resultant lifting of the top soil by freezing, and the contraction of the thaw, gradually shove ("heave") the wheat plants out of the ground. As a result, wheat is a much less important crop in many corn-belt localities than it was twenty-five years ago. The wheat regions have been shifted beyond the Mississippi Valley southwestward, to a less frosty climate for winter wheat, and also to the colder Red River Valley of the North and to the plains of Canada, where the rigors of the winter climate have no direct effect upon the wheat because it is spring sown. Between the spring wheat-belt of South Dakota and the winter wheat-belt of

Kansas is a transition territory in northern Nebraska that is too warm in summer for good winter wheat and where the winter so often injures the crop that it is of much smaller importance than in either of the more favored localities to the

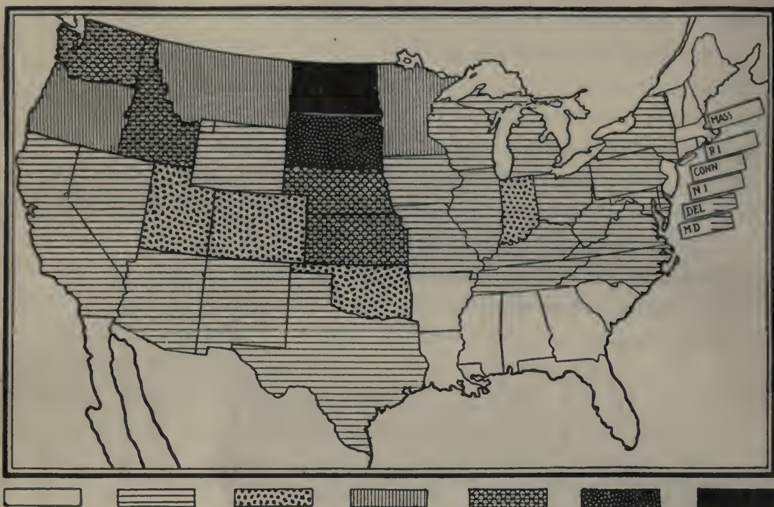

FIG. 11.—United States production of wheat per capita, by states. Wheat figures, three-year average, 1909–11. Pop., 1910. Compare with rainfall map. Note emphasis of belt of low rainfall from Texas to Dakota, also in Washington and Idaho. Another illustration of the fact that lands can have too much rain for wheat. (Finch and Baker.)

north or south of it. For example, in the winter of 1917-18 eighty-three per cent. of the 3,643,000 acres of winter wheat in Nebraska was so injured that it had to be plowed up and the land put to some other crop the next season.

The ideal winter for wheat is that of southern California and Spain, moist, with occasional frosts but no frozen ground. The second-best winter for winter wheat is that of Ontario or central Germany, where the cold is almost continuous, and the protecting snow wraps the wheat in a blanket for many weeks, finally melting and giving plenty of water for spring growth.

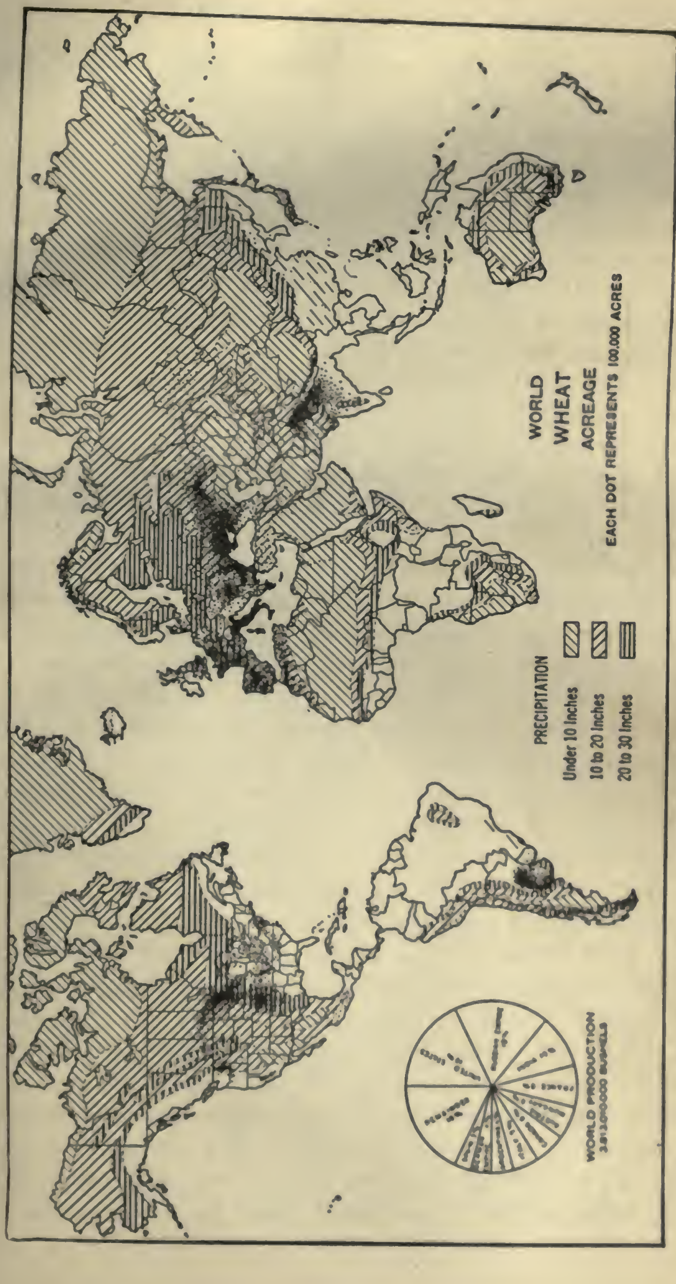

FIG. 12.—Showing distribution of wheat and its relationship to moderate rainfall. (Finch and Baker.)

REGIONS WITH GOOD WHEAT CLIMATE

The ideal wheat climate, with the rainy winter and dry summer, is sometimes called the Mediterranean type of climate because it prevails in most countries facing the Mediterranean Sea. This Mediterranean wheat climate is to be found upon the margins of the six arid or desert regions that afflict each of the six continents in the latitude of transition between the zones of trade wind and prevailing westerly wind. Thus we find drought along the northern edge of the Old World desert from Gibraltar through southern Europe, northern Africa, and Arabia, and on both sides of the desert in Syria, Persia, Siberia, India, and China. We find it again in South America, where the desert extends diagonally from Peru through northern Chile into western Argentina and is bordered by a wheat region on the west in central Chile and on the east in eastern Argentina, extending into Uruguay. Wheat lands border the cooler edges of the deserts of South Africa and Australia, but the desert encroaches upon the wheat lands so far that these regions are unimportant to the world's supply. South Africa with its scanty population even now imports wheat, and in Australia the moisture suffices only in the southeastern, southern, and extreme southwestern sections, and the crop varies greatly with the fluctuating rainfall on this desert margin. New Zealand is a regular wheat-exporting country because its location, a little nearer the south pole than Australia, misses the belt of scanty rainfall which roughly follows the tropics of Cancer and Capricorn. New Zealand receives instead the regular rains brought by the west wind. Australia gets the same amount of rain as southern California, and New Zealand the same amount as Washington State. Like England, in a similar latitude and climate, New Zealand has a splendid wheat yield per acre, about thirty bushels, in contrast to the ten or twelve bushels of southern Australia.

In the United States, also, the wheat regions are distributed according to the same conditions. Most of the western part (about thirty to forty-five per cent. of the whole) is too arid for cultivation, except when irrigated. The district of greatest aridity is in the Great Basin of Nevada and southeastern California, where rainfall is sometimes absent for a whole year and

FIG. 13.—The figures in the state show surplus or deficit of wheat production with regard to consumption, 1910–14. (Adapted from Finch and Baker.)

the average of two or three inches is the same as that of the greater part of the Sahara. Those parts of California having enough rain for wheat developed an important wheat crop in a few decades after settlement. The wheat crops of the Great Valley of California were world-famous for a time.

Going from the east toward the arid region we find the most important wheat-belt in America reaching from Texas north through Oklahoma, Kansas, Nebraska, the Dakotas, and Minnesota into Canada. The rainfall of this belt ranges from less than 20 inches at the north to 30 inches in Texas, where the evaporation is greater. A second belt is found as we emerge from the deserts of the Great Basin into regions of greater rain on the west, northwest, and north. On the north and northwest of these deserts of the Great Basin are the fine wheat areas of eastern Oregon and Washington. The Mediterranean conditions of the Pacific States give them, where they have enough rain, the best wheat-yielding climate in America. It should be pointed out that the highest priced wheat is from the spring wheat-belt.

In that part of the Mississippi Valley north of Nebraska, and in its continuation in the plains of western Canada, the winter is too cold for fall-sown (winter) wheat,* especially as there is no good snow cover; but a fortunate rainfall distribution that permits the planting of wheat in the spring. The rather light rainfall (fifteen to twenty inches) reaches the maximum in early summer or midsummer, and promotes the grassy growth of wheat. The wheat then ripens in the drier late summer. This distribution makes the plains in the center of North America one of the most promising granaries of the twentieth century. But the promise of great production in the next decades is due rather to great area than to perfection of climate. Parts of interior Washington have a better wheat climate than the spring wheat country, where the weather often makes the yield poor, despite good work by man. But this spring wheat country has many times the area of the Washington State belt.

The close relation of wheat growing to rainfall is shown in the region of the Great Plains, which lies between the winter rain

* No known variety of winter wheat can stand the severe, dry, and often snowless freezing of North Dakota, but such varieties may come.

Fig. 14.—This chart shows, for the United States east of the Rocky Mountains, the number of times in the twenty-year period, 1895 to 1914 inclusive, that precipitation to the amount of 0.25 inch in 24 hours did not occur for a period of thirty consecutive days or more, for the season March 1 to September 30, inclusive. Lines show the total number of drought periods for the twenty years. This remarkable map shows clearly why agriculture going westward across the United States was checked at about the 100th meridian in Kansas. The contrast in droughts between the eastern and western ends of that state explains why the east is good corn-belt and the western end a land for experimental dry farming and cattle ranches. (*National Weather and Crop Bulletin*, U. S. Dept. Agr.)

climate of the Columbia Basin and Pacific Coast, and the mid-summer rain type of the Red River Valley. Midway between these two there is a transition belt in which the maximum rain falls in spring and early summer, so that with the cool climate of the high plains, fall-sown wheat does better than spring-sown, because the rains of May and June and early July stop just in time for the wheat to ripen in July and early August. The milder winters are also a factor. Thus, while eastern Montana is in the spring wheat country, western Montana is in the winter wheat-belt, as is all the rest of the Great Plains southward to the Arkansas River, at which point recent tests with wheat have failed.

The very close dependence of wheat upon rain is shown by the yields on the experimental farm of the United States Department of Agriculture near Cheyenne, Wyoming, where at an elevation of 6,000 feet the crops and rainfall showed the following surprising relations:

	1913	1914	1915
Rainfall April-July	7.14	6.55	10.16
Winter wheat yield	9.3	7.8	37.6

Europe shows a climatic distribution of wheat-belts much like that of the United States. Near the Atlantic, where the rainfall is abundant as in Pennsylvania and France, winter wheat prevails. The counterpart of the North American spring wheat area is found in the drier interior which, like most continental interiors, has summer rain. The Eurasian spring wheat-belt begins in Rumania, and becomes very important just north of Odessa, whence it swings off in an unbroken stretch to the northeastward across the basins of the Volga and the upper Ural River to the Ural Mountains, and beyond them across Siberia, until wheat-growing possibilities end with the rough country of the mountains beyond Lake Baikal. This region has the winter of North Dakota—cold, windy, dry, with little snow. As North America has a winter wheat-belt south of the spring wheat-belt, so south-eastern Russia has a winter wheat-belt north of the Caucasus Mountains and due east of the Sea of Azov, reaching from that body of water to the Caspian Sea.

EFFECT OF THE GRADUAL REDUCTION PROCESS OF MILLING UPON WHEAT GROWING

Spring wheat is comparatively new in the world market. In America it had to await two mechanical developments: first, transportation to bring the produce of continental interiors to the sea; and second, the perfection of a process of milling that permitted the making of acceptable flour out of the unusually hard and brittle grain. The wheat crops of western Europe and of the eastern United States had always been sown in the fall and harvested at the beginning of summer. These varieties are starchy and soft. The spring-sown wheat of central North America, chiefly the Red Fyfe, is so hard and so brittle that the husk breaks into little particles, so that for many years the flour made from it had a mixture of brown bran particles, and was therefore dark in color. This flour was not wanted because of the American's quite irrational preference for white, very white, bread. So it was said that spring wheat made poor flour, and it therefore brought poor prices, and the lands upon which it was grown were in low esteem. The discovery of the gradual reduction process of milling with steel rollers made of this despised grain the most prized flour,* and gave to the northern country a great wheat boom which, in the last quarter of the nineteenth century, caused a migration of wheat growers, the shifting of wheat growing, and the rapid growth of population in Minnesota and the Dakotas and, in the first decade of the twentieth century, caused large gains in western Canada. This northwestern movement of people for purposes of wheat growing will doubtless continue for decades to come. After a century of westward movement, wheat growing, like the centers of human power, has started northward.

* The old-fashioned mills in which men had for ages ground their wheat, put the grain between two revolving stones and crushed it up. This splintered the hard husk of spring wheat. The roller process merely presses the grain between two steel rollers. A few particles of white flour fall out; the grain is then bolted and run through other rollers and again bolted. The process is repeated many times until finally the white flour has been completely separated from the torn, but unpulverized husk.

EFFECT OF MACHINERY IN WHEAT PRODUCTION

The methods of producing wheat have been made much cheaper and easier by mechanical inventions. Eighteenth century wheat was cut in the Scriptural way, by a sickle held by the laborer in one hand, while he grasped a few heads of wheat in the other. Then came the cradle, invented in New England in 1806. This is a kind of scythe (the scythe was invented at Lynn, Massachusetts, in 1655) provided with fingers to catch and throw into an even row the straw it cuts. The cradle was the main implement used in the United States through the first half of the nineteenth century. In 1851 Cyrus McCormick of Virginia made a reaper which cut and dropped the grain in bundles to be bound by hand. Then in rapid succession came the reapers that also tie the bundles, and finally the reapers that carry the bundles and drop them in piles where the shocks are to be made. One of these machines with three horses and a driver, has no difficulty in performing as much work as was done fifty years ago by from five to seven men working arduously with cradles, rakes, and hands. As wheat cutting is now merely the driving of horses and the adjusting of levers on the harvesting machine, the work is occasionally done by women. Bone-dry summers, such as occur in the Columbia River basin and the Great Valley of California, permit the combined harvester and thrasher to put into sacks each day the thoroughly dry grain of thirty or more acres of waving wheat fields.

Similar improvements have been made in thrashing, which is an equally important part of wheat production. Men are still living in the United States who in their youth helped thrash by driving horses around and around upon the sheaves that their hoofs might shatter out the grains upon the thrashing floor. A method similar to this, in which the horses drag a rolling stone around the thrashing floor, is still in use in Russia, Turkey, and other countries adjacent to the Black and Mediterranean seas.* A flail may still be found

* These floors are often unroofed, and by Turkish law the grain cannot be moved from them until the tax gatherer comes. Meanwhile birds, beasts, and weather injure the wheat. A bribe, if sufficiently large, may induce the tax gatherer to hurry. This instance is typical of the many ways in which the Turkish government or rather misgovernment limits industry.

FIG 15 —American thrasher at work Outfits of this general character can thrash one or two thousand bushels in a day, blow the straw off into great piles, and move themselves to the next farm after supper (International Harvester Co) hanging in many a New England barn. It may seem hard to believe, but the Arab on the desert's edge in Africa or western Asia still sometimes plucks his wheat or barley by hand and lets his women beat out the grain with a stick, preparatory to grinding it in a stone hand mill to make a precious and (in terms of human labor) very high-priced loaf. In more progressive regions, under the influence of high wages for labor,

FIG. 16.—Arabs in Tunis harvesting wheat by primitive methods preparatory to thrashing it under the feet of camels. The Bedouin is little influenced by our machine industry. His society is perhaps the oldest enduring society on earth.

the steam thrasher does nearly all the work. In the United States, it is common for one of these outfits to thrash a thousand bushels of wheat per day and be taken at evening to the next farm by the traction engine that runs the thrasher. These revolutionary improvements in wheat production have cheapened its labor cost from 133 minutes of human labor per bushel in 1830 to ten minutes in 1904.* Travelers recently returned from the interior of northern China report the natives to be growing and thrashing wheat by laborious hand methods that would have made the product cost $4 or $5 a bushel in the United States

* *Year Book*, Department of Agriculture, 1910.

in 1914. Sometimes they pull up the grain by hand and take it to the barn, cut off the roots to be rotted in compost heaps for fertilizer, and then thrash the grain by hand.

The cheapening that results from the easier production permits wheat to become more universally used as food. The machinery for planting, harvesting, and thrashing wheat has also been adopted, with minor changes, to do the same work for the other small grains—rye, oats, barley, and buckwheat.

In considering the use of machinery for making a cheaper wheat and bread, we should not overlook the transport services rendered by the efficient ocean steamer and the railroad. It is only by the improvement of the locomotive that such places as western Canada and Montana can be made effective in contributing to the world's supply of bread. Eighty years ago a locomotive weighed ten tons; fifty years ago it weighed forty tons; now in some instances it weighs 400 tons, and must come at least as close as thirty miles to the wheat field, for that thirty miles seems to be the practical limit for hauling by farmers' horses and wagons, even on the level prairies of western Canada. Beyond that distance from the railroad the prairie is still an unbroken turf, of value only to the pasturing animals which can carry themselves long distances to the railway stations. The influence of transportation on the bread supply is well shown in parts of Persia where, 300 miles from the capital, wheat sometimes sells for as low as $1.00 American gold for 650 pounds, and crops rot because there is no way of getting a surplus to market across the arid plain which surrounds some rich oasis. At the same time wheat in Teheran, the capital, may bring $10.00 for 650 pounds, a much greater difference in price than that between the price-setting market of London and the most remote railway station receiving wheat for the world's market. This farthest point happens to be in eastern Idaho. Remoteness is here measured by price, and price in turn is regulated by freight rates. Eastern Idaho is on a traffic divide. Freight rates are the same in each direction. The farmer there may ship his wheat by rail to a Pacific port, to a Gulf port, or to a Lake port, at any one of which ports it may slide into the hold of a steamer, the cheap carrier of peace times. In every direction from this central point in eastern Idaho the average price of wheat rises, being on the average fifteen cents per bushel higher in central Washington, and thirty cents higher at Chicago.*

FIG 17—Russian thrashing floor of type common in eastern Mediterranean countries. The grooved stone rolls after the horse and shatters the grain from the straw The man throws the straw out with a fork. The grain may be separated from the chaff by winnowing in the wind.

YIELD AND PRODUCTION OF WHEAT IN NEW COUNTRIES

The yield of wheat varies greatly in different parts of the world because of the combined influences of climate, knowledge, and farm economics. Farm economics, which is for America really a new science, has more influence than many people think. It is a peculiar fact that the world's greatest wheat exports come from regions that have comparatively low yield per acre, and that have not the ideal wheat climate. (See Table of Wheat Trade and Production, p. 42). For wheat is a good frontiersman's crop. With the aid of modern machinery and transportation wheat is a "money crop" (one readily turned into cash) easily grown on treeless frontiers of agriculture such as Kansas, Mani-

* See Bulletin 594, United States Department of Agriculture.

toba, and Argentina. It keeps well, is easily shipped, is in universal demand. It is of more value in proportion to its bulk than hay or any other grain save rice. It grows well in a greater variety of places than corn, oats, or rye. When it is safely sheltered near a railroad, it can be marketed many months later, many thousands of miles away. For decades it has regularly been carried from Puget Sound via Cape Horn and from South Australia via Cape of Good Hope to Liverpool, fully half-way round the globe. These advantages of wheat often make it the first and most profitable grain that can be grown by the new settler upon an open plain after the railroad is within reach, even though the average yield per acre be low.* Scanty population marks most of the world's wheat export regions—central North America, Columbia Basin, Argentina, Australia, southeast Russia. As the last half century has been an epoch of settlement and railroad building, the world's chief wheat exports for that period have come from such newly accessible plains: in the Mississippi, Missouri, and Red River valleys of the United States; in western Canada, Argentina, Australia, Russia, and Siberia. Owing to the fact that there is no rival cultivated crop, the settler on a new plain, if not a tender of flocks and herds, usually grows wheat year after year as long as the yield is at all profitable. Illinois and Iowa have passed through this exploitation or continuous cropping stage, which prevails at the present time on some of the more newly settled lands of central Kansas, Nebraska, Dakota, and Saskatchewan. The Red River Valley of the North, comprising the better part of the wheat districts of Minnesota, North Dakota, and Manitoba, like the black earth districts of southern Russia, is now experiencing decline in yield and is approaching the end of its continuous wheat production. With the possible exception of the Russian black earth belt there never was in the whole world an easier place to grow wheat than in the Red River country. This fertile plain, the bed of a glacial lake, often for miles literally as flat as a floor, without a stone or tree, lends itself perfectly to the use of the most complicated machinery and large-scale produc-

* The distribution of the world's wheat crop is a fine illustration of the fact that products are often grown in places that are not best suited to them. This unsuitability may not prevent the crop from being the best thing to grow on these lands.

tion. Year after year wheat has been grown until the declining yield and the rising prices of meat have made the farmers turn to other pursuits—the raising of horses, the keeping of cattle, the making of butter. The total yield from these districts does not decline because of the steadily increased area that is planted with wheat in the one-crop period and the improved yields that follow the introduction of crop rotation and livestock.

At the present time in western Canada, where new railroads have for two decades been building across open, empty, treeless plains, the new settlers are again beginning with continuous wheat growing which will last them one, two, or three decades before they too must take to other crops and to cattle keeping, as do their neighbors who have been longer on the land. In the meantime these wheat yields on the virgin prairie soil of Canada's harvest frontier are larger than those of the Red River Valley. It is possible that the Canadian region suitable for wheat growing reaches to 60° north, and extends from Lake Winnipeg to the Rockies. If experience proves this to be true, the wheat-growing possibilities are enormous, and the continuous cropping method will have land to support it for several decades longer.

The Italian farmers who went to Argentina at the rate of 100,000 per year before the Great War are having a similar experience upon the magnificent black soil plains that lie along the western banks of the Paraná River. The only difference is that they have to rent the land. The Russian peasant also exploits the land in the same way when he emigrates to central Siberia and settles on those endless plains called steppes where now the trans-Siberian railroad has made possible the export of grain. After a time these Siberians also must rotate crops, keep cattle, and export butter and eggs to London, as did their brethren in the older and more developed lands of Russia and western Siberia before the German blockade put a temporary end to this natural movement of food.

FIG. 18.—The states having substantial wheat surplus are surprisingly few, 1910–14.

WHEAT TRADE, COMPARISONS AND PROSPECTS

In addition to being important on the frontier, wheat is also important for several reasons in regions of established crop rotations and mixed farming. It affords an easy way to start pasture and hay fields because the young grass sown in the wheat can grow up as the wheat grows, the wheat serving as a nurse crop. Wheat fits well into the seasonal distribution of work. Among keepers of livestock the straw is valuable for bedding for the animals. Wheat thus becomes important in the systematic farming of Pennsylvania or England and also in the semi-garden agriculture of Belgium, where great care and labor make production large. Europe, with extensive spring wheat-growing areas in Russia and Rumania, and intensive winter wheat areas in western Europe, thus becomes by far the first wheat grower among the continents, producing more and also eating more in normal times than all the rest of the world combined.

EFFECT OF CHEAP WHEAT ON FARM VALUE IN OLD COUNTRIES

The new lands upon the plains of North America and other continents were recently opened for settlement by the construction of railroads, and often were actually given away. This giving away of land is still going on in western Canada. For the last decade before the Great War the Canadian Government actually begged people to come and take land for nothing; and the Canadian Minister of the Interior maintained offices in foreign countries, including one in New York State, to "sell" this free land. For years he has actually run paid advertisements in American farm papers urging the young men of America to come to western Canada and get 160 acres of rich and level prairie for the taking. It is true that the level prairie thus to be had for the taking is twenty to thirty miles back from the railroad, for the unused land near the railroad was already in the hands of speculators. This free land is bleak, windy, and often quite treeless, but it is fertile, arable, and fit to become the seat of empire. The same movement has of course been going on for three centuries on the western edge of settlement in the United States. It has progressed more rapidly since the frontier passed the forest belt and the railroads shot across the open prairies with the settler ever skirmishing ahead. The production of wheat is therefore a much cheaper process in these lands than in Europe, where rent or interest on land value is high. Wheat production, made easy by the new machinery, became so cheap, especially during the later years of the nineteenth century, that it was no longer profitable to grow wheat on much of the land in the eastern United States and western Europe, particularly Great Britain, where it had long been the mainstay as a money crop. Thus the United Kingdom, which had four million acres in wheat in 1869, planted less than half as much in 1910, and had reduced the area of wheat production to 11.5 per cent. of her total cultivated area. Animal products were cheapened by the same forces. Accordingly land values fell in both regions. Many farms were and still are abandoned in New England and New York and eastern Canada, while many thousands more throughout the North Atlantic slope even in 1914 would sell for less than they were worth before there was a mile of railroad in America. New York State produced twelve million bushels of wheat in 1839 and six million in 1909. England went through the same experience. Flocks of fine sheep and herds of fat cattle cropped rich grass in 1900 in fields that had waved green and gold with wheat in 1800 and in 1870.

CHAPTER II

WHEAT: TRADE, COMPARISONS AND PROSPECTS

COMPARISON OF CROP AND YIELD IN EUROPE AND AMERICA

AMERICA is such a heavy exporter of wheat that it is somewhat surprising to learn that Europe produces much more wheat to the acre and more wheat altogether than America or even the rest of the world, as the figures for 1911-13 clearly show.

	1911	1912	1913	Average	
Europe	1805.6	1931.3	2276.2	2004.3	mil. bu.
N. America	864.3	966.4	1005.1	945.2	
Entire world	3551.8	3791.9	4124.9	3822.8	

Europe and the United States do not differ greatly in size, but one has 105 million people and the other 420 million. In order

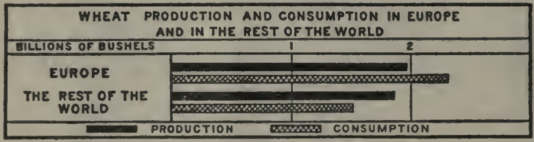

FIG. 19.—(Finch and Baker.)

to get enough to eat the Europeans must thoroughly till their land. While the wheat farmers on the cheap lands of Kansas, Argentina, or the Red River Valley of the North are by their hasty but inexpensive methods* getting less than twelve or fifteen bushels per acre, from land worth from $10 to $40 per

* Persons comparing the agriculture of the frontier with that of Europe often use the words "careless" and "careful." As a matter of fact, they are equally careful. The methods of England would bring loss in Saskatchewan or North Dakota. In these wide lands, the man rushes his tools over a large area, and by his un-thorough methods he actually gets the greatest yield per *man*, a greater yield per man than does the European with his more laborious methods and his larger yield per *acre*.

acre, the careful English farmer, with a systematic crop rotation, is averaging thirty or even more per acre on land worth $200 per acre. The English tenant farmer does not make proportionately large profits, because he has to pay high rent, and

FIG. 20.—The extent of Europe's wheat zone is one of the measures of her excellence as a continent for man. (Finch and Baker.)

because his higher yield requires expense for labor and fertilizer that are not profitable on the frontier.

EUROPEAN WHEAT GROWING

The hills and the rain of northern and western England, Scotland, and Wales, and the rains of Ireland, cause wheat growing to be of small importance in those parts of the United Kingdom. The rain that makes Ireland so emerald green is too much for wheat.

Eastern and southern England, protected by hills and distance from the rain-bearing westerly winds, are the chief British wheat districts. The rainfall is from twenty to twenty-five inches per year. With their suitable climate, level plains, and fertile soil these districts are about equal in output to any corresponding

WHEAT TRADE AND PRODUCTION

IMPORTING COUNTRIES

	Crop			*3 Yr. Aver.*			*Yield*		
	1911	1912	1913	Crop[1]	Import[1]	Yield[2]	1911	1912	1913
Belgium	15.7	15.3	15	15.3	74.5	39.	39.4	38.6	....
Denmark	4.5	3.6	4.5	4.2	7.5	35.8	44.7	26.9	....
France	315.1	336.2	321.6	324.3	54.7	20.3	19.8	21.	19.9
Germany	149.4	160.2	171.1	160.2	90.6	33.1	30.6	33.6	35.1
Italy	192.4	165.7	214.4	190.8	58.6	16.2	16.4	14.1	18.1
Japan	25.6	26.5	27.	26.3	3.	21.5	20.9	21.8	21.9
Netherlands	5.5	5.6	4.8	5.3	77.7	37.3	38.8	39.2	34.1
Switzerland	3.7	3.2	3.5	3.4	20.	13.7	13.7	....	....
United Kingdom	66.3	59.2	58.4	61.3	221.3	32.2	34.	30.	34.6
Average of Countries.						27.7			
New York	6.7	5.4	6.8	6.3		13.5	19.5	16.	20.

[1] Million bushels. [2] Bushels per acre.

WHEAT TRADE AND PRODUCTION

EXPORTING COUNTRIES

	Crop			*3 Yr. Aver.*			*Yield* { *Bu. Per acre*		
	1911	1912	1913	Crop	Export	Yield[1]	1911	1912	1913
Argentina	146.	166.2	198.4	170.2	100.9	10.5	10.3	9.7	11.6
Australia	98.1	74.	95.	89.	52.3	12.	13.3	9.9	12.9
British India	375.6	370.5	358.4	368.1	59.5	13.	12.3	14.6	12.1
Bulgaria	48.3	45.	45.	46.1	12.5	17.6	17.5	17.8	....
Canada	230.9	224.2	231.7	228.9	110.8	20.7	20.9	20.4	21.
Roumania	93.7	88.9	83.2	88.6	53.9	19.3	19.7	17.4	20.8
Russia	447.	623.8	962.6	677.8	127.3	10.	7.	10.3	12.9
United States	621.3	730.2	763.4	704.9	115.8	14.7	12.5	15.9	15.2
Average of Countries						14.7			
Kansas	51.03	92.3	86.98	76.77		13.	10.7	15.5	12.9

[1] Bushels per acre.

area of the United States. England (50,000 sq. mi.), with fifty-three million bushels in 1913, exceeded as a wheat grower any state east of the Mississippi River, and had a wheat area one-third larger than that of Missouri (68,000 sq. mi.). The superiority of England to Missouri as a wheat region is shown by the regularity of the yields in England and the lesser regularity, due to climatic causes, in Missouri. Thus, for three years, 1911 to 1913, England grew sixty, fifty-four, and fifty-three million bushels—14 per cent. variation. For the same years Missouri made thirty-six, twenty-three, and thirty-nine million bushels—69 per cent. variation.* France, with only one-sixth as much tillable land as the United States, had, before the war, a wheat crop double that of Germany and half that of the United States. French farms average about twenty acres each and those of the United States average one hundred and thirty-eight. Stimulated by a high tariff, the French farmers made their country more nearly independent in wheat than any other country of western Europe. The French wheat crop during the Great War well shows the influence of the struggle on European agriculture: 1914, 260 million bushels; 1915, 205 million bushels; 1916, 197 million bushels; 1917, 150 million bushels.

There has been great increase in the wheat yields of Europe since 1840. Belgium, with great manufactures and the densest population in Europe, had in 1914 an accompanying agriculture so productive that her wheat crop of thirteen million bushels was greater in proportion to her area than that of any of the leading American wheat states of Kansas, Minnesota, and North Dakota. Holland and western and southern Germany are also important wheat-growing regions in proportion to their area, and the crop is carefully tilled; yet the great manufacturing population of these northwestern countries of Europe consumes much more wheat than the fertile and well-tilled fields produce.

The European wheat grower, who gets twice the American yield on his high-priced home lands with their high rental, usually changes his methods if he migrates to the plains of the United States, Canada, or Argentina where land is cheap, and grows wheat there in the cheap way of the industrial frontier. The same process is repeated within the United States. Old states like Maine (with an average yield of 23.5 bushels for 1912 and 25.3 bushels for 1913) have, through good care and small acreage, a higher wheat yield than the rich plains states where North Dakota, a leading state, had a yield of 8 bushels per acre in 1911, 18 bushels in 1912, and 10.5 bushels in 1913.

* Before the war the United Kingdom imported more than two-thirds of her breadstuffs, but owing to the fear of submarine starvation she expected to raise five-sixths of the 1918 requirements.

In the Mediterranean countries of Spain, Portugal, Italy, and Greece, where the climate is so good for wheat, it is the chief grain. But the percentage of tillable land is small owing to the rough nature of the country, the yield is lower than in northern Europe, largely because of the inferior methods of less intelligent and less thrifty people, and the amount produced is not sufficient for the very dense population. Yet Italy, with 150 million bushels of wheat per year on 110,000 square miles of area, produces fifty per cent. more wheat per 1,000 square miles than any American state, and had thirty-eight per cent. of her crop land in wheat at the outbreak of the war. In Algeria this figure rose to forty-four per cent., and increased because of war demand.

EUROPEAN WHEAT EXPORTERS

Southeastern Europe is the only part of that continent having a normal wheat surplus for export. The grain-growing plains in Hungary and Rumania (Danube Valley) and the Black Sea Basin of Russia and Rumania, are given over to the growing of wheat as the chief money crop. During the four years, 1910-13, European Russia averaged 683 millions of bushels of wheat, while the United States had 687, but the Russian export averaged 153 million bushels, while that of the United States was only 109 million bushels. During that period Rumania exported more than one-half as much (57.8 million bushels) as the whole United States. Steamers by the hundred have for years loaded at the ports of Galatz, Braila, and Sulina on the lower Danube and at Odessa on the Black Sea and discharged their wheat cargoes at Piraeus, Palermo, and Naples; at Genoa for the people of northern Italy and Switzerland, at Marseilles for the people of France (in years of short crop in that country), at Barcelona for the Spaniards, or at Rotterdam or Hamburg for the factory workers of the lower Rhine Valley and Berlin. Britain also normally imports much wheat from Russia. To cut off the eastern European trade was one of the great blows Germany dealt the Allies, and to win it for herself by the collapse of Russia was one of her great hopes.

ASIATIC WHEAT GROWING

While wheat is grown from Smyrna at the west of Asia to Vladivostok at the east, only the plains of central Siberia and northwestern India are a factor in the export wheat supply. Large quantities are, however, grown for home use. The small populations clustered thickly upon the oases of Arabia, Persia, Turkestan, and other arid interior localities grow only limited quantities for their own use. In the north of China, also, great quantities are grown and consumed by the natives, but there are no crop statistics. An American consul reports (United States Consul Reports, February 23, 1911), as the result of observations during a journey through central and western China in 1910, that wheat is extensively grown there. He saw fine wheat fields in the Hoangho Basin that would yield over forty bushels to the acre. He thinks the region north of the Yangtse Kiang and west of the rice-growing plains near the coast, contains more wheat eaters than the United States. He estimated the crop of the two provinces of Shansi and Shensi at fifty million bushels.* New modern flour mills (owned by Chinese) are rapidly making Shanghai so great a center of exportation of flour to the Chinese coasts that the importation of American flour fell off heavily from 1907 to 1910. This change has gone steadily forward, aided by the war, until by 1917 American exports to Hong Kong, long an American flour user, had entirely stopped because of the new supply of Japanese flour made of wheat from the plain of Manchuria, where for the first time in centuries Japan had given the order and security that must precede prosperity and export.

India in bad years eats her crop and in good years has an export which equaled twenty per cent. of that of the United States during the years 1911-13. Indian wheat is chiefly grown in the dry Indus Valley and on the plateau near Bombay. Practically none is grown in the Ganges Delta or on the coasts of the Peninsula, which are low and moist.

There is little doubt that the great Siberian plain reaching

* F. H. King, in his very interesting book *Farmers of Forty Centuries*, p. 264, tells of seeing wheat in Shantung Province that yielded ninety-five bushels of wheat per acre under the extremely laborious care of the Chinese small farmer.

nearly all the way from Lake Baikal to the Urals, and closely resembling in its black flatness much of the Canadian wheat country, is the most promising future wheat exporter of the Old World. The Siberian crop goes out only through Russia, but there is good prospect of new routes by way of river steamers and the Arctic Ocean.

The Japanese wheat crop is equal to about one-tenth of her rice crop or to the wheat crop of Ohio. There is much interest over the discovery that there is room for the extension of wheat growing in the sparsely peopled north end of the Japanese Empire. Sakhalien, for example, long considered hopeless, is now thought to have winter wheat possibilities.

Manchuria is the only place in Asia outside of Siberia having large unused possibilities. An American agricultural expert in the employ of the Chinese Government estimates that the utilization of the now relatively empty wheat lands of Manchuria and eastern Mongolia should produce by native methods alone 300 or 400 million bushels a year. American flour disappeared from the Mukden market soon after the Japanese got possession, but there is no reason for Europe to expect to consume much or any of the prospective Manchurian wheat. The large and increasing population of eastern Asia, now importing some wheat, will probably take it all.

WHEAT-IMPORTING COUNTRIES

An examination of the table on wheat trade and production (see p. 42) will show that the chief wheat importers are the manufacturing peoples of west Europe, and that their chief supplies come from southeast Europe, central North America, Argentina, Australia, and India. International statistics do not reveal, what is likewise true, that the entire region east of the Appalachian Mountains in the United States, like the manufacturing countries on the other side of the Atlantic, draws large supplies of wheat from the agricultural hinterland. It happens that a shipload of wheat from Duluth to Buffalo is domestic (uncounted in official statistics) trade, and a shipload from the Danube to Amsterdam or to Barcelona is foreign trade. Europe and the United States are much alike in area and kinds of production, but differences in statistical records tend to hide the similarity.

SITUATION OF WHEAT-EXPORTING REGIONS COMPARED

The wheat exporters of southern Europe, on the Black Sea, share with the exporters of Argentina the advantage of cheap ocean transportation when the sea is free and the Bosphorus bottle neck is open. The wheat exporters of the United States and Canada grow their surplus for export in the heart of a continent a thousand miles or more from seaports. That this region nevertheless takes its place among export sources is due solely to the excellence of the transportation facilities for bringing wheat to ocean harbors whence it can be exported. In 1825 the Erie Canal connected the Hudson River with the Great Lakes and made possible boat transportation from the shores of the Great Lakes to New York at a fraction of the previous cost. This new route made possible the profitable export of wheat from western New York, northern Ohio, Michigan, and other lake-shore districts. Ohio ranked first among the wheat-growing states in 1839. Twenty-five years after the canal opened the lake shores to the world market, railroads began to reach from these inland seas out across the plains and from that time to this wheat has gone eastward to the sea by millions of bushels, being gathered together in the great markets, first at Chicago, and then at Milwaukee, St. Louis, Kansas City, Duluth, Port Arthur, and Winnipeg. But for the war a railroad already partly built would doubtless have been completed from the Canadian wheat country to Hudson Bay, where for a short time after wheat harvest steamers can get out with the Canadian wheat crop before the ice closes this great and at present unused arm of the sea.* Now, however, the whole movement of wheat east of the Rocky Mountains is to the Atlantic ports. Most of it passes over the Great Lakes, whence, as a result of railroad agreements of many years' standing, it is scattered to all ports between Montreal and Norfolk. Unification of railroad management should stop the scattering, so that all the wheat could be sent by the easiest routes.

* This plan is a duplicate of the Siberia-Arctic ocean plan.

This wide scattering of the grain carriage is due to railway rate wars and agreements rather than to natural advantage. The waterway of the Erie Canal, cheaper than any railroad, in a more rational future should carry a greater proportion of the total supply than it has carried in the past.

From Kansas southward, the Gulf is nearer than the Atlantic, and much wheat reaches the ocean steamer at New Orleans and Galveston. The wheat of the Columbia River Basin and some from western Montana is exported from Portland and the Puget Sound ports; and when the Great Valley of California had a wheat export, it went from San Francisco Bay. Some of our Pacific Coast export long went to the Orient, but most of it went and still goes to Europe by cheap water transportation, which has always been less expensive than an overland journey to an eastern port, as was proved by the costly attempt once made by the Southern Pacific Railroad to carry wheat to Galveston for export in competition with the sailing vessels that went "round the Horn." The Panama Canal, of course, gives a final advantage to the water route, save for the ship famine period of the Great War.

The Siberian wheat plains, drained to the frozen Arctic and shut off by high mountains and foreign lands from the southern sea, are in the worst situation of all wheat exporters. The Siberian crop must yet take the long rail journey to the Baltic or Black Sea unaided by any such gift of nature as the American Great Lakes or the Danube River. For this reason the Siberian plain has been the last of the world's great plains to be settled by the commercial agriculturist, although we know that it has for many centuries been the home of wandering tribesmen, since it was this great expanse that furnished the men who broke up the Roman Empire. Recent railroads have enabled Siberia to become a wheat exporter; but its crop, combined with that of the adjacent provinces of central Asia, amounted to only sixty-two million bushels in 1911 and ninety-six in 1912, while in the same years that of Minnesota amounted to forty-three and sixty-seven million; Kansas, fifty-one and ninety-two million; and North Dakota, seventy-three and one hundred and forty-three million. But Siberia has great area, fertile soil, and the fecund population of Russia from which to draw plenty of immigrants.

MANUFACTURE OF WHEAT PRODUCTS

The manufacture of wheat products has followed the line of wheat shipment. The waterfalls at Rochester and Niagara Falls, close to the Erie Canal, led to the early development of milling on a large scale; but the mills in these centers have long since been eclipsed by the great flour mills of Minneapolis, the greatest flour-exporting city in the world. Here the falls of St. Anthony on the Mississippi River give power for driving the machinery in a location very convenient for the assembling of the wheat from the northwestern fields of the United States and Canada. From these Minneapolis mills flour is sent to the cities of the northern and eastern United States and western Europe.

In various towns along the route of wheat shipment from the Missouri and upper Mississippi Valley to the sea have sprung up manufactures of prepared breakfast foods, an increasing form of cereal consumption. These, however, generally contain oats, barley, and corn, alone, or in combination with wheat.

The chief by-product of the American flour mills, bran, the outer covering of wheat, is used as stock food, especially for dairy cattle, in the same populous regions where the flour is bought. It is interesting to note that China has so few domestic animals that the flour mills of Shanghai are handicapped in the disposition of their by-products.

The bran trade was greatly reduced during the period of the Great War because so much bran has been eaten by men. Ordinarily in the making of the much prized very white wheat flour we kept about sixty-one per cent. of the grain for ourselves and sent thirty-nine per cent. off to the cattle in the form of hull and germ, called respectively bran and middlings. The food directors of various countries, however, have pushed this flour percentage up to seventy, and eighty, and even ninety per cent., thereby for the time being increasing our flour supply and reducing our bran supply.

WHEAT IN AMERICA AND FOREIGN TRADE

Wheat has been important in the foreign trade of the United States for two and a half centuries, although we imported some in 1837-38. As early as 1656 the traders of New York rejoiced over their shipments of flour and bread to the West Indies, where wheat could not be grown. A century ago, during the Napoleonic wars, American wheat helped to feed the European armies, and wheat export was a most important part of our foreign trade. Land values of American farms and the location of population depended partially upon the ability to get wheat to the sea by wagon or flat boat.* This circumstance gave great relative importance to such lands as the valleys of the Mohawk, Susquehanna, Delaware, and Potomac rivers, and even such branch streams as the Shenandoah (of the Potomac) and the Schuylkill (of the Delaware). The ideas of navigation in those days were little short of heroic. Farmers brought their wheat in flat boats down through rocks and rapids on streams which we now think of as being fit only for the black bass and the small rowboat of the fisherman. Thus the farmers on the headwaters of the Susquehanna in New York State brought their grain down to the schooners on Chesapeake Bay and the farmers of the Mohawk alternately boated their grain and hauled it around rapids and falls as did their brethren throughout the length and breadth of the wheat region of the Atlantic States.

Throughout the whole of the nineteenth century, save in a few bad years, wheat was the leading agricultural export of the Northern States. There is today, in addition to the heavy trade with Europe, a widely scattered trade in flour with the West Indies and other tropical countries, where some flour is used and little or no wheat is grown.

The future, however, probably promises to see the export of wheat from the United States decline in importance and in quantity. Exports of wheat declined first in favor of flour exports. But there is now in progress a conspicuous decline in the export of both wheat and flour, because increasing population leaves a smaller and smaller surplus for other lands. California furnishes an interesting example of this change. That state, once a great wheat exporter, reached her maximum wheat acreage in 1893. Since that time barley and alfalfa fields and fruit orchards have diminished the wheat area, until it is only one-

* See population map of 1800 and 1810, United States statistical atlas.

fourth as great as it was a generation ago. Thus it follows the example of New York and Illinois.

THE RECENT WHEAT SUPPLY

As the export of wheat from the United States declines, we are likely to see, during the first third of the twentieth century, the exports from Canada and Argentina increase, because of the large area of level plains in these countries, new to the plow, fertile, and sparsely populated—just the kind of place for wheat growing by the one-crop method, which produces large yields for a short time. Before the war the Argentine wheat exports of about one hundred million bushels a year nearly equaled the combined wheat and flour exports of the United States. In 1911 Argentina exports exceeded those of the United States. The proportion of the crop exported is significant. In 1881-90 the United States exported 27 per cent. of the crop; 1891-1900, 32 per cent.; 1901 to 1910, 18 per cent. In the year 1910 export had dropped to 10.9 per cent., while that of Argentina was 52 per cent. During the years 1911-13, the United States exported on the average 123 million bushels per year, or 17.2 per cent. of its crop, and Argentina 101 million bushels, or 59.4 per cent. of its crop. In 1910, when the United States exported 10.9 per cent. of the crop and Argentina exported 52 per cent., Canada sent out 28 per cent. Canada's rise is indicated by the yield of Saskatchewan—four million bushels in 1900, thirty-four million in 1908, 121 million in 1913, and 147 million bushels in 1916.

During the first two years of the war the United States accidentally and perhaps unfortunately was an important contributor to the world's wheat supply, but the next two years were different. In 1914 this country, having had wheat crops averaging 705,000,000 bushels in the three previous years, had the good luck to have a record crop—891,017,000 bushels. That crop furnished a surplus for Europe that season. Europe also had a fair crop. Then, by the same luck which enables a gambler occasionally to throw two double sixes in succession, the crop of 1915 again broke the record—1,011,505,000 bushels—and shipments to the Allies totaled 243,000,000. The 1916 harvest dropped back to rather below normal—640,000,000 bushels; 1917 brought

660,000,000 bushels—and the 1918 high price of wheat was the natural result in a war-torn world.

FUTURE WHEAT SUPPLY OF THE WORLD

After all, the crop of one country is not so important as the total supply, because if there is wheat on the surface of the earth it can go to any hungry country that has the price and access to the world market. What of the world supply?

In 1898 Sir William Crookes, a distinguished British chemist, wrote an alarmist paper prophesying an early world shortage of wheat. He was mistaken.* There is no shortage of wheat ahead of a peaceful world, certainly for the next fifty years. After that it depends entirely upon the rate of increase in population, for plainly if population increases in geometrical ratio there must come a time when any kind of food supply is manifestly impossible; but population does not so increase over large areas for long periods of time. Our present shortage is due to military, not to economic, causes. Wheat is piled up now in Australia and Argentina waiting to get to market.

Because of the uncertainty of future demand, *i.e.*, the prospect of abundance soon after peace comes, the United States Government felt it necessary to promise to pay $2.00 for wheat of the 1918 crop, even if the world price is below that figure, and $2.26 for the 1919 crop. This minimum guarantee is a sign of possible plenty rather than famine. Great future resources are yet unused. There are three ways by which we may get more wheat:

1. Discovery of new wheat areas.
2. Enlargement of existing areas through the planting of hardier varieties.

* Lord Rhondda, busy for two years rationing England, pinched by submarines, brought out a new edition of Crookes' book (1917) with this frightened statement:

"England and all civilized nations stand in deadly peril of not having enough to eat. As mouths multiply, food resources decline.

"The wheat-eating world is growing in population, while the wheat-producing acres are about all in use. What is needed is a thirty bushel to the acre crop in place of a thirteen bushel crop. Fertilizer, not more acres, is the hope."

Insular thought! He was thinking of the world in terms of England.

3. Increase of the yield through the use of more productive varieties, new methods, and more thorough culture, fuller utilization of land.

1. New Areas. In a sense one may say that there are no new wheat areas to be discovered, for we have made a beginning on all of the wheat-growing regions; but there are three regions of such great possibility of increase that they may almost be called new wheat regions. These are central North America, Argentina, and the region that we have long called the Russian Empire—Russia and Siberia.

a. The plains of western Canada, over which the wheat districts are steadily spreading, are a region of great but as yet undetermined possibilities. We do not know the wheat boundaries. Only years of trial and scientific experiment can establish the limits. But there seems to be little cause to modify Dr. Saunders's reasonable prophecy of 1904—that wheat grown on one-fourth of the land suitable to it in the Canadian Northwest, with the acre yield of Manitoba for the previous decade, would bring a crop of more than 800 million bushels, which, as he shows, would feed 30,000,000 people in Canada and three times supply the import need of Great Britain. The remaining three-fourths of the land would provide room for a vast animal industry with soil-enriching crop rotations.

It is quite possible that these figures are too small, for the boundaries of this region show interesting chances of enlargement. The northern boundary is set by cold and frost, the southwestern by increasing aridity, due to low rainfall and increasing evaporation with the greater heat of lower latitudes. Experiments in wheat culture, however, are steadily going on along the indefinite western boundary from northern Texas through western Kansas, Nebraska, the Dakotas, and western Manitoba, Saskatchewan, and Alberta; in fact, along the whole western edge of the winter wheat and spring wheat-belts of the United States and Canada—a full 1,800 miles. Perhaps in future decades we may find that the most of this region of the Great Plains down to, or even beyond, the Arkansas River may be counted on to yield wheat. The chances are in favor of the supposition. Suppose a gain of but one hundred miles for the wheat-belt—1,800 miles long. A yield of twelve bushels to the acre on nine-tenths of this every fourth year gives 420 million bushels, more than enough to feed the United Kingdom, and most of the land still left for other crops.

Most of the known wheat country of Canada is still uncropped. The Canadian wheat crop of 1916 covered less than 23,000 square miles, or just one-tenth the area of Manitoba. With present knowledge it is certain that the now recognized wheat-belt of central United States and western Canada is good for an increase of several hundred million bushels of wheat per year, perhaps a billion, possibly even more. It depends chiefly on the price.

b. The Siberian wheat region is the geographic double of North America, a long belt stretching in Canadian latitudes between a northern forest zone as in Canada, where the limit is cold, and a southern arid zone where the limit is drought, beginning north of the Caspian Sea and reaching to the mountains of Mongolia. The Siberian belt is even longer than the Canadian, and may possibly produce more wheat. At the present time there are not in all Siberia more than 5,000,000 white people. The region has, beyond any reasonable doubt, possibilities of an increase of hundreds of millions of bushels of wheat.

c. Argentina has not room for such a large increase, although it, too, promises to be a region of major importance.* It also has a long western drought boundary, and it is handicapped by hot winds and sometimes by late frosts. There is a considerable area of good wheat land east of the territory now growing wheat, but it is held in the large estates so common in Spanish lands, and the owners prefer the easier task of raising cattle and sheep.

As an evidence of possibilities, Uruguay, long a wheat importer, had an export surplus in 1918 due to war prices.

The exceedingly fertile lava soils of the Columbia Basin, Washington, Oregon, and Idaho, because of the limited area, rank in the second class of wheat regions of possible expansion. Manchuria is also in this class.

* A geographer thus describes the best section of Argentina: "Two hundred thousand square miles of fertile delta plain, one hundred to two hundred feet in elevation, with no streams in a day's journey. There are many little undulations with temporary lakelets in the hollows. Permanent water is sixty to seventy feet down, with tanks and windmills everywhere. Cattle have been paying seven per cent., wheat growing ten per cent., with shallow plowing and poor seed."

FIG. 21.—An experiment in plant breeding, cross-bred wheat showing great variation in offspring of hybrids.

ab, = parents..
a'a''a''' = offspring of ab-Cross.
c_1c_2, d_1d_2, e_1e_2 etc. = offspring of a'a''a'''.

AB=parents same variety as ab but crossed the other way.
A'A''A''' = hybrid offspring of AB-cross.
C_1C_2, D_1D_2, E_1E_2 etc. = offspring of hybrids A'A''A'''.

The hybrid offspring show every possible combination of the visible qualities of the parent stocks. By this means new varieties of great value in Washington and Minnesota have been produced. This method is applicable to thousands of species of plants, one of man's greatest tools.

2. ENLARGEMENT OF WHEAT AREAS THROUGH NEW VARIETIES OF SEED. There is every reason to expect increase in the yield on old areas through the raising of better varieties of wheat. We are just learning to apply Mendel's Law, the usable work-

ing law of heredity.* By its use plant varieties are almost like clay in the hand of the potter. We may expect to make over most of the crops grown by man, and even change so old a staple as wheat. This is not mere speculation. We have already begun, and progress in plant breeding should be very rapid from now on if science can turn its energies from destruction to construction. Recent work in the Northwest shows how this new-found ability is destined to enrich every land in the world and to increase the amount of bread for all mankind. On the lava plains of eastern Washington the practically rainless summer permits the farmers to let the wheat stand for a month after it is ripe. It gets so dry that it can be gathered by the most wonderful of all harvesting machinery, the combined harvester and thrasher, which, drawn by twenty or thirty horses or a big engine, swings around the broad acres and at intervals sets down a wagon load of sacked grain, absolutely ready for the miller. The harvesting can accordingly be extended over a period of several weeks, and a few hands can thus take care of vast farms. It so happened, however, that the best yielding variety permitted many of the grains to scatter out of each head and fall to the ground before it was cut. The rival variety that held its grain tightly was so tender as to be injured one year in three by the frosts, which follow periods of warmth and growth in this land of open winter, where wheat is usually sown in the fall. An experimenter at the agricultural experiment station in the State of Washington crossed these two varieties, and produced a third variety which has the frost-resisting qualities of one parent and the grain-holding qualities of the other, thus permitting a large extension of wheat growing on the wide, fertile lava plain of the Columbia Basin, where this splendid soil averages 50 per cent. more wheat per acre than the rest of the United States. Thus a new wheat land was made out of scanty pasture.

The introduction of foreign varieties has already been very effective in increasing the American harvest. The large production in the spring wheat-belt of the United States and Canada did not take place until after the introduction of the Red Fyfe,

* See Punnet, R. C.: *Mendelism.* New York (Wilshire Book Company), 1909. Also much current literature.

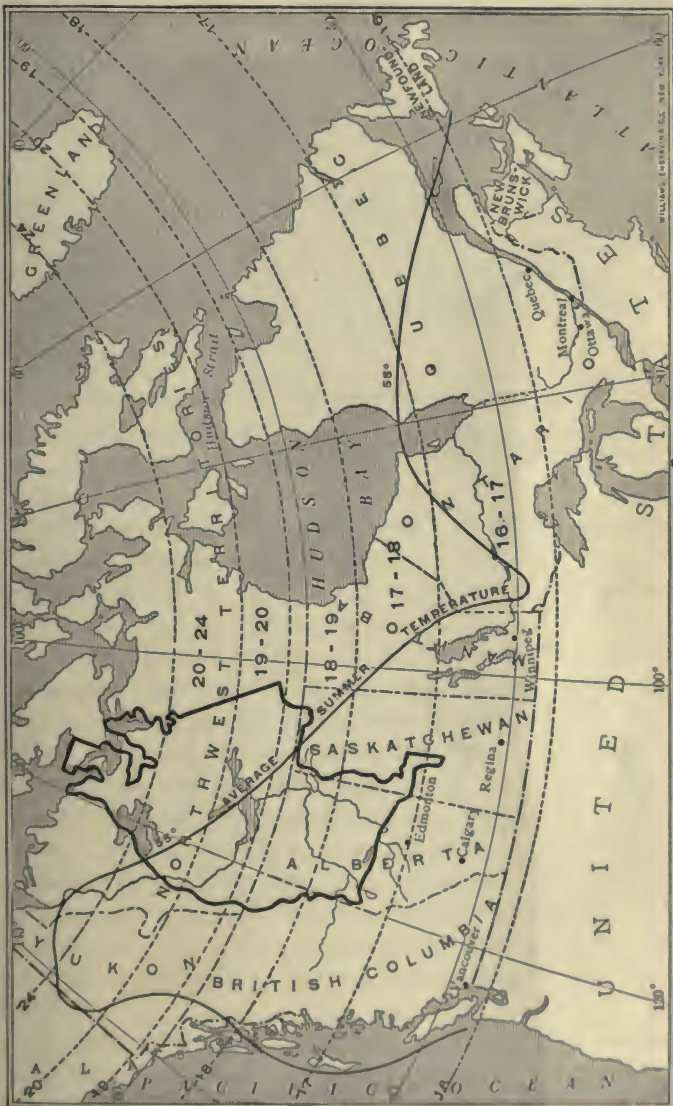

FIG. 22.—Map of Canada showing by dotted lines the number of hours' daily sunshine in June. A moderate summer temperature prevails in high latitudes because of the long days and short nights. The space enclosed in black line shows the areas of the Siberian province of Tobolsk in its proper latitude, which produced in 1907 nearly 12,000,000 bushels of wheat and has since increased the production. This shows what may be expected of Canada in the future.

a variety well suited to that climate. The recent introduction to the United States and Canada of a drought-resisting and rust-resisting variety of wheat known as Durum, from the arid lands of eastern Europe, has caused the farther extension of the spring wheat area into the drier lands. This variety of wheat contains much gluten and is thus very valuable for the

FIG. 23.—The location of the Canadian wheat area shows what a small proportion of that great country has yet been utilized.

manufacture of macaroni. More than fifty million bushels per year have been grown in the United States, and the acreage is increasing rapidly in the more arid sections of the spring-wheat belt.

Wheats of arid lands are of more value to man because of the higher content of nitrogen and protein, and the consequent greater value of the bread as a meat substitute.

The introduction of new varieties gives new *materials* for the plant breeders to use. Plant explorers are now scouring the corners of the world in search of plants particularly adapted to particular purposes and environments. These plants, specialized in one quality to the point of genius, can be used as parent plants by the plant breeders. Before long we may expect from this source other new varieties that will still further invade that ever shrinking enemy empire, "the Great American Desert."

3. INCREASE OF THE YIELD THROUGH THE USE OF MORE PRODUCTIVE VARIETIES, NEW METHODS, AND MORE THOROUGH CULTURE. The wheat grower can obtain more grain from a given piece of ground by better cultivation and fertilizing. If wheat should become relatively scarce, that is to say, stay at a price corresponding to the United States Government price of the

present time, $2.26 a bushel to the farmer, it would pay the farmer to put on more work and more fertilizer than it would pay him to use if the price were to be only $1.00, as it was before the war. It might pay him to make a yield of twenty or twenty-five bushels, where before it had not been profitable to make more than twelve or fifteen. There are enormous possibilities of increased wheat production if wheat should become relatively higher in price. If we now turned some money that goes for automobiles, phonographs, high-heeled shoes, and other luxuries toward flour it is difficult to predict the amount of wheat that might result. There are also very large possibilities of increase in yield at a very slight increase over pre-war prices, merely by the use of more intelligence and by the enactment of necessary legislation to promote rather than to interfere with large scale scientific use of the land. Thus the increasing price of meat products, which, for a time before the war, rose more rapidly than the price of wheat, made it desirable to keep more cattle; and it is true the world around that where farmers keep more cattle their farms tend to increase in fertility, and the grain crops to increase in yield.

Russia, with its low yield of ten bushels per acre, might easily average fifteen or eighteen bushels, with a slight increase of animal industry and a system of land ownership that would place a premium on good farming rather than on bad farming. The democracy in the life of the Russian village or mir, while it produced absolute equality of men with regard to the ownership of the land on which they lived, has also produced very poor crops, because no man owned a field. He owned a share in the village holdings. The shares were from year to year redistributed, so that there was no reason why a peasant should enrich his patch and hand the results of his labor over to his neighbor the next year. To make matters worse, in the attempt to get equality of land, each of the four or five types of soil that the village happened to own would be divided into as many pieces as there were farmers in the village, so that a farmer might have a field only eight feet wide with a dead furrow and no grain at the edge where it joined his neighbor's tract, which might also be but five or ten feet wide. If out of their revolutions the Russians establish order and individual land ownership, their yield of wheat will probably increase—if demand exists.

There are few countries indeed where social and legal improvement may not make substantial increase in food production including wheat.

The most important single element to increase the fertility of the soil and stimulate the growth of wheat is nitrogen, used by the plant in the form of nitrates of which we have in recent decades begun to import hundreds of thousands of tons from the natural beds of Chilean nitrate (nitrate of soda). Much more significant, however, is the manufacture of nitrates directly from the air, with the assistance of limestone and heat derived either from the electric arc or from coal. This product, commonly called cyanamide (containing nitrate of lime) is now being manufactured by the thousands of tons at Niagara Falls, and in Norway, Sweden, and many places on the continent of Europe. Germany even boasted that she was free from any need of the Chilean nitrate from which the British blockades had barred her. The late Lord Rhondda, British food administrator, said in 1917, "England and the United States are laggards in the fixation of atmospheric nitrogen. . . . The German farmer now produces much more food per acre than the British, though he has a poorer soil and climate."

Ammonia is also obtained from sulphate of ammonia made in the by-product coke oven, which distils many pounds of precious plant food for every ton of coke that passes though it. People in the United States are today mining and wasting by burning with their coal enough ammonia to fertilize far more wheat than they eat.

We must, however, be careful not to capitalize all these new substances too highly. Many writers point to England's thirty bushels of wheat per acre, as compared with America's fifteen bushels and Russia's ten, and say that the difference is all due to the slipshod work of the farmer. This is not true. England has one of the most dependable climates in the world. The great wheat regions of the United States and of Russia and of Argentina are subject to freaks of climate that cannot be overcome by the keeping of cattle or by the use of nitrate of soda, or sulphate of ammonia, or nitrates from the electric furnace, or new varieties from the desert's edge or the sub-arctic regions. Without water the grass of the field withereth, and wheat is grass. The figures previously mentioned (p. 28) show that the

FIG. 24.—Cultivating beans with traction engine, Sutter Basin, California Scenes of tractor plowing and harrowing are very common If it develops perfection in cultivation also, the limits of its usefulness will be enormously widened. (Courtesy *Country Gentleman.*)

experimental fields at Cheyenne yielded under similar culture in consecutive years nine bushels, seven bushels, and thirty-seven bushels respectively, because of a difference of three inches of rain (369 tons per acre) in the growing season. England with her system and her climate can maintain an average of thirty bushels per acre (her extremes have been 38.75 in 1863 and 15.5 in 1879), but there is no reason to expect a thirty-bushel average in a developed Dakota, or a developed Canada, or a developed Siberia. Nature shuffles her cards roughly in these regions. There will be fine crops and there will be failures that are beyond the power of man to remedy, so that

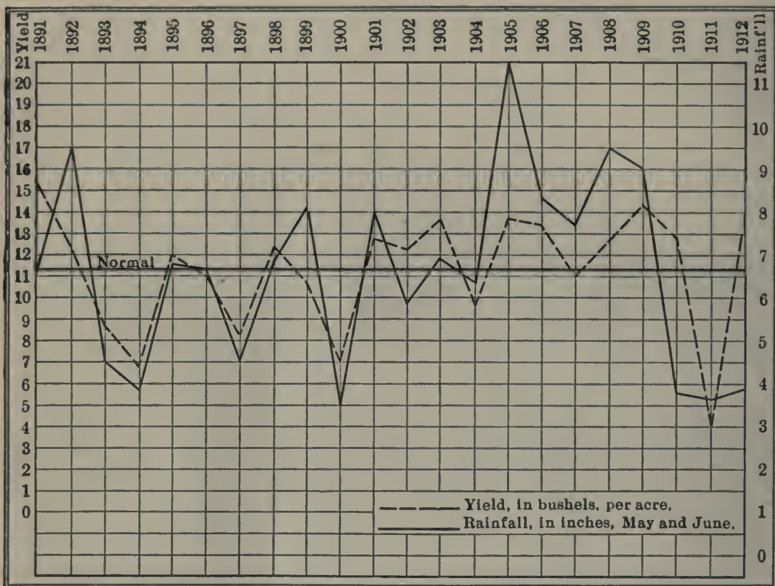

FIG. 25.—Relation between rainfall and wheat yield in South Dakota. They do not always agree because of the heat factor. (T. A. Blair, *Monthly Weather Review.*) See Fig. 8.

seventeen to twenty-two-bushel averages are perhaps our highest reasonable hope.

There has, however, come on the scene a new factor, whose possible power to make wheat is almost as little foreseen today as was the influence of the locomotive in 1840. It is the farm tractor, a machine still in rapid process of technical development. We have made great strides in the cheap production of wheat by getting tools that depend on the muscle of our strong beasts rather than on the muscle of our weak selves. The iron horse, hitched to the wagon and the boat, has made a new world. The iron horse (tractor) hitched to the plow is going to work another transformation, particularly in the world of wheat. It has just begun. The wheat crop of the world is today dependent, with a few exceptions, upon the muscle of beasts. The Italians are even still cutting much wheat by hand on their terraces and little odd-shaped patches on their steep and rocky mountain slopes. But most of the land for the world's crops is plowed by the horse, the mule, the ox, and the Indian buffalo, which also draw the seeding drill and the reaper. There are enough camels helping to make the list picturesque. At the most, these farm animals may be needed for only six or eight weeks of work in producing the grain crop; but they must eat for twelve months. If there is a crop failure every third year they must eat for eighteen months in order to make two crops; and if there is a failure every other year, they must eat twenty-four months in order to make two crops.* Despite their months of necessary loafing they get tired when they work, and must rest. They get hot, they get sick, they go lame. The farm tractor does not get tired, it does not eat when it is not working. It can go night and day, and in the rush season a man who has had a long period of rest can work fifteen or sixteen hours a day for many days, and then some one else can take his tractor and, with our present knowledge of lighting, keep it going throughout the night. One man, instead of driving three or four or even ten horses, turns on the power of twenty, or forty, or sixty horses that may work twenty-four hours a day. The acreage of level plain that a family can plant with this new help may be several times as large as that within the reach of man aided merely by beasts. It is already claimed that in level portions of Dakota a man, with the help of his wife and one child, can plant 120 acres.

After purchasing their tractors, 9 of the 14 Kittson County farmers stated they farmed an average of 183 acres more per farm with the

* "Our records show that the use of the tractor has increased the amount of land handled per person. Records from 149 farms in Minnesota show that 44 of these farms increased their farm area on an average 105 acres and at the same time farmed this increased amount with two horses less. Records from a 322-acre farm using 4-bottom plows show that before the tractor was used nine horses were kept and afterwards eight. Records from very large farms of 1,074 acres show the use of 21 horses before a tractor was used and 12 afterwards."—Extract from letter from L. B. Bassett, Assistant Professor of Farm Management, University of Minnesota, February 26, 1919.

To a considerable extent horse food may also be man food.

same amount of help. This made an average increase of 67 acres per man. Since small grain is the principal source of income in this county, this could more easily be done than in regions where corn is an important crop. Nearly all of the co-operators said they were able to save in hired help.—University of Minnesota, Agricultural Extension Div. Special Bulletin No. 31, page 5.

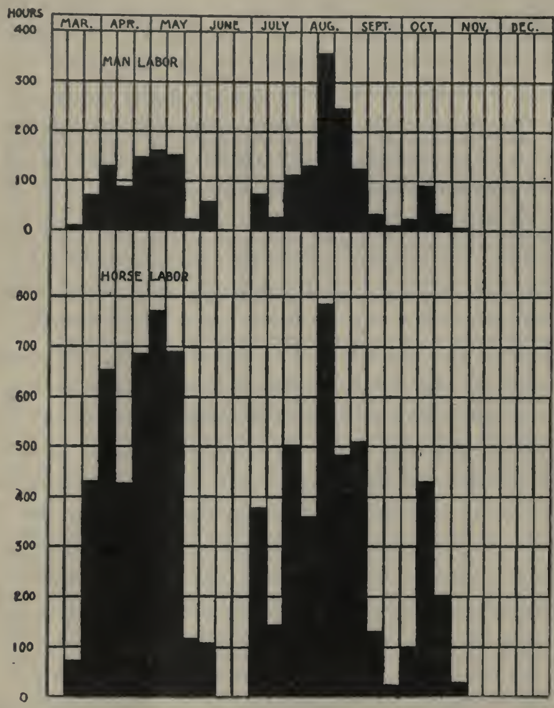

FIG. 26.—Distribution of labor on a Dakota grain farm. One of the great needs of the farms growing small grains only is something to equalize the work. The importance of winter dairying is made evident by this chart, as is also the advantage of the tractor. (U. S. Dept. Agr., *Year Book*, 1911.)

This enlarged acreage means reduction in the cost of wheat growing. It means that wheat, since it can be produced more cheaply, can be grown in lands that we before thought worthless because of the uncertainties of rainfall. Take again the case of Cheyenne, which in three seasons produced respectively 9.3, 7.8, and 37.6 bushels. The average was 18.2. Four of the low crops and one of the high would still average 14.3, a figure that looks well among national averages, made possible by one good season in five. Such farming would scarcely be profitable with the aid of beasts, but it is easily practicable with the aid of the tractor.

In lands of low rainfall it has been well proved that the wheat yield can be increased in quantity and certainty by the practice of summer fallowing, which means plowing the land one year and raising the crop the next. By this means no plant is allowed to grow during the fallow season and much of the water that would otherwise evaporate through the growing plants (a surprising amount) remains in the subsoil, where it welcomes the next year's rainfall and combines with it to water one good crop out of the two years' supply. The trouble with this system in the work-beast era is that it requires much cultivation. It is easy to see how the tractor helps at summer fallowing and so will push the wheat fields out into the lands of little rain and of frost. The tractor will enable wheat growing to become a dependable business in climates where frost or drought may almost spoil two crops out of three, if one bumper crop gets to the thrashing machine; farms, towns, and food supply may then be found in places where now the farmer gives up in despair.

There is no way as yet to reduce to figures what the tractor may do for us, but it probably will enable seven great wheat-belts running through five continents to be widened out—toward the region of drought and frost through central Asia and central North America, and toward the region of drought through Argentina, Australia, and South Africa.

WHEAT IN THE UNITED STATES, 1839-1909 [1]

Year	Production Total (bushels)	Per cent of all cereals	Per capita (bushels)
1839	84,823,272	13.7	5.0
1849	100,486,944	11.5	4.3
1859	173,104,924	13.9	5.5
1869	287,745,626	20.7	7.5
1879	459,483,137	17.0	9.2
1889	468,373,968	13.3	7.4
1899	658,543,252	14.9	8.7
1909	683,379,259	15.1	7.4

[1] Census statistics not available for years prior to 1839.[*]

[*] From *Geography of the World's Agriculture*, p. 14.

This possibility of development means that we are in the beginning of another century of spring wheat which has in the last sixty years made wheat more abundant in the commercial world.

Taken altogether, the undeveloped lands of the present wheat regions, the possible regions of the new wheat growing, the new varieties, the new fertilizers, the new knowledge, and the farm tractor, seem to promise that a wheat supply is within our reach for many, many decades if we can but devote our powers to the conquest of nature rather than to the destruction of man.

CHAPTER III

MINOR CEREALS OF THE TEMPERATE ZONE

ORTHODOXY IN DIET AND THE BREAD SUPPLY

BREAD is the staff of life, but must it be of wheat? There are many other grains, but amazing is the orthodoxy of diet.

"I'd ruther eat what I'd ruther," said the slum woman. Thus she ended the efforts of the intelligent friend who was trying to improve the condition of a family suffering from malnutrition. Here is one of the great, perhaps the greatest, of limiting factors in the world's food supply—*i.e.*, unreasoning preference, a senseless conservatism that, having heard the teachings of science, will not try or even stop to consider new foods which involve the changing of dietary habits. Because some common foods do not agree with some persons, it was long ago said that "One man's meat is another man's poison," and it may equally be said that "One nation's food is another nation's amazement." It is hard for the Virginian, eating good corn pone, to understand why nations refuse to eat a cereal produced by the thousands of millions of bushels, a staple food for hundreds of millions of people—a staple food for thousands of years. Yet even the hungry Belgians at times refused it, and English and Irish people short of food would eat anything else before they would touch it, simply because they had grown up with the notion that corn is hog and chicken food.

Emerson's correspondence with Carlyle on the use of corn meal shows how hard it is to introduce new foods.

Style, that habit of doing what others do, particularly what those whom we consider superior, do, is one of the strong forces that helps to limit man's food supply in certain directions, though sometimes it makes him enlarge his food supply by eating the most surprising things.

How did seaweeds and candied grasshoppers come into use in Japan, and fried rhinoceros hide in Africa, and powdered deer horns in China, and pickled pigs' feet in Germany, and mouldy cheese with skippers in it in England, and snails and frogs' legs in France, and grasshoppers, fried and reduced to a meal, in Arabia, and snakes and lizards among the North American Indians, and octopus among the Neapolitans, and wood-grubs among the New Zealand Maoris, and larks' tongues and eels fed on the flesh of slaves in Rome, and caviar, the eggs of the Volga sturgeon, among the Russians, and rats and mice and dogs and cats among the Chinese, and human flesh among the Fiji Islanders? Is it reasonable to suppose that these customs were acquired in some mysterious evolutionary way? Is it not highly probable that these foods came into vogue just as we know coffee and tea and the potato and tobacco and chocolate have come to be fashionable today in European and American countries, through the encouragement given by those who set the fashions of the day? *

The vogue of the potato is an example of the successful introduction and rapid spread of a new food no better than many others, but having the great help of proper patronage.

Sir Walter Raleigh is given credit for its introduction into Ireland. The friars of Spain took it to Italy. There are records of the governor of Mons having received it from the papal legate of Belgium. When we remember the rank of Raleigh and the standing of the Catholic Church, it is easy to understand how potato eating became fashionable in Ireland—came to be the great food crop of that island. It was, in my opinion, the fashion for it which started its cultivation.†

When we think of the almost indefinite variety of plants that are already eaten by man somewhere, and the yet greater variety that certainly contain elements of nutrition, it is an astounding pity that man should be so bound by unreason that he actually displays less sense than a cat.

There are conclusive proofs, for example, that cats and rabbits wandering through our gardens taste of the new plants which are put there. The cats of Boston learned in less than two years from the time of its introduction into America that a wild vine from central China was good to eat, and ate it to the ground. The wild rabbits of western Canada singled out, nibbled, and killed a new species of ash from Turkestan the first year it was grown in a nursery on the prairie.‡

* Fairchild, David: "The Palate of Civilized Man and Its Influence on Agriculture," *Journal of Franklin Institute,* March, 1918, p. 311.

† Fairchild, David: *Op. cit.*

‡ Fairchild, David: *Op. cit.*

Now that we have begun to study the sciences of nutrition and of economic botany, and have made a feeble beginning at the teaching of nutrition and cookery in the schools, we may hope for better progress toward the time when man looks at his food supply as a scientific question. When he does, the world will be twice as big as it is now, as a home for man, for it will have twice its present food possibilities.

Our American children of the next generation should be more untrammeled than we have been in their diet, and able at any time to shift from one food product to another as the price or shortage dictates. They should have a mobility of action which will enable them to go anywhere and eat anything fit to eat, and test out and eliminate or keep, as the case may be, any new foods which the investigations and experiments of plant introduction and plant breeding and the growing genius of food chemistry will surely bring into existence. . . .

We have a curious spectacle in our common schools—thousands of little children poring over books on the volcanoes of the world which they will never see, the North Pole, which they can never expect to visit, and, when the noon hour comes, satisfying their hunger from their dinner pails with no word from the teacher regarding perhaps the most acute sense they have—the sense of taste.

Taste is the avenue of our contact with the world of chemical things. It is, after all, one of our five senses. Is it not worthy of all the study which can be given to it, and should not the education of the human palate become a matter of great importance and every effort be made to teach the value of a wide liking for everything that is good to eat? Let us not be misled by those who scoff at the problem. Scoffing is a trait unworthy of intelligent man. Think of the conservatories of music where the sense of hearing of thousands of our youth is trained, and the academies of art where the sense of sight is cultivated, and then compare these with the schools of Domestic Economy and see what a gulf there is between them. How far we must yet go to put the cultivation of the American palate where it really belongs! *

In that day we will laugh at the panic of Sir William Crookes, the English scientist of 1898, for we will have discovered that the danger of his threatened wheat shortage is removed into the indefinite future, because we can make bread from many other things. These other bread materials may be classified in five great groups: the minor cereals of the temperate zone, discussed in this chapter; corn; rice; starchy roots, and nuts and acorns—discussed in the following chapters.

* Fairchild, David: *Op. cit.*

RESEMBLANCE OF THE MINOR CEREALS TO WHEAT

Of the minor cereals, three, barley, rye, and oats, are grasses like wheat and greatly resemble it in most of their agricultural qualities, as well as in actual food value. They differ, however, from wheat in various minor ways, which give them a different place in farming and a somewhat different distribution over the earth's surface.

1. Rye. Botanically, this plant is so closely allied to wheat that it is often hard to tell one plant from the other. Rye will grow where wheat grows and also in other places. But the grain is smaller, a little less nutritious, less highly esteemed, and hence less valuable. It rarely outyields wheat. It is, therefore, almost entirely absent from all the important wheat lands of the world, and is primarily the grain of poor lands and the food of poorer peoples. The straw is longer than wheat straw; because of its value as packing material the rye grower is sometimes able to sell it for a good price, but this advantage is relatively unimportant. That rye is grown, nevertheless, is due to the fact that it will grow in many soils and climates where wheat will not grow so well, if at all. Compared with wheat it is a kind of goat in its ability to live under harsh conditions. It is much hardier and will grow in colder and more exposed places. For this reason there is a huge rye-belt in south-central Russia, occupying the northern edge of the great black soil belt, of which wheat holds the southern part. It is also the only grain that can live over winter in parts of South Dakota. Rye will sprout more quickly than wheat and in colder weather. It will sprout and grow at a temperature of but a few degrees above freezing, when wheat will be practically at a standstill. This hardihood permits the farmer in northern lands to plant it late in the autumn, when it would be impossible to grow wheat, and also allows him to extend the season of work for man, teams, and tools. It has great value as another crop and therefore really another job for the spring wheat farmer. Late planting and the ability to stand a cold winter made rye a more profitable grain than wheat during the five-year period of 1910-14 in Minnesota, North Dakota, and South Dakota. The amount grown is increasing in these states. It is also attacked by fewer insects and diseases than wheat, and

usually is ripe before rust, the great enemy of wheat, becomes severe. For these reasons rye was a better crop than wheat in 1910-14 in South Carolina, Alabama, and Texas, although the amount grown in those states was very small indeed.

Rye will also grow in sourer (more acid) soils than wheat can endure. To grow wheat it would be necessary to put on lime to neutralize the acid and sweeten the soil. In the region of northern Pennsylvania and southern New York, where prevail the so-called Volusia soils, which are naturally acid, rye has become the leading winter grain. Rye requires only four-fifths as much nitrogen as wheat per pound of yield (it also has less nitrogen in it) and therefore grows on poorer lands and with less artificial fertilizer than must be used for wheat. Finally, on sandy soil rye grows better than wheat. This explains a very large region of rye production in Poland and eastern Prussia, in exactly the same latitude as the great wheat region of central Germany. Again in sandy Holland and Belgium rye comes to the front as the chief grain, while northern France with the clayey soils, in which the feet of so many millions of soldiers have stuck, is a wheat country. Sandy soil helps to explain each of the large rye districts (see map, p. 73) of western Michigan, Wisconsin, and southeastern Minnesota.

Rye has one more agricultural virtue. Not only will it stand the cool autumn, the cold winter, the wet, the sandy and poor soils, but it will also grow in rough, ill-prepared land in hilly country. Thus it tends to become the grain of mountain peoples, and is grown to some extent in the hilly country of south-central Pennsylvania and western North Carolina, and on each of the three high hill regions of the western European mainland: namely, northwestern Spain, Brittany, and the plateaus of southwestern France, where there is a considerable area with a surprisingly cool climate. Rye would doubtless be grown also in the non-wheat growing parts of Britain but for the British prejudice against rye products. Barley and oats have the ground instead.

It is not unnatural that rye, with these qualities, has long been called the grain of poverty.

As a breadstuff it is almost the peer of wheat in nutrition, except for some shortage of protein. It does not, however, have as much gluten; that is to say, it does not make as spongy a dough or as light a bread, so that the rye loaf is more solid, lacking the big pores found in wheat bread. The bread is also much darker in color. For these reasons rye sells at a lower price than wheat; and, while most of it is used as a breadstuff, it is primarily used by people with a low purchasing power and consequent low standard of living. Where the land is poor

FIG. 27.—Compare this map with the map of European wheat growing (Fig 20) and note slight difference in location. (Finch and Baker.)

and weather cold, the people are also usually poor; the cheap rye is the breadstuff of the masses. For example, in central, northern, and northeastern Europe rye is the chief breadstuff of the poorer people, as Indian corn, the cheap grain of the warm land, is in parts of southern Europe and Mexico. The normal world production of rye is about half that of wheat, from 1,500 to 1,800 million bushels.

REGIONS OF RYE PRODUCTION

Fully nineteen-twentieths of the world's rye is grown and eaten in Europe. We are too rich for it yet in America, although we have increased its production remarkably (on a percentage basis) during the war. The crop of 1917 was sixty million bushels; that of 1913, forty-one million; that of 1909, twenty-nine million. The world's greatest rye production is on the low plain of northern Europe, reaching from the English Channel through Holland, Belgium, Germany, Denmark, and Russia to the Ural Mountains. The soil is in many places sandy and poor; and the climate is cool or cold and often damp and

Fig. 28.—(Finch and Baker.)

foggy. Here, as in Norway and Sweden, rye grows better than wheat, and exceeds it in production. Although Russia is the world's greatest wheat grower, she grows more rye than wheat. Her large export of wheat is due to the fact that the people eat the rye. Russia alone produces more than half of the world's rye crop, in normal times, and the average yield is twelve bushels per acre, while that of wheat is ten. Germany produces more than a fourth of the world's supply, Austria-Hungary more than a tenth, and the United States, with its thirty to forty million bushels, less than a fiftieth. Austria-Hungary grows four times as much rye as does the United States; Germany ten times, and Russia twenty-five times as much. In peace times Germany grew three times as much rye as wheat. The peasants and factory workers of rye-growing countries eat the most of the rye in the form of black bread, which, after all, is nearly as nourishing as wheat bread. But these people frequently substitute the superior and more highly esteemed wheat bread for rye bread when they become able to buy wheat.

Two-thirds of the rye grown in the United States in normal times is used to feed farm animals, and part of the remaining one-third is used to make alcohol. Rye bread is seldom used in this country except by people who acquired the habit in Europe. It is said that the German emperor, William II, used occasionally

FIG. 29.—This shows why Russia and Germany, and to a lesser extent Austria-Hungary, have long been known as lands of black rye bread. (Finch and Baker.)

to trade the white bread of the palace kitchens for the black rye bread of a peasant boy.

As it grows with little care and on rough ground, rye was relatively more important in the earlier days in the United States, before the settlement of the level West, than it now is. The census of 1839 shows the per capita production to be three times that of 1909. Rye mixed with corn meal was an important breadstuff in New England before western New York began to ship wheat to the East. The chief centers of production in the United States are the Appalachian region, from the Potomac and the Ohio to Lake Champlain, and the sandy districts between Minneapolis and Detroit. As the conditions of eastern Canada resemble those of the eastern United States, rye is grown to a similar extent there.

In Nebraska the rye acreage has jumped from 60,000 in 1909 to over 200,000 in 1915, chiefly because part of this state lies between the regions where June is cool enough for good spring wheat and those where the winter is suitable for good winter wheat. This helps to explain the loss of eighty-three per cent. of the winter wheat sown in that state in 1917, and the rapid increase in the amount of rye, which throughout the world is almost exclusively sown in the fall like winter wheat.

In respect to crop rotations and farm practice, rye, oats, and barley are similar to wheat. If the Anglo-Saxon world becomes just a little bit hungry for wheat bread it will, of course, discover that the rye we now feed to the pigs and the cows is good breadstuff. Witness the American experience of 1918:

"All bread used at West Point Academy is composed of 45 per cent. wheat flour, 45 per cent. rye flour, and 10 per cent. white bolted corn flour. This bread is entirely satisfactory and many students consider it superior to the former product composed entirely of wheat flour." * If breadstuffs become scarce, we shall also find that rye production can in all probability be greatly extended, though not so far as wheat, for rye does not have great ability to withstand drought. Its superior ability to survive cold, however, may give us on the northern edge of the world's spring wheat-belts great spring rye-belts through northwestern Canada and north-central Siberia. It should be noted, however, that this possibility is not now indicated by any extensive spring rye industry, although a little spring rye is grown in a number of places.

2. Oats. The Scotch, probably because their moist climate gives them an oat country, have most largely utilized the oat as human food. Dr. Johnson's dictionary is said to have defined oats as "food for men in Scotland, horses in England," to which the Scotch replied, "And England is noted for the excellence of her horses, Scotland for the excellence of her men." The people of other countries, since forming the breakfast food habit, are learning to eat more oatmeal. A little oaten bread is used in parts of northern Europe, but the main use in all countries is for horse food. In the United States at the present time the consumption for human food is about three and one-fourth pounds per capita, less than one-thirtieth of the crop. In parts of Scotland the agricultural laborer lives very largely on oat products and milk, while the dairy cattle that produce the milk live very largely on oat straw and turnips.

As horse food, the crop seems to be without peer in giving spirit and energy, so that people say of a frisky horse, "He is feeling his oats." As human food, analysis shows that it is

* Official Bulletin of the Food Administration, February 28, 1918.

very high in protein, giving some basis for the Scotch faith in it and an explanation of its fitness, when taken in combination with milk, to nourish the Scottish workman.

The experience of antarctic explorers with oatmeal compressed in two-pound cans shows it to have wonderful durability, and points to its excellence not only for transportation and storing, but for hoarding against a time of need.

Fig. 30.—The wide distribution of this important forage grain again attests the excellence of Europe for agriculture when compared with the United States, which in Fig. 31 and in all other charts shows such light production in the western half of the country. (Finch and Baker.)

The soil requirements of the oat plant are not unlike those of wheat, but it can grow in a greater variety of soils and is not so exactingly fond of limestone soils. In its climatic requirements it differs from wheat in being unable to stand as much drought; but it is able to stand more rain, because it can fertilize its blossoms in weather rainy enough to make the wheat plant barren. The oat blossom and later the oat grain hang like fruit, stem up, wrapped in a protecting envelope, which lets the fertilizing processes of the blossom go on through rain as they cannot in the wheat, which holds its head erect. The oat can stand nearly as much heat as wheat, but being nearly always spring sown it has a later growing season and requires more rain than winter wheat. In regions having mild winters like southwestern France and southern United States, it is grown to some extent as a winter grain, and harvested before wheat, but its growth in this way is not extensive. Its moisture requirements bar it from regions having the Mediterranean type of climate (Spain, California, Australia), with their hot, dry summers, but it is grown in California as a hay crop, for which purpose it makes sufficient growth before the drought stops the growth of the plant.

The fact that the oat requires a shorter growing season than wheat makes it a competitor of spring wheat, and enables it to grow further north than spring wheat. It thus becomes important on the northern edge of the wheat-belt in Manitoba, Saskatchewan, and Alberta. It grows almost up to the Arctic Circle in Sweden and Finland, and is of great relative importance in Denmark, Germany, and Russia, in all of which regions it grows on the northern edge of the wheat-belt. Its ability to thrive on sand is shown by its heavy growth on the Baltic shores of Germany and Denmark. Because of these qualities, it is grown to some extent in very nearly all the important northern wheat regions and also in rye and northern barley regions. It is of the greatest relative importance in such cool, damp countries as Ireland, Scotland, Sweden, Norway, Holland, Belgium, and Denmark, and is grown to a great extent also by the people of the central and eastern European rye-belt. In Sweden it takes up thirty-three per cent. of the crop land, and in England twenty-four per cent. It is also important in the eastern half of Canada, where the climate is too cold for corn. In the colder northern parts of Korea and Japan, where rice does not thrive and wheat is not at its best, the farmer resorts to oats and barley, but feeds oats only to cattle.

GROWN ON THE SAME FARM AS INDIAN CORN

Because oats may be sown in the spring and will stand the hot summer if the rainfall is abundant, it is a very important grain in parts of the corn-belt of the United States. In much of this territory the summer is not fully suited to spring-sown wheat, and the alternate freezing and thawing of the open winter often injures winter wheat. Oats, being unhurt by a little frost, are well adapted to these climatic and agricultural conditions. Sown very early in the spring before it is warm enough to plant corn, the crop requires no attention until harvest time, after the corn has been planted and received all the cultivation

FIG 31 — (Finch and Baker.)

that is considered necessary. Then while the corn is maturing, after the hay harvest or possibly before it, the oats are harvested. The oat crop is not particularly profitable of itself, but the dovetailing of these crops makes the field of oats as well as the field of corn and the field of hay a part of the farm system, in much of the corn-belt, and here is grown the greater part of the United States crop, nearly a billion bushels. Oats have another value to this corn-belt farm, in that they serve as the nurse crop for the young clover and timothy, which are the chief hay crops. In sections where winter wheat is grown a crop of oats can be sown as a catch crop in early spring after a bad winter has ruined the wheat crop.

The United States leads in the production of oats. The Russian crop is almost equal to that of the United States and nearly double that of Germany, the third oat producer. The greater intensity of European culture is shown by average yields per square mile in 1913 of 2,248 bushels in Illinois, 3,064 in Denmark, and 4,216 in well-tilled Belgium.

EFFECT OF THE LIGHT WEIGHT ON EXPORT

The oat grain has a thick, light, close-fitting husk which is not removed by thrashing. It is left upon the grain if used for animals and only removed by special machinery when the grain is prepared for human food. This husk contributes to the great variation in the weight of oats, ranging from twenty-five to fifty pounds per bushel, in contrast to the small variation commonly found in wheat and corn. The usual legal weight of oats is thirty-two pounds per bushel, corn fifty-six, wheat sixty. The large bulk per unit of value is one of the reasons for the small export from the United States, which amounts to less than a twentieth part of the crop. Another and greater reason for the small export from America is the great importance of oats in the agriculture of the grain-importing countries of Europe. Northwestern Europe imports ordinarily about ten per cent. of its oat consumption, southwestern Europe about five per cent., of which all but one per cent. is produced by the regions commercially tributary to the Baltic.

Oatmeal makes up an important part of the American export of oats. The centers of manufacture are a number of small towns in Iowa and other corn-belt states, from which the familiar little pasteboard boxes and the more economical sacks and barrels go out by millions. There is also little doubt that if we set our minds to it we can devise various kinds of bread and cakes that will permit men to make a much larger use of oats as a wheat substitute.

The recent successful growth of experimental plans and some fields of oats in the Yukon Valley of Alaska show that this plant along with rye and wheat can help extend the grain and bread lands northward. The farm tractor is just as important in the cultivation of rye, oats, and barley as of wheat. The utilization of this machine in extreme northern agriculture is of peculiar value because of the ever-lengthening season of idleness and non-employment for the work animal, as we go north, and the ever greater difficulty of getting food for him. The oat crop in this northern extension of the grain district is of extra fine quality, because, as it is apparently native in cold, moist lands, the northern crop is likely to have a larger grain and greater weight of food per bushel than the grain grown farther south.

Fig. 32.—The universal growth of oats in eastern Canada finds its counterpart only in cornless Europe. (Finch and Baker.)

3. Barley. It is natural that the writers of Scripture, as well as the Latin writers, should have mentioned barley loaves, for barley is the breadstuff of the desert's edge. It is also the breadstuff of the Arctic edge—the hardiest of the important cereals. Having a shorter season of growth than rye or oats, it finishes quickly in a short sub-arctic summer or a short, rainy season in lands of little rain. The wheat limit in Russia is near Petrograd, but barley extends to the Arctic regions. Its green blades are stolen alike by the sledge-drawing reindeer and the desert-crossing camel. The appearance of the growing plant and of the seed bears close resemblance to wheat. Under similar cultural conditions the yield per acre is much greater than that of wheat, with the advantage of wider climatic range. The average yield in the United States (1912-14) was 26.4 bushels per acre, while the yield of

wheat was 15.9 bushels, and of corn 26.0 bushels. Barley is important in northern Norway and Sweden, and in the adjacent Lapland, growing beneath the midnight sun, and ripening 150 miles beyond the Arctic Circle. It is regularly grown in Finland and northern Russia to the shores of the Arctic Ocean, and its ability to resist droughts and heat causes it to be grown as far south as the Nile Valley, Abyssinia, and the eastern point of Africa, near the equator. It has been the breadstuff of the nomad Bedouin for unnumbered centuries, and the stalwart and exceedingly handsome appearance of this noble-looking villain shows that it is good breadstuff, too, even though, with wheat at our command, we refuse to use it. Barley has less protein and carbohydrates than wheat, but more fats and salts.

Unfortunately it lacks the gluten necessary to make soft, light bread. But for this gluten shortage barley would doubtless, because of its cheapness, replace wheat as our dominant breadstuff, and with the new knowledge of plant breeding such a change may yet be possible. The large yield of barley in combination with its ability to resist drought made it the chief grain food of the ancient Hebrews, Greeks, and Romans, who had rather dense population in lands with a very dry summer (Mediterranean climate). At the present time it is used as breadstuff in Scandinavia, Russia, Germany, and to a smaller extent in southeastern Europe, and is beginning to be used in the United States to a small extent in the preparation of breakfast foods, for invalids and as an ingredient in the food of babies who must be bottle-fed. Its admixture with wheat flour was very important in Europe during the war. The shortage in gluten and failure to make sticky dough and light bread limits its use in the countries with high standards of living chiefly to forage and the making of malt for beer, for which it has been extensively used in Germany, England, and the United States.

I have seen and eaten the barley loaf made by the cave-dwelling Berbers of south-central Tunis, who cultivate small patches of barley in land of so little rainfall that they count on getting only one good crop in three years. The barley is ground between two stones, of which one is turned by hand; it is then mixed with water and salt. A handful of the mixture is slapped against the vertical side of a big earthen jar buried in the earth, in which fire has burned to coals. The radiation of the coals and heat of the earthenware slowly bakes this piece of nutriment, which is so solid that if a man were hit with it he would surely go into a swoon, and so solidly nutritious that when a man has eaten his fill of it he stays full for the space of about two ordinary meals.

The large yield makes barley a substitute for corn as a food for hogs, horses, and cattle in countries that cannot grow corn, such as Canada and Europe north of the Alps and the Pacific slope of the United States. In England and Germany it occupies about as much of the farm land as wheat, and to a considerable extent takes the same place in farm economy that corn does in the American corn-belt. It can be grown in the United States over a wide range of territory, but it pays well only in certain localities.

The temperature range of barley in the United States is wider than that of any other cereal. It is grown up to 10,000 feet elevation in Colorado where the summer temperature is only 52° and frosts are frequent, and it is grown in the Imperial Valley of southern California where the summer temperature is 95°. Barley matures on an annual rainfall of less than 10 inches in California, excelling wheat in drought resistance; but does not endure much wet weather. In general the barley regions of the United States have a slightly subhumid to semiarid climate, with plenty of sunshine.*

Importance in Arid Lands. Its resistance to drought makes barley important in arid lands, such as those around the Mediterranean Sea, Asia Minor, central Asia, Australia, and California, where it will grow nearer to the desert than does wheat. In countries having winter rain and summer drought, especially in such horse-loving countries as Australia and California, the barley is often made into hay by being cut before the grain is mature. At this time the entire plant makes good forage. In California much of the wheat land has been planted to raisins and other fruits, and the wheat crop has greatly declined, but the barley area has increased and barley has replaced wheat,

* Finch, V. C., and Baker, O. E.: *Geography of the World's Agriculture*, p. 40.

as a market grain, probably because of superior resistance to drought—a factor of great importance in a state with so much arid land. As in summer-dry California, so also is it important in Spain and Algeria.

Aside from California, with forty million bushels (twenty-five per cent. of the national crop in 1911, eighteen per cent. in 1915), the only barley district of importance in the United States is the southern end of the spring wheat-belt, southern Minnesota, and the Dakotas, where half of the American crop is grown. Some barley is also grown in eastern Wisconsin, where the breweries of Milwaukee have long given a nearby market. The fact that barley ripens earlier than wheat is a factor of very great importance, because the two crops, one food for man, the other food for beast, do not compete for the grower's time at harvest, so that he can grow a larger number of acres of the two grains than he could of either alone. The superiority of corn as a forage plant in the more humid parts of the country has in the past limited the total production of barley in the United States (in 1911, 160 million bushels; in 1915, 228 million, about one-fourth the amount of the wheat crop); but almost cornless Europe grows a billion bushels, nearly half of it in Russia. Little Denmark, with her many cattle and hogs, grows nearly six times as much barley as wheat. Esteem for it as a forage plant is increasing so rapidly in the United States that the crop has doubled within fifteen years, and the increase is steadily mounting. Its recent growth in Kansas for hog feed suggests its substitution for corn on the arid edge of the corn-belt. The fact that we are just now beginning to cultivate large arid areas gives us good reason to anticipate a great increase in barley growing. The injury of this crop by grasshoppers is a reason why it has not already made greater advances.

The Japanese use it on uplands not suited to rice. Because of its heavy yield, it is the second cereal of Japan, the crop being more than one-third as large as the rice crop, and three or four times as large as the wheat crop. The country people of Japan eat it mixed with rice.

Barley flour, with its excellent flavor and nutritive qualities, can be mixed with wheat and makes good bread, as the experience of hundreds of thousands of American families has shown during the recent wheat shortage in the United States. A fifty per cent. mixture of barley and wheat flour has been successfully used for quick hot-breads and biscuits with baking powder. The wheat of the dry countries has a larger gluten content, and therefore permits the admixture of a higher percentage of barley, so that our semi-arid regions hold out to us a double bread promise. Of course, if we had to, we could keep as healthy on barley bread as did Jeremiah, Hannibal, Caesar, or Demosthenes. We have in barley one of the easy avenues of escape from any possible bread famine.

The dietitians are constantly hammering away to make people chew their starches more and many kinds of bread and biscuit are advocated because they are baked without yeast and it is necessary to chew them well. Such unleavened breads could easily be made of barley.

4. Buckwheat. Buckwheat, an unimportant cereal, even more than rye, is among grains as the goat is among animals—conspicuous for its ability to nourish itself where the supply of nourishment is meager. This quality habit of the plant, enabling it to live on the poorer and rougher lands, in combination with its very short period of growth, makes it the cereal best fitted for growth under the worst conditions, particularly in the eastern parts of the United States and northwest Europe. Buckwheat does not resist drought well, but grows well on rough, cool mountain lands. The plant is a voracious feeder, exhausting the soil, but this makes it grow so quickly that it can be sown in midsummer in central Pennsylvania after other crops have failed, or have been harvested, and yet it ripens before frost. One climatic weakness of buckwheat is its inability properly to fertilize its blossoms in hot weather, which makes it almost necessary to sow it after the heats of summer are past, and accounts for some surprising failures of the plant to produce seed in central parts of the United States and in the spring-wheat country.

Its qualities combine to make it a crop for farms of rough and mountainous localities, such as the upper part of the Appalachian Plateau in New York and Pennsylvania, parts of New England and Canada, the mountainous districts of France, the Alps, Russia, and Japan. The excellence of the buckwheat flour for making batter cakes is well known in the United States, but the Japanese, who grow 400,000 acres and make of it a very excellent macaroni, never heard of buckwheat cakes. Apparently the vogue of the buckwheat cake is declining in the United States, probably on account of the onslaughts of our manufactured breakfast foods, and the grain is at times used as stock food. Persons who keep bees for the large-scale production of honey sometimes grow buckwheat because of the large amount of honey in the flowers, thus getting a double harvest.

Our buckwheat acreage of 1,250,000 just after the Civil War has declined to 750,000 acres. New York and Pennsylvania produce three-fourths of the total crop of the United States, which amounts to about three per cent. of the wheat crop.

The five above-mentioned grains do not exhaust the list of small grains even of the temperate zone. Mr. O. F. Cook, of the United States Department of Agriculture, reports that before the introduction of wheat and barley into South America, the quinoa, a cultivated pigweed, was one of the two most widely grown crops of the remarkable Inca civilization. A Scotchman resident there today pronounced it better than oatmeal as a breakfast food. The plant appears to be very vigorous and productive, and may possibly be gathered and thrashed by machinery. There is no immediate prospect of this plant's entering into competition with our other small grains, but the plant breeders have not yet tried their hands on it. Its growth on the high cold plateaus of the Andes might give it qualities of value in many other parts of the world if its introduction were seriously attempted. There are many, many varieties of wheat, rye, barley, oats, and buckwheat yet to be found or created. This means increased yield for old acres and new crops on new acres—a large possible increase of our grain supply, and therefore of our bread supply.

CHAPTER IV

RICE

RICE CHARACTERISTICS AND RICE CLIMATE

THE saying that bread is the staff of life arose naturally in a country where man had bread, and for the same reason it overstates the case. Hundreds of millions of men, strong, healthy, and industrious, never heard of bread as we know it. Bread is merely the form in which we Occidentals happen to get some of our carbohydrate nourishment. The hosts of non-bread eaters get carbohydrate just the same, but in other forms, one of which is rice, sometimes called the greatest of all the cereals. It happens to be low in gluten, and therefore will not make light bread. It has less fat and less protein than wheat, two facts, however, which help it to keep in hot damp climates, for it is the oil in the corn germ that makes corn and corn meal so difficult to keep and transport in bulk.

In the adjustment of plants to different climates, nature has fortunately given the rice plant an ability to survive conditions fatal to the successful growth of the grains which have been the great dependence of the white races. The humidity that debars wheat from the cotton-belt and makes parts of that region unsatisfactory for corn, is still insufficient for rice, which is really at home only in the swamp, the kind of land from which the white man has mostly run away, although for cen~~turies and millenniums it has been the~~ choicest of the choice field~~s in the rice-growing~~ lands of Buddha and Confucius.

Without rice the human race would be greatly handicapped for locally grown cereal food in some parts of the warm temperate zone where there is a heavy summer rain, as along the Gulf coast in the United States, and also in the torrid zone, especially equatorial South America, equatorial Africa, the East Indies, and great stretches of the southern and eastern coasts of Asia. In such a climate all the European grains—wheat, barley, rye, oats, and buckwheat—fail miserably, and corn is far from its best, owing to the bad effects of the moisture. Even if the people could afford to buy, commerce would find difficulty in filling the gap, because it is so difficult to keep these northern grains in a hot moist climate. Trouble is often experienced in shipping corn down the Mississippi River and through the Gulf of Mexico to Europe, because the humidity causes the grain to heat and mold. It is indeed fortunate that these climates have rice, Asia's great gift to the world, which thrives under wet summer conditions and which, owing to the dryness of the kernels and a protecting husk, can also be kept without deterioration.

Rice is to the regions with wet summers what wheat is to the regions with dry summers. Rice shares with wheat the unusual distinction of being grown almost exclusively for human food. It probably exceeds wheat in this respect, for a few million bushels of wheat are used for poultry food, as nothing else is so effective for egg production. The two plants do not thrive in the same region unless, as in a few districts of China and Japan, a crop of winter wheat can be harvested before the beginning of the summer rains, which furnish the proper conditions for rice.

There is one other kind of place where the two grains flourish together, namely, a dry flood plain such as that of the Nile, the Sacramento or the Po rivers, where irrigation can make enough moisture for rice, in a wheat climate. In the main, however, the world's rice is grown in the reeking humidity of a moist summer with frequent, almost daily, rains. In Louisiana it has been found that the rice plant requires about one-half inch of water a day for ninety days; and since the rainfall is twenty inches during the rice season, twenty-five inches must be put on by irrigation, or 675,000 gallons (over 5,000,000 pounds per acre) to produce 1,500 to 2,000 pounds of rice.

THE ASIATIC MONSOON AND THE WORLD'S RICE

Rice has been grown for ages. Centuries ago it was introduced into Western lands, but ninety-seven per cent. of the crop is still grown east of Suez, the waterway through which the steamer brings to the Western World far more than the Western World produces. This will not always be so, for rice culture in the West is increasing. Its beginning and continuance in the East has a very natural explanation: the Asiatic monsoon, a seasonal summer wind, a gigantic sea breeze, blows inland from

FIG. 33.—Transplanting rice, Philippine Islands, by the age-old, Oriental, hand method in the flooded fields. Note the carabao, or water buffalo, said to be the slowest of work beasts.

the warm, moist Indian and Pacific oceans across all coast lands between the upper Ganges Valley and latitude 51° north in Japan. It brings to eastern and southern India, Ceylon, Burmah, Siam, and Cochin-China, the Philippines, China, southern Korea, and Japan, hundreds of millions of cubic miles of steaming air in which man sweats and gasps as in that last sticky half-hour before an American thunder shower. Thus these countries have heavy warm midsummer rain—an ideal rice climate.

This Asiatic summer rain produced by the monsoon is one of the most important factors in the relation of man to the earth. Southeastern Asia and adjoining islands, the region of monsoon climate with rice as the leading cereal, is the home of more than half the human race. An important reason why this small corner of the world holds so many people is, that this monsoon climate brings rain at the season of greatest heat and growth rather than in the cooler period of least growth, as in California, Spain, Italy, Persia, Australia, South Africa, and Chile, with their winter rainfalls. The climate possesses, first, the intermittency which compels people to work during the non-productive season of drought, and then rainfall enough to permit the production of food for great numbers.

In all those parts of southeastern Asia where the moisture is sufficient to insure satisfactory growth, rice is the chief cereal and the mainstay of the population. It is said to be the chief food of one-third of the human race; but the extent of its use has been somewhat exaggerated through our contact with Oriental people at seacoast points and our consequent ignorance of inland districts, especially in China. The rice is the grain of the moist low plain, and, contrary to general opinion, it is a luxury to millions of Chinese and Japanese who live on the cheaper and less desirable millet, corn, and potatoes, both sweet and white, the European small grains, and other cereals not known in America.

These European and other grains are raised where it is impossible to cultivate rice. Thus, in northwestern India, the valley of the Indus does not have much rain and is an important wheat-producing region, as are the central plateaus of India around Bombay and upper Bengal. (See Fig. 12.) The upper Ganges is a great barley country. In north-central and northern China, also, rice does not thrive, and wheat is extensively grown. In colder or more arid localities comes barley, and in the region of Pekin and southern Manchuria, corn, while many districts of central and north China have millet as their chief cereal. Southern Korea depends much upon rice, while in the rougher and colder north they grow barley, rye and oats, millet, and some wheat; the same practices prevail in Japan.

Wheat and barley are often grown on rice land in winter, and the two grain crops per year measure the intensity of production. The moisture requirements of rice, namely, one-half inch of water per day, are so great that irrigation is necessary for a dependable crop in nearly all parts of the world, despite man's efforts to find productive varieties of rice that will thrive on uplands. In some parts of the Philippines, the summer rain of forty to sixty inches is enough, without artificial watering.

The rice plant has been grown so long and there are so many separate localities having little intercourse with each other, that a vast number (11,000 some say) of separate varieties have been produced. These may be grouped into two classes: hill rice and swamp rice. In a few parts of the Old World and of the United States a little rice is grown without irrigation in localities of heavy rainfall, but the yield is less than one-half that of irrigated rice, which produces almost all the world's crop.

Irrigation of rice requires that the water must stay on the land for some time, making a pond in which the rice grows. This requirement necessitates a water-tight subsoil. The best soils for rice growing have a tight clay subsoil one to two feet down, with a friable clay soil on top. This condition is furnished especially well by deltas, and rice is therefore preeminently the grain of the delta, as may be seen by an examination of the crops grown on the deltas of the Mississippi, the Nile, the Yangtse Kiang, the Ganges, and the lesser rivers of India and eastern Asia. Where nature has not been so kind as to level off the land ready for rice growing, as in deltas, man has in some places expended almost inconceivable labor in making his farm into a series of ponds, into which and from which water may be turned at will. We sometimes count the pyramid of Cheops as one of the wonders of the world, one of the great monuments of human labor, but its construction was child's play in comparison to the work done on paddy fields at the same and later periods in many an Oriental sultanate.

THE ANTIQUITY AND USES OF RICE

The use of rice in these old lands of the East goes back to the unknown past. Centuries ago rice spread from China and India to Egypt and north Africa, then in 1468 to Pisa in Europe, and in 1694 the governor of South Carolina succeeded in cultivating it in his garden and thus started the industry in the United States. A little rice is grown throughout nearly all tropical America and on both coasts of equatorial Africa, but no peoples depend upon it so fully as do those of southern and eastern Asia, with whom it often replaces wheat, potatoes, and, to some extent, meat also. Among the people of Europe and America, rice is used as an ordinary vegetable, as well as for pudding, and as a substitute for the potato in periods of shortage of that article of diet. It keeps better and is more convenient to transport than the potato. In keeping qualities it is the peer of flour and the dried bean, and can be used anywhere. It is consumed throughout the Western World from Iceland and Lapland to Patagonia and New Zealand. This consumption, along with its use in the Orient and the tropics, probably makes it the most widely used of human foods. It is easier to boil rice than to bake bread. This fact, along with the ease with which it may be kept and carried, makes it a great standby in the tropics, so that it is said to be the staple food of the black men of Hayti, and also of the white men of Porto Rico. The average Porto Rican eats bread once a day with his morning coffee. The chief articles of the other two meals are rice, dried beans, dried codfish, and mafáfa, a kind of banana. The men of Hayti and Porto Rico alike have been almost entirely dependent upon the swamps of Asia for the rice they eat, paying for it with sugar, cacao, tobacco, and other more easily grown products.

As its lack of gluten keeps it from being a bread grain, the Oriental boils rice and eats it in that form, or flavors it with a bit of meat or fish if he can afford it; or uses curry, a hot seasoning preparation made in endless varieties. With peas and beans, rice furnishes almost the entire nourishment for hundreds of millions of people. The legumes furnish the protein that the rice lacks. Peas and beans are widely grown by almost all Eastern peoples who raise rice, and they are the substitutes for the meat, milk, and cheese of the West, while the starch of rice is the substitute for bread, potatoes, and many puddings as well. The unpolished rice eaten by the Oriental is much more nutritious than the shiny, white grain which we of the West insist upon eating. The process of polishing it takes off the most nourishing part, and is one of the numerous cases in which appearance leads the purchaser to select the really inferior article. The Japanese, with their general adoption of Western ways, adopted from us the habit of polishing their rice, with the result that the Japanese sailors got the dreadful disease of beri-beri, much like scurvy, a disease of malnutrition. There is a record of a man supposed to be dying of this trouble in a Japanese hospital, who was given a single dish of gruel made of rice bran, with the result that in four days he got up and went home. The secret seems to be that the rice hull, like the outer part of most grains, has in it mysterious and as yet largely unknown things known as vitamines. While we do not know much about their nature, we do know a great deal about their work. While not nourishment in themselves, vitamines enable us to get nourishment out of food that otherwise we could not digest. They seem to be to the process of digestion what salt and other flavorers are to a good meal. Seasonings are not a part of the food, but they give the flavor that makes the meal a pleasure. So the vitamines are not a part of nutrition, but they are essential to digestion. The polishing of the rice removed this element from the food of the Japanese sailor, who became sick at sea, because away from the other common sources of vitamines which are so abundant in nearly all green foods.

The rice bran left from polishing rice is a valuable cattle food and is exported as far as Europe. The straw is used for many purposes, including fodder for animals, and the hats and shoes worn by Oriental workmen.

RICE GROWING IN THE ORIENT

Like wheat and almost any other crop, rice receives careful cultivation where land is scarce, and careless cultivation where land is plentiful. In parts of the East Indies, for example Sumatra, Borneo, the Malay Peninsula, and in some parts of Burma and Indo-China, where the population is scanty and the tropical jungle covers with its dense tangle every foot of the land except where man has fought it back, and keeps it back, upland rice is grown in the shiftless manner which commonly prevails wherever a sparse population uses abundant land.

When a new rice field is wanted, the people of a valley begin

Fig. 34.—Flooded mountainside rice fields of the Ifugaos, Philippine Islands—a monument to be classed with any of the great works of man anywhere. The owners of gullied American lands call these people savages. (From *Asia*, the American Asiatic Association.)

the year by cutting down the forest. Among stumps and prostrate logs, often higher than the worker's head, the upland rice is planted in holes made with a sharp stick and filled by the bare foot. As young rice is much prized by wild animals, the elephant and the small rodents being alike partial to it, the clearing must be watched until the harvest. After two crops of this upland rice are taken, the field is abandoned for a fresh field, and the tangled jungle promptly reclaims the land.

Most of the countries with monsoon climates are too densely peopled for the land to be wasted by this crude method of rice-growing. In such localities the land, once cleared, is cultivated for centuries. Dense populations nearly always grow the wet variety of rice, because of its greater and more certain yield. Few crops are surer than the wet rice, and few more uncertain than upland rice—"providence rice," they call it in Louisiana. It is doubtful if the world's agriculture affords a more perfect adjustment of cultivation to natural conditions than that of rice growing in a swamp. Ordinarily flood or drought constantly harass the European and American farmer. Too much or too little alike destroys, and crops are rarely at maximum, but in the rice swamp the absolute maximum of water is required and supplied, and an almost perfect adjustment therefore prevails. As evidence, note our national average grain yields for 1917—wheat, 14.2 bushels; corn, 26.4 bushels; rice, 37.6 bushels. Certainly rice is the king of grains so far as yield is concerned—hence its importance to dense populations. Thus the Japanese, crowded so that they must make utmost use of land, grew in 1916 three hundred and five million bushels of rice as compared with one hundred and eighteen million bushels of three other small grains—forty-five million of barley, forty of rye, thirty-three of wheat. In this same year the average yield of wheat in Japan was twenty-three bushels, and of rice, forty bushels per acre.

The devices used to make and keep the land fit for this service are among the greatest monuments of human diligence in the world. They are certainly the most creditable constructions produced by tropical peoples, the only rivals being the slave-built monuments of tyrants. In Ceylon, for example, the railway that goes from the seacoast to the highlands passes through an irrigated plain divided by low banks into ponds of small area,—rice fields, each of which has by great labor been leveled so that the water may be of uniform and proper depth for rice growing. As the railroad climbs the slopes of the hills the rich patches continue, with smaller area and higher banks, turning at last into a giant flight of gentle water steps, one of the most beautiful landscapes in the world. Many mountains in Java are similarly terraced for rice far up their sides; and, in China and Japan, similar stupendous works have been constructed for the nourishment of the populations, which, like those of Java and of Ceylon, are very dense and mainly dependent upon agriculture, in which rice is the largest staple. In Japan fifty-six per cent. of the arable land (11,000 square miles) is laid out in these irrigated paddy fields.*

In the Philippines some of the mountain tribes, whom we in our complacency call savages, have built rice terraces with an amount of labor and a degree of perfection nowhere excelled. In some of their habits, for instance, their willingness to inflict suffering, they may properly be called savages; but, if they looked at the gullied corn fields of the United States, they could with great propriety say that we are agricultural savages, as a member of the Italian senate recently said of his own countrymen when he looked at the steep and eroding wheat fields of Sicily. The irrigated rice field is permanent agriculture. The eroded grain field of the West is self-destroying agriculture.

The common treatment of lowland rice is alternately to flood it and to draw off the water during the early periods of its growth. It is kept under water during a larger part of its development, the water being entirely drawn off as it ripens. The water must not become stagnant; to keep it in motion it is the common practice on the hillsides to lead a stream to the top terrace, and let the water pass from terrace to terrace down the slopes. In many places, especially in China where the water supply is often inadequate, it is necessary to lift the water from the lower terrace to the higher by some artificial means. Sometimes, where the water is abundant, a high water wheel is used. As it revolves, the bamboo buckets, mere joints of bamboo on its rim, empty water into a trough when they reach the top

* King: *Farmers of Forty Centuries.*

of the wheel. Only in exceptional places is there sufficient water for this water-power method. In many parts of China and India two men may be seen straddling a little dyke that separates two terraces. With a bucket they dip the water from the lower to the upper, where they pour it out upon mats so that it may not injure the little rice plants beneath. On the banks of the Nile one may sometimes see a string of three or four men, one above the other, using human muscle in passing water from

Fig. 35.—Irrigation in Japan by foot wheel One of the many laborious means by which the Oriental gets the precious water up to his food patch. (F. H. King, *Farmers of Forty Centuries.*)

man to man to get it from the muddy Nile to the field at the top of the bank.

In the East a light foot-driven water mill is another very common device, by which human muscle does the work which we of the West do with machinery and which the Oriental may in time also do by machinery.

The care of these terraced hillsides with their accompanying menace of an avalanche of water is as great a monument to the diligence and patience of these peoples as is the construction of the terraces. Only constant vigilance prevents the breaking of the upper terraces, which, should they give way, would promptly discharge the water into those below and fill them to overflowing, so that, gathering force as it went down the hillside, the water would, like an avalanche, spread death before it and leave ruin behind.

AMOUNT AND KIND OF LABOR IN GROWING AND PREPARING RICE

The greater part of the rice quite naturally is grown on the level delta lands where the paddies are separated from each other by low banks, and the bullock or water buffalo wallows in the mud, dragging the plow that works up the clay into a thin paste, before the rice plants, produced in small sprouting beds, are transplanted by hand. This work, like much of the other work in connection with terrace-grown rice, can be done only by hand. The small fields make it impossible to use such machinery as the reaper or even at times the ox. But beasts of burden are often unobtainable in a densely populated country like China. There is not land enough to raise food for many animals, so the spade in the hand of a man replaces the plow drawn by a beast, and the garden replaces the field. Parts of China and Japan and India have reached the ultimate stage of agriculture, where man grows by his own labor the food for his support, and there is small possibility for increase of food production. This lack of animals is by no means universal, for there are millions of water buffaloes plowing rice fields in the Philippines and on the mainland of southeastern Asia; and India, inhabited largely by people who eat little or no meat, has more cattle than the United States—cattle whose chief purpose is to serve as beasts of burden.

When the Asiatic rice field is finally drained, the ripened grain is usually cut by hand, tied up in bundles, and allowed to dry. In order to dry them in moist places, it is often necessary to put the sheaves upon bamboo frames. The grain is usually thrashed by hand with the aid of some very simple devices. One of these is a board with a slit in it. Drawing the rice through the slit pulls the grains from the heads and allows them to fall into a basket. The grain at this stage is called paddy because of a close-fitting husk not unlike that which protects the oat kernel. Like oats, rice keeps much better before the husk is removed, and the final husking is always deferred until the time of use approaches. Among the Oriental people the husking of the paddy to prepare it for food is a daily occurrence, commonly done by hand. One of the commonest sounds throughout the East from Bombay to Manila and from the equator to Pekin, is the pounding of a heavy mallet or pestle as it falls into a vessel full of paddy.

REGIONS OF GROWTH AND EXPORT

It is probable that the greatest rice grower in the world is China, but that country has not yet the habit of keeping commercial statistics, so those best informed can only guess that she grows more than India, whose crop of a billion bushels is far greater than the wheat crop of any country, and makes the 20 million bushel rice crop of the United States look small indeed. In India as in China the conditions for rice growing are to be found only in scattered localities, because of the very exacting nature of the plant. Down the west coast of India is a rice region, because the southwest monsoon blows squarely against the nearby western Ghats just back from the coast, making summer dampness and a rainfall of from seventy-five inches in the north to one hundred inches on the Malabar coast in the south. On the east coast the rainfall is less, and rice-growing centers around the deltas of the four rivers Mahanadi, Godavari, Kistna, and Cauvery. In the presidency of Madras alone some 11,500,000 acres are irrigated, of which nearly 2,000,000 are irrigated by the laborious means of wells. A pair of oxen walk down a ramp pulling a rope, which, by means of a pulley, lifts a huge bucket of iron or leather. Thus the farmer gets water enough to irrigate an acre or two, which, because of the costliness of the water, he must tend with great care as he grows his rice, beans, and millet. There are 600,000 of these wells in this district alone.

The greatest rice region of India is the lower Ganges Valley with its wide reaches of alluvial soil and one hundred inches of rain, falling mostly in the summer season. Other flood plain areas of a similar nature but lesser extent are furnished by the delta plains of the other southeastern Asiatic rivers, the Irrawadi in Burma, the Menam in Siam, the Mekong in Cochin-China, making trade for a great rice port at the mouth of each river. Rangoon in Burma is the greatest rice port in the world, while Bangkok at the edge of the Siamese rice delta sends out a million and a third tons per year. Rice comprises seventy-five per cent. both of weight and of value of the exports from the port of Saigon in French Cochin-China; ten mills in the nearby town of Cholon clean a million tons a year for export.

The enormous home consumption of rice in China, Japan, Java, the Philippines, and most of India prevents these countries from having a surplus of rice for export. In comparison with wheat, rice is quite a home crop: the world export of rice in 1913

FIG. 36.—It should be noted that this map is not complete because some of the states of India do not have suitable statistics and are therefore shown by shadings. Note size of unit. (Finch and Baker.)

was 270,000,000 bushels, while that of wheat was 840,000,000. In Burma, Siam, and Cochin-China, the rice-growing delta plains contain the larger part of the population, which, however, is less dense than in India and China, so that large quantities of rice are left as the money crop of the natives who grow it in these unwholesome swamps. This surplus they carry in their native boats down through the winding waterways to Bangkok, Rangoon, and Saigon. Here, in the mills of English, French, Chinese, and (before the war) German firms, the paddy is cleaned in the wasteful fashion demanded by Caucasian consumers, by whom the part eaten is only half as nutritious as the part consigned to the animals that get the rice bran.

These three countries of southeastern Asia, Burma, Siam, and Cochin-China, are to the rice-shipping world what western Canada and Argentina are to the wheat-shipping world—regions of large area and small population, having therefore, a surplus for export, but playing a comparatively small part in the world's production. China and India proper are among rice-growing nations what Europe is among wheat-growing nations, the greatest producers, with almost no surplus. India produces 1,000,000,000 bushels and exports almost none, while Siam produces 100,000,000 and exports half of it. Japan herself, with 170 pounds of rice per capita as compared with eight in the United States, has of late entered the class of rice importers, despite a crop of 300 million bushels cultivated with the greatest care. As a trader, Japan imports cheap rice for home consumption and exports her own fine quality grain.

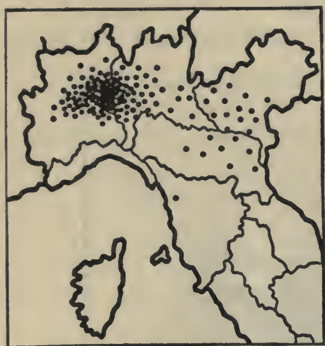

FIG. 37.—Each dot represents 2,500 acres. (Finch and Baker.)

THE SPREAD AND EXTENT OF RICE GROWING

Rice came into the West late in history and thus far the development of rice growing outside the Orient has been slow and small. The annual overflow of the Nile due to seasonal rains in central Africa, and the resulting easy irrigation, make rice as much at home as it is in the garden farms of Japan, the lower valley of the Yangtse Kiang, or the terraces of Ceylon and Java. Some rice is grown in Egypt, but not enough for the population, probably because of the European dominance of the Egyptian agriculture. Europe unfortunately lacks the natural facilities for extensive rice growing, or she would doubtless long ago have developed it. Only southern Europe has a climate warm enough, and there the Mediterranean climate with its dry summer prevails, so that little rice can be grown. Wherever water can be found in sufficient quantity to meet the needs of rice, little patches of it are cultivated in Spain, Portugal, and Greece, but only in the level valley of the Po where Alpine snows feed the streams is there a European rice region worthy of mention, and its production is not sufficient to supply the Italian demand. Although rice is a standard article of diet in every country of America and Europe and in every European colony, all these lands are importers, with the possible exceptions of Peru and Brazil. In Peru the combination of Chinese immigration and irrigation has caused a production one-tenth as great (1916) as that of the United States, and in Brazil the scarcity due to the war caused home production suddenly to increase until in the first six months of 1917 there was an export of 20,000 tons.

RICE GROWING BY ASIATIC EMIGRANTS

The emigration of East Indian laborers to the islands of Mauritius and Reunion in the Indian Ocean has introduced rice growing there, while similar people, lately taken to the British colonies of Jamaica, Trinidad, Honduras, and Guiana, have carried with them the methods practised by their rice-growing ancestors for a hundred generations. Of these tropical American rice fields British Guiana has the best. Here, although the country is mostly uninhabited forest, are large stretches where the leved, alluvial swamp along the seashore has been utilized by the building of dykes, after the manner employed in Holland. The country was settled by the Dutch and later ceded to England. The reclaimed land greatly resembles the rice-growing deltas of the rivers of southern Asia, and, since the decline in the profits of sugar growing, the East Indian workers of Guiana are growing ever larger quantities of rice. Between 1898 and 1908 the acreage increased from 6,000 to 38,000 and to 48,000 in 1916.

RICE GROWING IN THE UNITED STATES

After the surprising success of the governor of South Carolina in raising a patch of rice in his garden in 1693, rice growing became an industry in that colony and in Georgia, since swamps along the seacoast and rivers could cheaply be dyked off and cultivated by negro slaves in the Oriental way. They were irrigated by river water and drained at any low tide. In 1787, negro slaves were more profitable in this region than in any other of the thirteen colonies, and it was due to the influence of Georgia

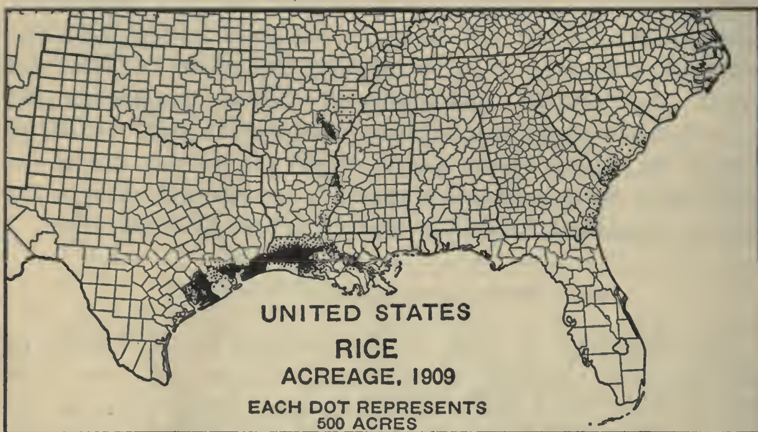

Fig. 38.—Compare the significance of each dot in this map with that of Fig. 36. (Finch and Baker.)

and Carolina rice growers that slavery received its recognition in the Constitution of the United States.

These two states have grown rice of excellent quality down to the present day, but they are now suffering from the competition of newer and more interesting rice fields, those upon plains near the Gulf coast not far from the boundary between Louisiana and Texas and upon the flood plains of eastern Arkansas. Here are lands wonderfully level, with a very satisfactory clay subsoil to keep water from soaking through. By dams, wells, and pumping plants, the irrigation water is mechanically supplied, after the ground has been plowed and harrowed by teams and cultivators akin to those used in the preparation of large areas of wheat land. This method is made possible by having the dykes gently sloping so that teams can be driven across them. After the water has been drawn off at ripening time, the ground is firm enough and the area large enough to permit reaping machines to harvest the rice like wheat, and steam thrashers to throw off the chaff and straw into piles, and to fill the rice sacks as quickly as they fill wheat sacks. This conquest of the primeval Oriental hand-labor garden crop by American farm machinery has enabled one man to take care of eighty acres of rice in a year, and though he is paid twenty times as much as the Chinese laborer, he produces rice more cheaply because the Chinaman, by his arduous hand labor, cares for only a little patch of land.

	Acres per laborer	Farm wage with board per year	Labor cost per acre
Japan	½ to 1	$10 to $18	$10 to $36
China	½ to 2½	8 to 12	4 to 6
India	3	10 to 20	4 to 7
Egypt	4	15 to 30	4 to 8
Italy	5	40 to 60	8 to 12
United States:			
Carolina	8	96 to 120	12 to 15
Mississippi Delta	10	120 to 144	12 to 14
Louisiana-Texas	80	160 to 240	2 to 3[1]

[1] *Geography of the World's Agriculture,* Finch and Baker, p. 47.

This new rice region grows many times as much rice now as the more expensively managed swamps along the South Atlantic Coast,* and it is possible that before long the United States will become a rice exporter rather than, as now, an importer. But it will take a good many years for the American rice-growers to become acquainted with their new industry and acclimated (if possible) to the necessarily damp climate which accompanies the irrigation of land upon the warm and moist shores of the Gulf of Mexico.

The land is peculiarly adapted to rice—almost as level as a floor, underlaid by impervious clay at an average of fifteen to

* The deadly effect of this machine competition is shown by the rice acreage in South Carolina—17,000 acres in 1910, 3,000 in 1917—a striking counterpart of the abandoning of wheat fields in eastern Canada and eastern United States after the railroad and the reaper reached the cheap and level West.

eighteen inches below the surface, while water-bearing gravel sixty to two hundred and fifty feet deeper furnishes abundant water for irrigation where rivers do not suffice. In the immediate vicinity of the Mississippi the irrigation is facilitated by one of the peculiarities of flood-plain rivers. In times of flood these streams drop their mud most heavily near their banks, which thus become the highest part of the plain and therefore slope away from the stream bank so that the rice planter draws water from the river, which is higher than his field, and lets it out to run back into the swamps, which begin from one to three miles away from the river itself.

FIG. 39.—Each dot represents five hundred acres of rice and of course covers actually much more than that area on the map. (Finch and Baker.)

This area of rice land runs from the Colorado River in Texas 500 miles northeastward into the Mississippi delta in Louisiana, and extends about sixty miles inland, with an average elevation of from six to forty feet. It is plain that with our acreage of 964,000 in 1917 we have but begun to utilize our Gulf Coast rice area. But the value of land formerly worth \$3 or \$4 an acre has rapidly risen to \$50 or \$60 an acre. Meanwhile another area of rice fields, with rapidly increasing acreage, has been established in east-central Arkansas, although its ultimate possibilities cannot be so large as those along the Gulf Coast. This Arkansas district was land made worthless for ordinary culture by June freshets along the rivers flowing out of Kansas and the Ozarks.

The most interesting of all the rice areas in the United States, however, as well as the newest, is in California on the delta of the Sacramento River, where in six years' time the acreage increased from 1,400 to 80,000 acres, and rice of the finest quality is produced. California's average on these new lands in 1917 reached the astounding figure of seventy bushels, whereas the United States average was 37.6 bushels, and that of Louisiana, with more than half the total acreage, was 36.5 bushels. The ultimate possible acreage in California with its Sierra snow-field water must be but a small fraction, however, of the acreage of the Gulf Coast.

THE FUTURE SUPPLY OF RICE

There is every reason to believe that the world can double, triple, quadruple, and still further multiply its rice crop, which at present amounts to about 2,500,000,000 to 3,000,000,000 bushels. Most of the land in the tropics is undeveloped. Extending around the world at the equator and for a considerable distance north and south of it, almost everywhere that land appears, is a zone of dense forests, flourishing in the rice climate. This great belt is almost untouched. In only one portion of it is rice grown to any appreciable extent, and that is in Java, which may be taken as an object-lesson. The extension of rice growing by machinery in the temperate zone may be duplicated in the torrid zone. The recent purchase by the French Government of a forty-five horsepower caterpillar tractor for experiment on the rice lands of Cochin-China is exceedingly suggestive. So is the sudden export of 20,000 tons of rice from Brazil in 1917, when for a few seasons the Brazilians could not go to Paris to spend their money, and the price of rice was high. If white men stop fighting and utilize science and machinery to develop the tropics, there is no reason why the 70,000,000 acres of rice land in India cannot be duplicated over and over again in the vast wet stretches of Brazil, Peru, Bolivia, Venezuela, Guiana, Congo, Siam, Borneo, Papua, Sumatra, and North Australia. These countries resemble the few spots that now produce rice for export. The doubling of the rice crop in Congo in 1916 is suggestive and even prophetic.

There appears to be no reason why the tractor may not permit us to grow great acreages of rice without irrigation. It is true, this method will not be so productive as irrigation, but neither will it be so costly, and, as explained in the discussion of wheat, with cultivation by tractor men can afford large acreages at lower yields than with existing methods. It is also true that the plant breeders can doubtless greatly improve the ability of hill rice to survive moderate drought. Recent fertilizer experiments from Hawaii are also indicative of enlarged future yields. Nitrate of soda, the standard source of nitrogen, had been used at a loss; but the crop was doubled by applications of sulphate of ammonia, a comparatively new fertilizing material produced from the by-product coke oven, a source from which we can get almost unlimited quantities of fertilizer while coal lasts; and, when coal is gone, any source of mechanical power, of which there are many yet untouched, will enable us to get nitrogen from the air to feed the rice-plants which feed us.

Therefore it seems plain that if in future decades we should develop an actual shortage of wheat and of the other small grains of the north, the lands of the equator can be called upon to produce for us an almost unlimited quantity of rice.

CHAPTER V

CORN AND ITS SUBSITUTES

THE VALUE OF CORN TO THE SETTLERS AND PEOPLE OF AMERICA

From the American point of view, corn has been well called the king of crops. It is the greatest crop on American farms to-day. It saved the civilization of New England in the winter of 1621, and again in a different way in 1918. It is said that the corn procured from the Indians by the Pilgrim fathers in the dreadful winter of their first landing, 1620-21, saved them from famine, and American agriculture, based on corn, enabled the Western World to withstand the German onslaught in the third and fourth years of the Great War.

When the first American settlers landed in Massachusetts and Virginia, the Indians were using this valuable grain, which the settlers called Indian corn, corn being the English word for grain. The Spanish called it maize.

Its growth and use by the natives of America extended over much of this continent from the northern limit by climate in New England to the upper limit by altitude in Arizona, Mexico, and Peru. The European colonists, to their great benefit, at once began to cultivate it, because it was so much easier to grow than wheat, barley, rye, and oats, with which they had been acquainted at home. These small grains, grass-like in their early growth, require for their satisfactory cultivation smooth land free from stumps and stones. This the new settler in the woods did not have. But the Indian showed him how to kill the trees by cutting the bark, so that he could immediately plant corn among the standing trunks and, with a little rough cultivation, have unripe corn ears for roasting as early as August—a much quicker return for his labor than wheat could possibly bestow. By September or October the settler would have ripe grain that would stand a month or two awaiting his convenience to harvest it. It would even stand on the stalk most of the winter unless eaten by non-carnivorous wild animals, such as the squirrel, the rabbit, the opossum, the raccoon, and the deer. In this respect it was superior to the small grains, which must be harvested at

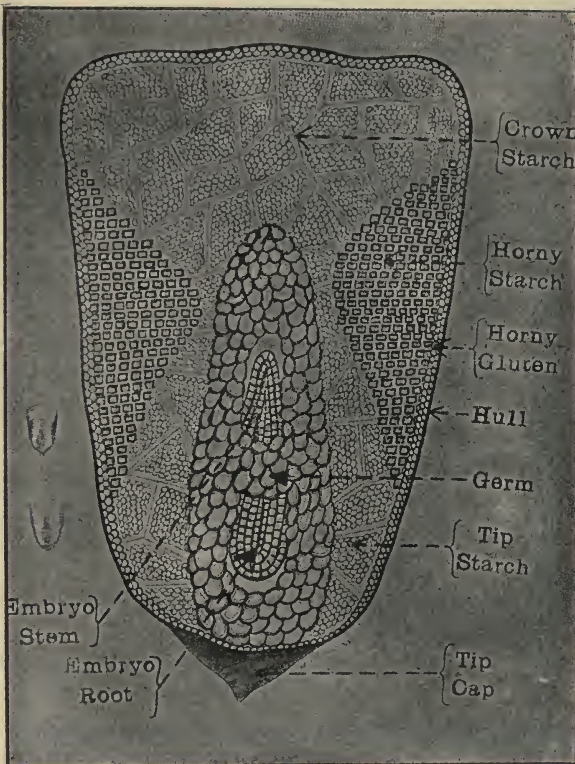

FIG. 40.—Cross-section of corn grain much enlarged. (University of Illinois.)

once lest storms beat them down. The corn, moreover, yielded twice as much as the wheat, was easily kept, and could be served as food in many forms—as parched corn, made by heating the whole grain in a frying pan or over an open fire; as hominy, which is the grain thoroughly boiled after the outer layer is removed by soaking in lye leached from ashes; as mush (samp), made by boiling the meal; or, finally, as corn bread. The husk that had protected the ear was used in the mattress of the colonist's bed; the stalks and blades fed the horses and cows through the winter, even after serving for months as a thatch for the temporary shed that shielded the animals from storm. Unfortunately the poor Indian had, before the white man came, no domestic animal stronger than the dog. Therefore he could not plow, and he had not enough metal even for a good hoe, so that his growth of corn depended chiefly on exceedingly crude tools—the stone hatchet to mash the bark of a tree, or fire, to kill it, and a sharpened stick to plant the grain in the leaf mold of this small and temporary field in the forest. The first Massachusetts explorer who reached the Connecticut River tells in his journal that he saw forty Indian canoes loaded with corn shoot the rapids at Holyoke. The Indians had found a good piece of rich glacial soil near Becket, Massachusetts, which now raises 300 bushels of potatoes to the acre. Here they grew corn for carriage to lower river points as far as the Long Island Sound.

USEFULNESS OF CORN IN ROUGH COUNTRIES LIKE APPALACHIA

Owing to its ability to grow on very rough land where the other grains will not do so well, nor yield so much, corn, where the climate permits, is the mainstay of primitive or isolated hill-peoples in many parts of the world. On the central Appalachian Plateau of eastern Kentucky, eastern Tennessee, and West Virginia, for example, where many counties covering several thousand square miles are entirely devoid of railroads or good wagon roads, the primitive conditions of the Revolutionary period continue, and corn, both as food and a staple of commerce, is of greatest importance,* covering twenty-five per cent of the crop area.

* This locality with its inferior corn crop furnishes a good example of the influence of environment on history Almost the only means of exporting corn from this district of unending roof-steep slopes is by converting it into whisky or livestock. Owing to the fact that the United States Government taxes whisky a dollar a gallon there has been a century-long struggle between the collector of revenue and the illicit distiller, the "moonshiner" as he is called, of the Appalachian Mountains. The mountaineer feels that it is a tyranny for the Government to tax the most profitable thing he can sell. This feeling took its strongest form in Washington's administration, when the people of western Pennsylvania, objecting to the tax, rose in insurrection against the new Republic in

CORN AS FOOD

Despite the use of corn as food for an unknown period by the aboriginal inhabitants of two continents, despite its early importance to the white settlers of the United States and its wide-spread use in many parts of the world, its value as a foodstuff has declined rather than advanced in that part of the world most busily engaged in world trade, namely the northern United States and northwestern Europe. There is no question about the excellence of corn as food. History settles that. Analysis shows that it closely resembles wheat. The marching records of regiments of corn-fed Southern soldiers in the American Civil War, corroborate the evidence of millions of workmen in the Southern States that corn is good and sustaining food. Whittier in the middle of the last century celebrated the dish of samp (corn-meal mush) and milk. The well-to-do sons of Harvard University named one of their clubs the "Hasty Pudding Club." Nevertheless, the more glutenous wheat with its better keeping bread has won the day. I have even been told, by intelligent people, after a year of campaigning by the American Food Administration to persuade the American people to eat corn and of showing them how to eat it, that corn is the cause of pellagra in the South.*

Our prejudice against corn is for most of us a part of the universal prejudice against the new; but it is weak in comparison to that of many European countries. Prejudice against corn is,

the so-called "Whisky Rebellion." More successful, however, has been the generation-long work of the illicit distiller, who, in some hidden recess, converts a sack of corn into a few jugs of whisky for stealthy sale. So strong is public sentiment in some of these localities that the man who serves in the Federal prison for breaking the revenue laws or shooting the revenue officer is a local hero on his return.

* "Pellagra.—This disease has been common in parts of Europe for centuries. . . . It was first observed in America in 1907, and has been steadily on the increase, especially in certain of the Southern States. . . . Goldberger has accomplished a great work in demonstrating that diet, when properly constituted, causes the disappearance of pellagra, and prevents its recurrence His dietary studies have demonstrated beyond a doubt that a faulty diet is the most important factor in causing the development of the condition. He has shown that when liberal amounts of milk and eggs and of meat are introduced into the diet of institutions, such as insane asylums and orphanages, in which the disease was previously common, they become free from it even though new cases are admitted freely and the sick are mingled with the well."—E. V. McCollum in *The Newer Knowledge of Nutrition*, pp. 103, 106, 107.

however, by no means world-wide.* The poorer portion of the populations of Portugal, Spain, and Italy long since found out that they can be fed more cheaply on corn than on wheat, and millions of them almost live on it either in the form of bread or mush, which the Italians call polenta. I have been told by the English owners of Portuguese estates that within recent years they have contracted with large numbers of workers, chiefly women, from north Portugal, to come to central Portugal for the winter months and grub bushes from beneath the cork trees. The conditions were wages of $3 a month in American gold, a cabin where the workers could sleep on beds of boughs around a central fire, and all they wanted to eat of a boiled mixture consisting of fifteen parts of corn meal and one part of olive oil. Out of generosity the employer gave one square meal a month of fish, white bread, and vegetables. This was evidently better fare than the people were accustomed to at home, for they came in the autumn thin and, after a winter's work, went back in the spring, fat.

The science of compounding new foods and the practice of factory preparation is causing corn to creep back to a small but increasing extent into the dietary of America and even of other countries, in the form of prepared breakfast foods. Americans now eat an average of fifty to sixty pounds of corn per capita per year. Green corn, the so-called roasting ear, is widely used in the United States for a short season in late summer. Canned green corn is also in favor throughout the year; twenty-five million cans a year are now manufactured in the United States, and the quantity is steadily increasing.

The war shortage has caused corn oil (Mazola) to appear suddenly on our grocery shelves as a substitute for olive oil.

Two other food supplies of wide-spread use are made from corn: corn-starch and karo, or corn syrup, which is glucose, a liquefied sugar manufactured from corn-starch and recommended by food experts as being a thoroughly wholesome substitute for sugar or other more expensive syrups. The same grain of corn

* "Americans used to respond with a shipload of corn whenever an appeal came from famine sufferers in Armenia, Russia, Ireland, or Austria, but their generosity was chilled when they found that their gift was resented as an insult or as an attempt to poison the impoverished population, who declared that they would rather die than eat it—and some of them did."—Edwin E. Slosson, *The Independent*, March 9, 1918, p. 416.

produces in the factory both starch and oil. Meanwhile most of the world's corn, like most of the world's oats and barley, goes to feed our four-footed servants, the farm livestock. The

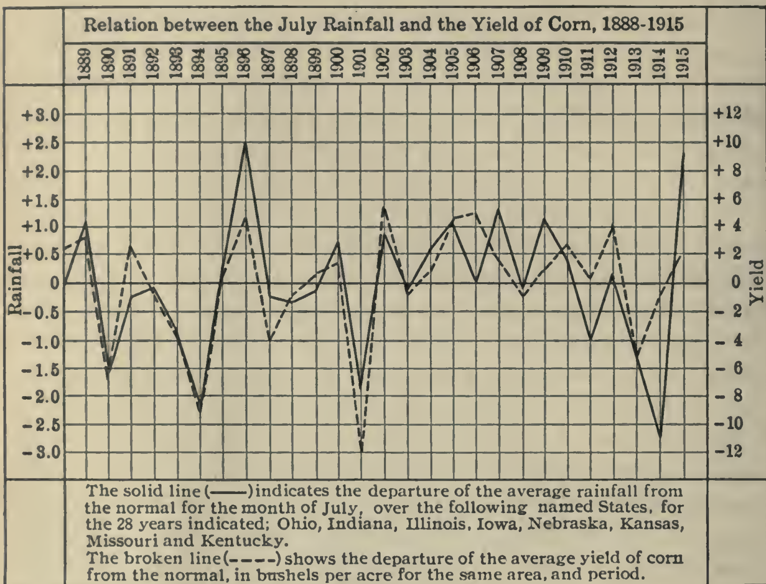

FIG. 41.—The relationship between July rain and moisture and the corn yield seems to be as absolute as the relationship between June temperature and wheat yield in Dakota. (Wm. G. Reed, United States Weather Bureau.) See Fig. 8.

total per capita corn consumption for this purpose in the United States is about twenty-eight bushels per year and in Canada four bushels.

CLIMATIC REQUIREMENTS OF CORN

Corn is a crop of the warm moist summer. It will mature if there is a five-months growing season and a hot midsummer with sufficient rainfall to keep up the growth of the plant, which at times amounts to several inches a day. Where conditions are very favorable, and a giant variety is selected, it will in a few weeks reach a height of from five to fourteen, and occasionally even twenty, feet. The speed of growth and size of the plant, which in a few weeks passes from knee-high to head-high or more, makes it require much material for its development; it is therefore very dependent upon the proper conditions for growth. As this great rush-growth of corn in the American corn-belt takes place during the month of July, this period is peculiarly critical, especially as the corn plant passes quickly to maturity, whether conditions are favorable or not. Thus August rains will not save the crop that suffered from July droughts. Mr. J. Warren Smith, of the United States Weather Bureau, states that in every year when the rainfall in Ohio has averaged less than three inches in July, the corn yield has averaged 30.3 bushels to the acre, and in every year when the July rainfall has been five or more inches the corn yield has averaged 38.1 bushels to the acre. He also found that an increase in rainfall from three inches to three and one-half resulted in an increase of four and one-third bushels to the acre. If we apply these calculations to the corn crop for five leading states in the corn-belt in 1917 (Iowa, 11,100,000 acres; Illinois, 11,000,000 acres; Nebraska, 9,240,000 acres; Kansas, 9,156,000 acres; Missouri, 7,200,000 acres) we find that one-half inch of rain might be worth 206,628,667 bushels of corn, worth at the present time $258,000,000 ($1.25 per bushel).

Other studies show that the corn plant is almost equally dependent upon heat, most of the world's crop being produced in a region where the mean summer temperature is between 70° and 80°, with a night temperature of at least 58°. So important is the influence of heat on corn that very little of this crop is raised where the mean summer temperature is less than 66°, or the average night temperature during three months less than 55°. Where it has the right temperature conditions it ordinarily ripens in Kansas in 130 days, and in Ohio in 140 days. In a cool season, however, its development is slow, as in the year 1917, when unusually cool weather caused eighteen per cent. of the crop to be in the dough stage when frost came. Ordinarily but four per cent. is caught in this condition by frost. Regions with a cool summer, such as England, Scotland, France, in fact all of northern Europe, most of New England north of latitude 44°, and Canada, excepting a part of Ontario, cannot well produce a crop of ripened corn. The heat requirement of the maize plant includes warm nights as well as warm days, so that many arid regions having very hot days and cool nights, such as Nevada, are not suited to the profitable production of corn, despite an apparently satisfactory average temperature.

Although a lover of heat, corn often does not do its best in the continuous heat of the tropics, because of lack of water and of

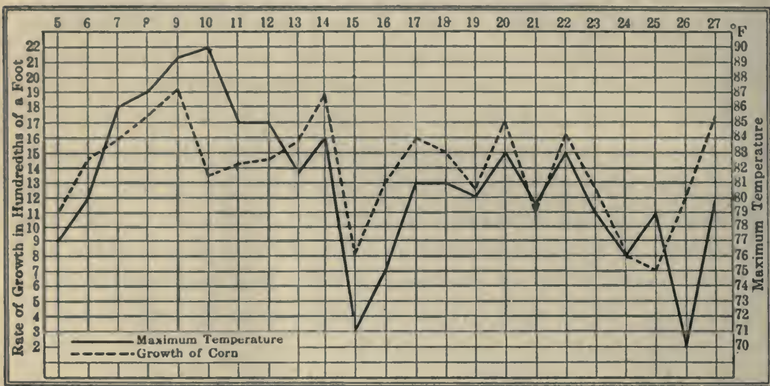

FIG. 42.—Relation between maximum temperature and daily growth of corn in Pennsylvania, July 5–27, 1889. The great fall in the growth of corn when the thermometer went from 84 to 70 shows how definitely corn is a warm-summer crop. (J. Warren Smith, *United States Monthly Weather Review.*)

humus in the soil. The yield is larger in the latitude of the central temperate zone than in its warmer parts or in the tropics, even though conditions may appear to be similar during most of the growing season. For a ten-year period the average production of Louisiana corn was 16.3 bushels per acre, while that of Wisconsin was 33.2 bushels per acre.* The cultivation of corn is, however, widely scattered throughout the warmer parts of the world between 45° north latitude and 40° south latitude, and it is quite likely that science applied to agriculture can make the yield in Louisiana equal that in Illinois or Wisconsin.

The chief regions of large-scale production may be divided into seven zones: the upper Mississippi Valley, the United States

* Some vegetables of the beet family produce nothing but leafy tops in the continuously warm West Indies, although the nourishment stored in their thick roots for the next year's seed growth makes them an essential feature of agriculture in Canada, Sweden, England, France, and Germany, and other lands of frost and cool summers. Is corn subject to this influence?

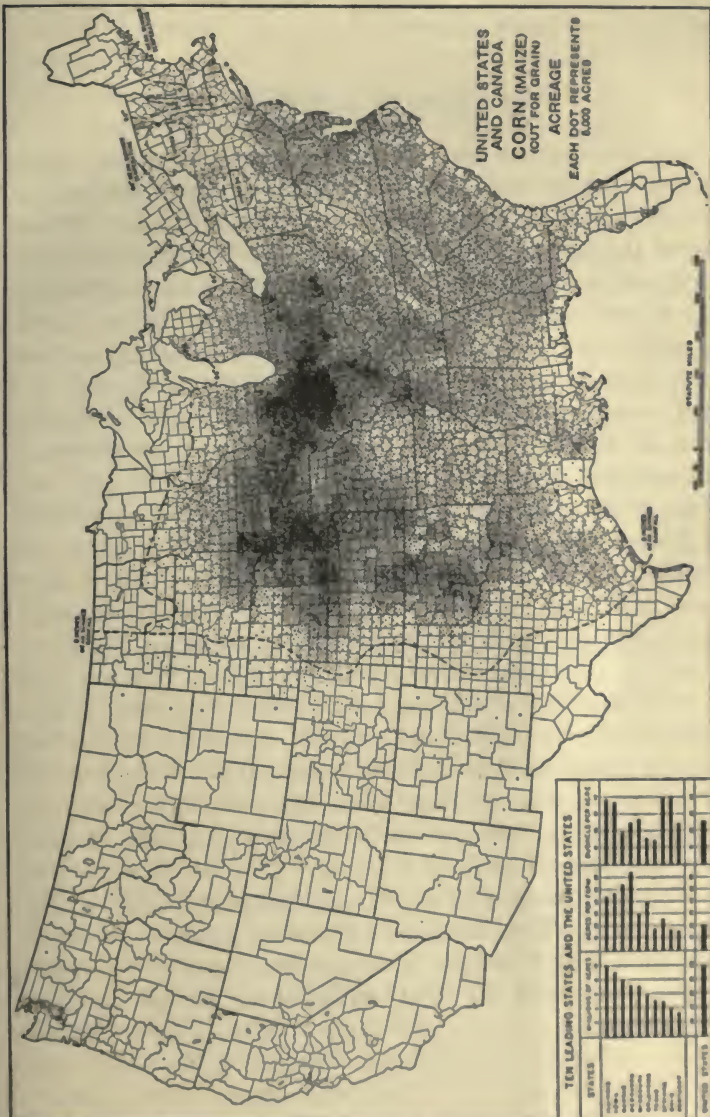

FIG. 43.—Note the close relationship to the summer rain line on the west, the summer temperature line on the north and in the Appalachian highlands. (Finch and Baker.)

cotton-belt, tropical America including Mexico, the Black Sea basin, the Mediterranean countries, southeastern Asia, and the Paraná Valley of South America.

THE AMERICAN CORN-BELT

Of these the first and most important, indeed more important than all the others combined, is that of the upper Mississippi Valley, the so-called corn-belt of the United States. Three-fourths of the world's corn is grown in the United States, and three-fourths of the American crop is grown in the Mississippi Valley. Corn is grown from the Gulf of Mexico to the Great Lakes, and from the Atlantic Ocean to western Kansas and in scattered areas beyond, but the region of greatest production, the corn-belt proper, reaches from central Ohio to central Nebraska, and from Kentucky and central Missouri into southern Wisconsin and southern Minnesota. It includes all the state of Iowa, nearly all of the states of Illinois and Indiana, Ohio, and about half of Missouri, Kansas, and Nebraska. The region is one of the finest agricultural sections in the entire world. Hundreds of miles of almost level prairie are rarely varied by undulations steep enough to interfere with the laying out of roads on meridians and parallels at regular intervals of one mile. This soil that lies so satisfactorily for tillage is naturally fertile, and so free from stones that the worker can ride the cultivator with which he tends the corn. Most of these cultivators till both sides of one row of corn, and some of them even take two rows of corn at once. Thus a farmer unaided can cultivate a large area of corn, in many cases more than forty acres, and produce the grain that was so cheap for many years. Serious droughts are infrequent in the corn-belt. The abundant rainfall of summer comes in short showers which do not seriously interfere with agricultural operations, and the heat is sufficient for an excellent growth of corn.

RELATION OF CORN TO OTHER PRODUCTS OF CORN-BELT

Corn is not the only crop in the corn-belt. On a single farm there may be, in addition to corn, fields of wheat, oats, and hay which require the farmer's labor at different seasons from that of the corn (see section on oats); also there may be a field of grass upon which cattle can graze.

A surprisingly small portion of the corn-belt grain goes directly to the market as grain. In the parts of the corn-belt farthest distant from the great markets, as Iowa and Kansas, the major part of the corn is grown as a supply crop (a crop used on the farm), is fed to the farm animals, and goes to market in the more condensed forms of beef, pork, mutton, horses, mules, and poultry. Near the great markets, where the transportation is cheaper, as in Illinois, the proportion of grain sent directly to market is much greater. In 1910, forty-eight per cent. of the corn of Illinois was shipped out of the county where it was produced. In Kansas the corresponding figure was twenty-two per cent.; in Texas, yet farther from markets, it was seven per cent.

THE IMPROVEMENT AND EXTENSION OF CORN GROWING

Conditions in corn growing improve from year to year as the scientific agriculturists breed new and better varieties and select the seed according to the known laws of heredity. In a recent corn test in Illinois one large field yielded forty-eight bushels to the acre and a similar adjacent field yielded seventy-seven bushels to the acre; the only difference in conditions was the superior, well-selected seed that produced the larger crop. The breeding of earlier ripening kinds will doubtless make possible a greater growth of corn in northern parts of the United States and in southern Canada, where it is not now a dependable crop. Its culture is slowly creeping northward into the cold, westward into the drought, and southward into the land erstwhile monopolized by cotton and "Molly Cottontail." At present it is grown in Canada only near the Great Lakes and in much of the northern part of the United States it is of little importance.

Another means of extending the area and value of corn production, especially in cool climates, is offered by the silo. This device, recently introduced from France, is a barrel-like structure, ten to thirty feet in diameter, made of wood or concrete. Its use is rapidly increasing, because by it the entire corn plant, stalk, blade, ear, and husk, when chopped into bits, may be kept moist, warm, and edible for cattle for one or two years. In this form, called silage, corn makes its greatest possible food return

FIG. 44.—A good measure of the advancing season and of the agricultural advantages of the South. (U. S. Dept. Agr.)

to ruminant animals, is much used in the feeding of dairy and beef cattle, and, since it can be put away some weeks before it is fully matured, can be grown much farther north than can the ripened grain, which can be kept only after fully maturing in the field.

It is difficult to appreciate the full possibilities of the silo as a factor in the increase of American animal industries, especially the milk supply, for which the succulent silage is so well suited. No other easily grown crop is the equal or half the equal of corn as coarse forage, and the silo easily cuts two to three weeks off the corn season and therefore permits the grain to be grown in a wide belt to the north and west of the existing corn-belt, in a region where the seasons, shortened because of frost and drought, do not permit it to ripen its grain, but do permit it to make a stalk and perhaps start the ear. The silo, which was a novelty in many American localities in 1900, has now become as common in these same places as the Ford automobile. A few years ago along a road nine miles long just west of the Adirondacks in New York State there was one silo; at the end of a decade every farm but one along that same road had a silo. This wonderful barn even helps corn to cross the Canadian boundary in the Red River Valley of the North and to extend to the great plains of the United States.

In the short summer of parts of New England, the silo helps in a suggestive industrial combination. While corn may not ripen, it easily and surely gets ready for table use—the so-called roasting-ear stage—so that from a field of sugar corn, wagon loads of ears may go to the canning factory or the vegetable market and the stalks may be put into the farmer's silo to feed his dairy cattle—an important improvement in systematic agriculture. Moreover, the canned corn of the North is in some markets recognized as of superior quality, because the cool climate delays ripening and gives it a longer period in the edible milky condition.

CORN IN THE COTTON-BELT

Corn is the crop second in importance in the cotton lands of the South, but cotton is so overwhelmingly the main crop that the corn crop is often insufficient for local use, and import from the corn-belt is necessary. This is not the case in Florida, southern Alabama, and Mississippi, where cotton is little grown and corn covers over half the crop area. Corn, but little used as human food in the northern half of the United States, is in common use in the Southern States and is often the chief breadstuff of white and black alike.

The production of corn in the Southern States is rapidly increasing because of its high price, because of the injury to cotton by the boll weevil, which makes another crop necessary, because of the high price of meat products that can be produced by the corn, and lastly, because of the systematic attempt to promote science in agriculture. The states of the American cotton-belt, probably because of their shockingly wasteful agriculture, have led their Northern neighbors in the development of the county farm demonstration service. By this service each county has one or more officials whose sole task it is to promote in every possible way better crop production and better life

FIG. 45.—Barn with masonry silos. The chopped corn goes up the pipe by air pressure. (U. S. Dept. Agr.)

conditions among the people. Among their activities is the promotion of boys' corn clubs and pig clubs, and girls' tomato and chicken clubs. The yield of corn on these school-boy acres, often twice or thrice that produced by their fathers, and four or five times that of the state average, has been so astonishing as to result in a distinct improvement in crop yield throughout large districts. Thus the yield in North Carolina between 1896 and 1905 was 13.4 bushels to the acre; in the next decade, 1906 to 1915, 18.3 bushels. In the same time the yield in South Carolina rose from 9.5 bushels to 16.7, an increase of forty-three per cent.; in Georgia the yield increased from 10.5 to 14 bushels.

Examination of the figures within this last decade of education proves the increase to be progressive. Thus in North Carolina in its first two years the decade showed an average of 15.9 bushels, while in the last two years the average was 20.7 bushels. There is no reason, except human shiftlessness, to which all mankind is more or less inclined, why this increase in yield should stop until it has reached forty or fifty bushels per acre in North and South alike. There are in almost every township of the United States farmers who regularly make yields of wheat, corn, and other crops that are twice and sometimes even thrice the national or local average of that crop. These men have no patent. They merely utilize well-known facts in a careful way. The demonstration service in the South has diffused that knowledge; and one of the first steps of the 1917 campaign in the United States for more food was to put one of these experts in nearly every county in the United States.

AMERICAN CORN EXPORTS

America has often exported a hundred million bushels of corn annually, and sometimes has doubled that amount, to northwestern Europe, where the grain is fed to farm animals, including work horses. It is almost always sent from the region of heaviest production in our corn-belt, after being assembled in the markets of St. Louis, Kansas City, Omaha, or Chicago. From these points it passes by lake steamers and the Erie Canal or by railroads to the Atlantic ports between Norfolk and Montreal for export by the North Atlantic steamships. A smaller amount goes to Gulf ports, but they are not desirable stations from which to export corn because of the humidity and heat of the Gulf.

At various times before the Great War, exporters of corn from the United States have unsuccessfully attempted to spread the habit of corn-eating among the peoples of northern Europe. At the present time, owing to the necessities of war, there are doubtless many more corn eaters in Europe than ever before.*

* In Switzerland, for example, the Italian portion of the population has been eating corn for a long while; and during the food scarcity of the war the government has encouraged substitution of corn bread for wheat. It has been used in all official institutions, and the poor people were permitted to buy it at twenty per cent. below normal price. Cook-books have

The American corn export has declined of late from 195 million bushels per year in 1896-99 to fifty million bushels 1910-11, and even the Great War has been unable to increase it, although the crops of 1916 and 1917 were 2.5 and 3.1 billion bushels respectively. This decline in export is not due to crop failure, for the average crop in 1896-99 was 2,040 million bushels and in 1910-11 it was 2,719 million bushels. With an increasing population we have a per capita consumption that rose from twenty-six bushels in the first period to about thirty-one in the later period. As we have no new corn lands to turn to and some of the old ones are declining in natural productivity, we seem to have reached the end of an era of cheap corn. When Kansas corn land was worth $10 to $25 an acre there was plenty of corn to be had; it was at times cheaper than coal and was burned by the farmer as fuel in the family stove. We have opened no corn frontiers since 1895 and the price is rising from natural causes. It was about thirty-four cents on the Chicago market in 1899. Ten years later it was sixty-seven cents, and the influence upon the European buyer was shown by the decrease in our exports during that decade from 213 to 38 million bushels. The lessened corn export has helped to drive up the price of other stock foods, producing world-wide price disturbance and industrial adjustments. The war has sent the price of corn and its derivative, meat, to prices heretofore unheard of outside of beleagured cities; in the post-war period the prices will stay relatively high because of the great demand for the products in which corn appears on the market—pork, beef, mutton, horse, mule, milk, butter, cheese, poultry, eggs. More corn can be had only by the use of more intelligence, and especially of more labor, both of which mean increased cost.

been issued telling people how to prepare it in nourishing and agreeable forms; consequently it is now frequently seen in homes, hotels, and restaurants. The prejudice against it seems to have been expelled, and it is almost certain that its use as food will be greater after the war than before, even when the old ratios between grain costs are reëstablished. (See United States Commerce Report, July 7, 1917.)

CORN IN TROPICAL AMERICA AND MEXICO

The Spanish-American highlands, reaching from the boundary of the United States to Argentina, comprise the third corn-growing zone. No corn is exported from these countries and little is raised for farm stock, since the animals graze the year round. In every one of them—Mexico, the five Central American countries, and Colombia, Venezuela, Ecuador, Peru, and Bolivia—the majority of the population, native Indians or half-breeds who live in the higher altitudes, derive a surprising amount of their nourishment from corn and beans. Many of these Indians and half-breeds, known as peons, have a very low standard of living. The simplest shelter suffices; and, rather than work much, they content themselves with beans, one of the most easily grown of vegetables, and corn, the cereal which they can most easily and cheaply grow. In Mexico and other of these countries the commonest form of corn bread is the "tortilla" or hot corn cake which can be baked over an open fire. This monotonous diet is made acceptable by a flavoring of pepper, which the people eat in quantities that seem appalling to the foreigner who tries their dishes. It is said that the flesh of a Mexican peon is so impregnated with pepper that if he dies in the wilderness the coyote will not eat him. For similar reasons cannibals complain that white man tastes of salt and tobacco.

In these mountainous Latin-American countries the lowlands are scantily peopled, the population living chiefly on the plateaus where most of the land is hilly. The corn fields are usually small, and the production, which is almost always for local consumption, resembles the family garden rather than the broad fields of the American corn-belt. Some of these plateau patches are of great fertility. It is said that there are certain fields in Ecuador where the soil, made of dust blown from the volcanoes Chimborazo and Cotopaxi, and with the usual richness of lava soils, has yielded crops of corn continuously for 200 years. There is no prospect that corn will ever be grown for export from these countries in any important quantities.* As their in-

* Venezuela exported a little corn to the United States in 1917, under the stimulus of war prices, but there is little immediate prospect of its playing any large rôle.

dustries expand they will develop other resources. All Mexico north of San Luis Potosi (lat. 22°) is importing more and more corn as its mineral resources and railroads give employment to workers. The climate in most parts of the Mexican highland region north and west from the city of Mexico is too dry for corn without irrigation, so that while this crop covers over thirty per cent. of the total crop land, the yield is less than fifteen bushels per acre. The crop is grown chiefly on the outer slopes of the highlands at about the latitude of the southernmost bend of the Gulf of Mexico.

Among the negro population of the West Indian islands, corn is widely used for food, but not enough is grown for home use, and here, as sometimes in Yucatan, there is a relatively large import of corn and corn meal from the United States.

THE CORN REGION OF THE BLACK SEA BASIN

The corn zone second in importance to the United States corn-belt is that of the lower Danube Valley and adjacent districts of the Black Sea Basin in southeastern Europe, comprising part of Hungary, most of Rumania, northern Bulgaria, and a little corner of Russia to the west of Odessa. Further to the eastward the climate becomes too dry and in the Volga Basin near the Caspian Sea the aridity is too great for any tilled crops. The greater part of Russia and the regions to the north of the Danube Valley and to the west of Hungary are too cold for corn. The crop of this Danube region is from 350 to 400 million bushels a year, about one-tenth of the world's supply, and about equal to the crop of Illinois, our leading corn state. Although occupied by several different nations, the lower Danube Valley is, like our corn-belt, one economic region. Some corn is also grown in the more hilly part of the Danube drainage basin on the slopes of the Balkan Mountains in Serbia and Bulgaria. Austria-Hungary produces about as much corn as Indiana; Rumania somewhat less than Oklahoma, and Russia somewhat less than South Carolina. The greater number of the people in this corn region are rather poor, and they depend for breadstuff almost entirely upon corn, exporting to western Europe the wheat which they also grow. They also export some corn to western Europe, Russia sending

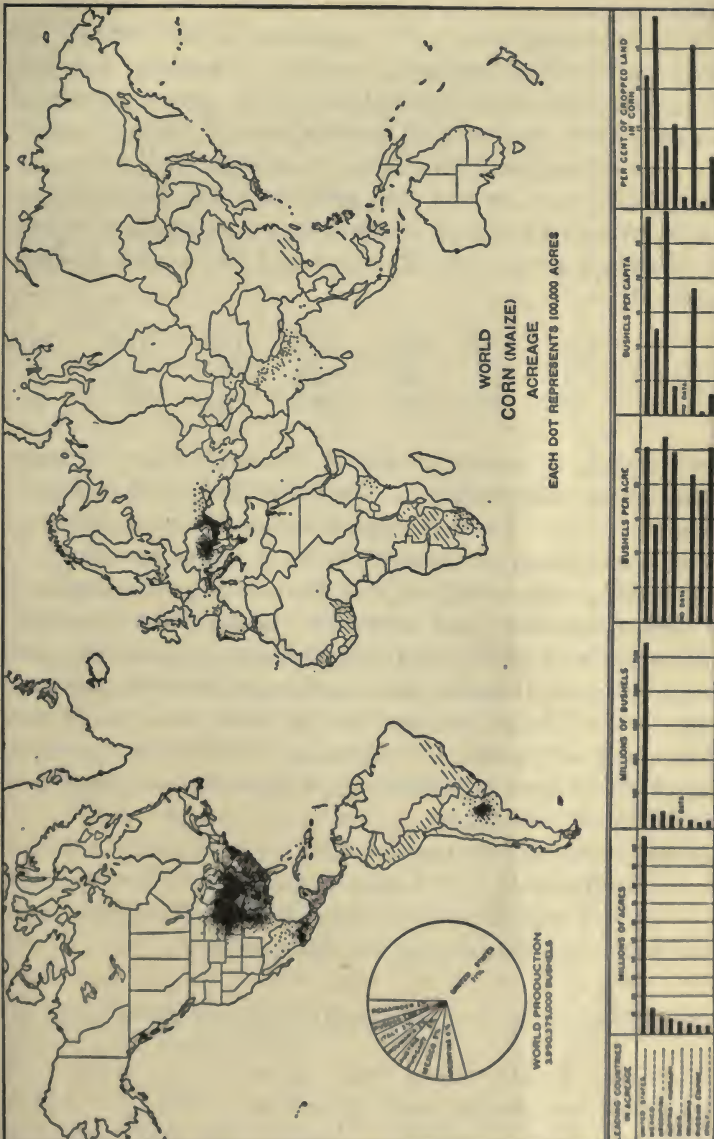

Fig. 46.—Note the restriction of corn area in comparison with wheat area on wheat map, Fig. 20. (Finch and Baker.)

forty per cent. of her crop and Rumania fifty per cent., before the war.

Corn is very important in the agriculture of this region. Of the cultivated land in Rumania, one-third is in wheat, and over one-third (or one-sixth of the total area) is in corn, as compared with a little over one-fourth of the *total area* of Illinois in corn. In the Black Sea Basin droughts are encountered with ever-increasing frequency as one goes eastward. The inferiority of the region as a corn producer is shown by a comparison of annual yield in bushels per acre in Rumania and Illinois for a seven-year period:

	1904	1905	1906	1907	1908	1909	1910
Rumania	4	12	25	12.5	15	13.4	21.2
Illinois	39.8	36.1	36	31.6	35.9	40	39.2

The certainty of reward is one of the surest spurs to labor, and conversely, uncertainty of reward is one of the greatest deterrents to labor. The sure relation between labor and harvest in Illinois and the great uncertainty in Rumania, as shown by the fluctuating corn yield, help to explain why one region is filled with progressive and aggressive farmers and townsmen and the other with rather backward peasants who still use oxen for work animals. Despite these handicaps Rumania managed to send to the foreign markets during these years about one-third as much corn as the United States. Water transportation and markets are more accessible to the Rumanian corn-belt than to that of the United States.

Hungary (182 million bushels, 1913) grows nearly twice as much corn as Rumania (118 million bushels, 1913), but consumes nearly all of it within her own boundaries. The people have eaten a great deal of it during the Great War.

CORN PRODUCTION IN MEDITERRANEAN AND ADJACENT REGIONS

Most of the Mediterranean basin is too dry in summer for the growth of corn except under irrigation. France has a little patch of corn climate wedged in between the cool summer of northwestern Europe and the dry summer of the Mediterranean. The large yield of corn per acre, however, makes it greatly desired as a crop by peoples poor enough to use it as their chief food. Italy with 100 million bushels a year (about equal to Kentucky) is the leader, producing twice as much as Spain and the south of France combined. Wherever corn can be irrigated it is grown for home use, largely as human food, in Turkey, Greece, and Egypt, where it is an important crop; but the dense population consumes all of the 100 million bushels of corn and wheat produced along the Nile, and in addition imports some of both grains. In Egypt the corn land is irrigated every ten days from July to October. In the northwest of Portugal and Spain, close to the sea, there is enough rainfall for a poor crop without irrigation, but the yield is low. The crop of Portugal about equals that of Maryland and Delaware. Conditions of corn growing in Portugal would make the Illinois farmer laugh with derision, for Portugal unfortunately is a country where most educated men think that work would hurt their social position, so that agriculture and industry are left in the hands of foreigners and the uneducated, with the result that production is far less than it might be under scientific management.

The desert heart of the Old World and regions adjacent to it, extending from southern Morocco across northern Africa, Arabia, Persia, and the deserts of central Asia and Gobi to the Great Wall of China, can, like Egypt, produce corn only where irrigation can be practised. The people of the Barbary States grow some corn, as do those of Palestine and Asia Minor. It is grown to some extent in Persia, and it is relatively important in Bokhara and other oases of Russia, central Asia, and Turkestan. In all of these regions it is so highly prized as human food that no surplus is available for export from the small area that can be irrigated. The only possible exception to this condition is the at present unutilized land of Mesopotamia, once the seat of world empire, now almost empty, but capable today of larger production than ever if it can be freed from one of the greatest curses of mankind—the misgovernment with which the Turk has long cursed this historic land.

THE CORN-BELT OF SOUTHEASTERN ASIA

The sixth corn zone is to be found in the moist countries of southeastern Asia. In the drier parts of the monsoon countries, especially China and India, there are districts as well suited to corn as to rice, if not better, for rice flourishes in the wet summer, whereas corn flourishes in the moist summer, when rain is interspersed with dry days, during which the ground gets dry enough to be plowed without becoming mud. In these less wet parts of China and India, the American grain is extensively grown, though not for export. The amount grown in these countries cannot be estimated; but vast quantities are eaten by the 700 million inhabitants. It is extensively grown in the part of China adjacent to Pekin and in southern Manchuria. Some of the battles of the Japanese-Russian War were fought in fields of standing corn. In India the chief centers of corn production are along the Ganges River and in the irrigated lands of the upper Indus Valley.

THE PARANÁ VALLEY

The seventh and last corn zone is the Paraná Valley of South America. The lower part of this valley is similar to the lower Mississippi Valley in latitude and climate. To understand the character of this South American region we should turn the map of it upside down so that the lands along the Paraná can be likened to the swamps and forests of Louisiana, forming a region from which the moisture gradually decreases through the corn-belt and the wheat-belt to a grass-belt, as in the regions of Louisiana, Oklahoma, Kansas, and Texas. In Paraguay, near the edge of the tropics (comparable to the extreme south of Louisiana and beyond), a rather large amount of corn is grown for local use. Further down the valley in the cooler latitudes are several provinces of Argentina and a small area in Uruguay where corn is of increasing importance. While the methods are said to be exceedingly careless, the soil is very fertile, and the crop is receiving more and more attention from the large number of Italian farmers who have settled in that country. Argentina exports at the present time a larger proportion of its corn crop than any other country of the world, because the people, about as numerous as those of Illinois and Iowa, do not yet use it largely as food, and for fattening livestock alfalfa generally suffices.

Another reason why so little corn is used locally is the absence of the hog industry, which requires rather intelligent farming, and lands fenced off for the care of the animals. These conditions are not found among the corn growers, usually transient tenants, who rent the lands from large landowners, possessors of Spanish grants. Often they do not have a shelter under which to put the corn, but merely cover it up with fodder so that sometimes it is much injured by the heavy rains which at times make the roads so wet and muddy that for weeks at a time the corn cannot be taken to the railroads for shipment to the fleets of tramp steamers that lie in the Paraná at Rosario and Buenos Ayres.

During the four-year period from 1907 to 1910 Argentina exported seventy-seven million bushels per year or almost exactly one-half her crop, while the American export of fifty-two million per year was a little over one-fiftieth of the total crop. The possibilities for the relative increase of corn production are probably better in the Paraná Valley than in any other corn zone, because of the sparse population and large area, of which only a tenth is yet in cultivation. The present production is about equal to that of the Mediterranean countries. As compared with the United States there is, however, a disadvantage in the less regular rainfall, which comes a little later in the summer than the American. This will be a permanent hindrance to great production because of the uncertainties of the harvest. Thus the fine crop of 1906, 195 million bushels, nearly thirty bushels to the acre, led to enlarged plantings the next year; but the crop fell to seventy-two million and the yield to thirteen bushels per acre. The area planted in 1908 was reduced to that of 1906. In 1911 the crop throughout the country was a failure, giving but 3.4 bushels per acre. In 1915 its yield exceeded that of the United States, being 33.8 bushels, with a crop of 338,000,000 bushels. The next year it was more than cut in half, with 161,000,000 bushels, and but sixteen bushels to the acre. This indicates a permanent handicap. Compare the Illinois yield above mentioned.

Corn is grown to some extent in a few scattered places, such as northern New Zealand and the eastern margin of Australia; but there it has to battle against droughts and scanty rainfall and because of these obstacles it is an unimportant crop. The same conditions prevail in South Africa. The grain may be grown almost anywhere throughout the tropic latitudes and is grown in many scattered places in Africa. This continent may sometime have European management for its industries and become a large corn grower. It is probably true, however, that corn does better in the temperate zone with its chilly nights toward the end of summer than it does in the unmitigated heat of the tropic lowland. But as corn must have hot nights for a part of its growth, the cool nights of arid climates debar it from many irrigated districts in the western part of the United States. This climate, and the dry summer of the Pacific Coast, cause corn to be of almost no importance west of the Rocky Mountains. Both coolness and aridity are unfavorable on the Great Plains of the United States at the eastern base of the Rocky Mountains.

The present leadership of the United States in the world's reported corn crop is well shown by the following:

	World Crop million bu.	U. S. Crop million bu.	U. S. Percentage
1911	3,481	2,531	72
1912	4,369	3,124	70
1913	3,605	2,446	68

THE FUTURE OF THE CORN SUPPLY

Corn holds less probability of increased production than wheat. The plant is too exacting in its climatic needs and cultural methods. It cannot stand the cool climate in which wheat thrives, and while it requires much more moisture than wheat, it cannot stand the wet climate of rice, and is for this reason at a disadvantage on the moist Gulf Coast of the United States. Here continued rain often prevents cultivation and lets the weeds and grass get a dangerous leadership.

The tractor offers less possibility of revolution in corn growing than in wheat growing. Unlike wheat and the other small grains, corn cannot be sown broadcast, but each plant must be given the monopoly of several square feet of soil to attain its gigantic size and make its great ear of grain. Therefore it must be cultivated; and for this work the tractor offers less aid at the present time

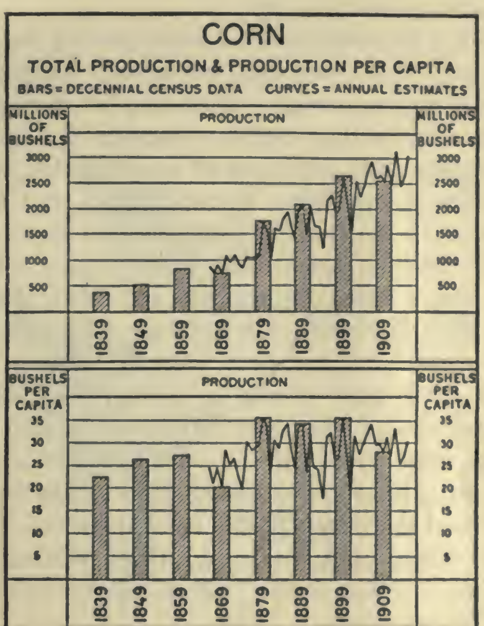

FIG. 47.—Compare the per capita with the total output and one sees a reason for change in land values and meat prices, and therefore of nearly all other prices.

to corn than to wheat, which requires merely to be sown and harvested. While the tractor can prepare the ground for corn, the limiting factor in its production is cultivation after planting; and for this it is difficult to see how the tractor can give such wholesale aid as it does in the drawing of gangs of plows, harrows, and reapers. It is also unfortunate that no generally satisfactory labor-saving machine has been invented for the harvesting of corn. As a result most of the corn fodder in most of the corn-belt of the United States is wasted. The practice is to let the frost kill the corn plant. After the grain is thoroughly dry, the farmer drives through the field with a wagon, and husks the ears as he goes and throws them into the wagon bed. Sometimes the ears stay out thus until after the snow melts in the spring. Ordinarily this work is done in the autumn and cattle are turned in to glean some of the fodder, but it has by this time lost most of its virtue and much of it is trampled into the ground by the wasteful beasts.

Furthermore, the cultivation of corn, leaving the ground bare, favors erosion. It is, therefore, not so well adapted to hills as are the small grains—another limitation of the corn area.

For these reasons the possible extension of corn land seems meager in comparison with that of wheat, which has two great northern zones of expansion, across Eurasia, and another from Lake Superior to the Rocky Mountains; three great dry zones, one from the Caspian Sea to Lake Baikal, another from Alberta to Texas, and a third throughout the whole length of the Argentine. The European corn lands are already on the margin. The Asiatic corn lands are already on the margin. On neither continent is there much possibility of increase. The American corn-belt may extend somewhat farther north into the lands of cool climate, and westward into the lands of drought. The Argentine belt also may be enlarged westward into the lands of drought, and there may be two belts along the outer edges of the African tropics, but these are quite problematical. Better culture seems to offer better promise of increased production than does the extension of areas.

MILLET AND SORGHUM—CORN SUBSTITUTES

While the possibilities of extending the corn lands are plainly less promising than the possibilities of increasing wheat lands, we have by no means reached or approached the maximum corn production, especially since corn, whose chief service is to feed the farm animals, achieves this end by two means: one the production of corn, the other the production of stalk for coarse forage.

Indian corn, which our predecessors on this continent cultivated, is not the only plant of this general character which renders these services. In the dry country of South Africa we have recently found what we call Kafir corn, a variety of sorghum, a plant much resembling the broom corn, from which brooms are made. Kafir corn bears little round seeds on the ends of short broom-like straws in the form of a bunch or brush. From China we have recently introduced other varieties of sorghum, with the same fruiting habit, and from India and many other

Fig. 48.—Compare this map with the rice map of India and see the difference between wet-land and dry-land crops. (Finch and Baker.)

parts of the world comes yet another class of plants much like these, called millet. Both of these groups of plants have grown for a long time on the edge of Old World deserts. They have become adjused to the dry environment, especially the sorghum, which the Chinese farmers have for centuries been growing under dry conditions until by the process of natural and artificial selection some varieties have developed a marvelous power of pumping water out of the earth. So desperately do they fight for water, that in lands of little rain a crop failure can be counted on for the year after the sorghum has grown, so thoroughly has it exhausted the subsoil water. This valuable ability really means that the sorghum can make one crop out of the scanty rainfall of two years, which is quite insufficient for the common kinds of corn.

Sorghums and millets produce small round seeds. Some varieties have been specialized to produce grain to serve as food for men and beasts. Others have been specialized to produce stalk as food for the beasts only. Many varieties of these corn substitutes have been grown for centuries, indeed for ages. Their recent introduction into the United States has shown that they are distinctly superior to common corn on the western edge of the corn-belt, and beyond question they are extending the corn-belt farther into the dry lands of Texas, Oklahoma, Kansas, and Nebraska.

By selection the Chinese sorghums have been much improved within a few years. They have established their distinct superiority over Indian corn, and have replaced corn in many counties of this southwestern region. The 1,250,000 acres of this crop in the United States in 1910 had increased to 4,000,000 acres in 1916, an area greater than that of the potato lands of the United States. We can better appreciate the possibilities of these plants if we understand their importance throughout the world.

Millet is probably even more important at present than sorghum. It is a plant not unlike corn or sugar cane in general appearance, with its seed in a head somewhat like that of the cattail. It is estimated that one-third of the human race uses the seed as food. We can scarcely say more of wheat. The grain, which is smaller than the wheat grain, is boiled and used like rice, or eaten parched, or made into meal and porridge. There are many varieties, some a dozen feet in height. Some are grown for forage only, some for human food, some for both purposes; some varieties furnish fuel in their woody stalks. In parts of northern China it is almost the only fuel used by the peasant farmer, who has a low brick platform around one side of the room, with a slow fire beneath it made of millet stalks. By this means a very small amount of fuel keeps the brickwork warm, and on it the family sits and sleeps.

Millet is grown to some extent in most parts of the temperate zone and also in the tropics. It is grown occasionally in nearly all parts of the United States for forage only, but the excellence of corn in the East and South keeps it from having any wide use in this part of the country. Its cultivation for forage on the western edge of the American corn-belt is, however, very rapidly increasing. In Europe, also, in the Mediterranean region and Russia, it is extensively grown for forage. It is used as food

FIG. 49.—Compare this area with the location of the corn area on the corn map, and also compare it with the drought map, Fig. 14. (Finch and Baker.)

to a slight extent in Europe and among the natives of Mexico and Africa, but it is in Asia that millet reaches its greatest importance. Japan is credited with an annual consumption of thirty-five million bushels. India annually cultivates forty million acres, while her wheat crop covers but twenty to thirty million acres and that of the United States but fifty million (1913, only 46 million 1917). In China also millet is widely used as food, and there are records showing that it has been so used for about 5,000 years. The accounts of the Russo-Japanese War show that some of the campaigns were waged in Manchurian fields of millet, as well as of Indian corn. E. R. Scidmore *

* *National Geographic Magazine*, April, 1910.

says that a giant millet ten or twelve feet high, along with a short millet and sorghum, is extensively grown in Manchuria. The giant millet looks like the corn shocks of Indiana and "is used for food, fuel, distilled drink, mats for the floor, and for building material, and has thousands of uses and the yield is a thousandfold." Millet seems to have been very important to the prehistoric lake dwellers of Switzerland.

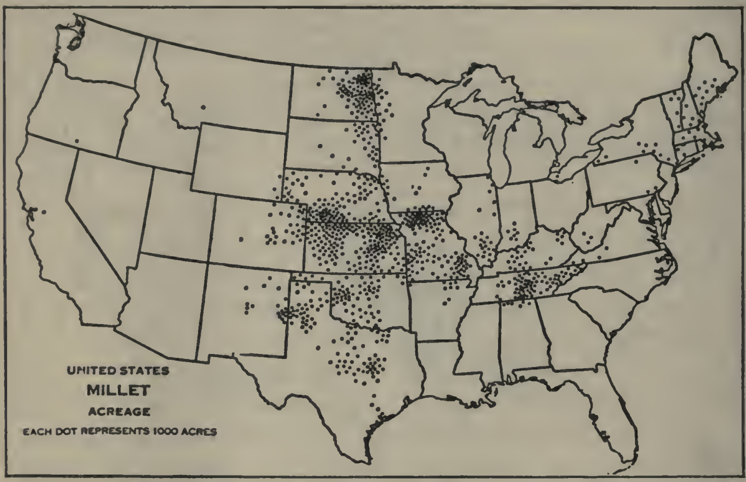

FIG. 50.—(Finch and Baker.)

The sorghum family, until recently little known in the United States, is also important in many parts of the world. To this family belong the sugar-producing sorghum (see chapter on Sugar), and many other varieties entirely unknown in this country. They are tall plants resembling millet in appearance, except for the different form of seed-bearing head. They are substitutes for both millet and corn. In China, India, and Africa their use as forage and as human food is very common, while some of the many varieties are cultivated for human food in nearly all the warmer countries of the world. One member of this family is dhurra, the oft-mentioned food grain of many African tribes. For example, it is said to be the staple food of the native population in the valley of the Blue Nile, a typical piece of transition land between the Sahara desert and the African forest.

In these millets and sorghums lies the great hope of extending the corn-belt into arid lands. A recent report on the agriculture of the Imperial Valley, that interesting American counterpart of the Nile Delta, shows that in June, 1918, of over 488,000 acres under cultivation, 150,000 were in milo maize (an imported sorghum), 110,000 in alfalfa, 75,000 acres in cotton. Already the experience of the American West is being copied in Argentina, where the Central Argentine Railroad Company is making an effort to duplicate the experience of Oklahoma and western Kansas by persuading the farmers of the provinces of Santiago del Estero and northwestern Santa Fé to grow kafir corn and milo maize instead of Indian corn, which in this territory suffers from frequent drought. These grains may perhaps also attain great importance in Africa, the land of their nativity: for there is a very long belt where these grains are today grown in small quantities throughout north Africa at its widest from the Arabian Sea to the North Atlantic, and across south Africa near the tropic of Capricorn. Under conditions of order and the opportunity to trade, these lands may, like Java, become populous with grain growers, who will raise sorghum and millet for export. It is conceivable that this region might in time yield more than the American corn-belt.

As these grains have fed countless millions for countless centuries in both Africa and Asia, they may also if needed become food for the American and European as well as for his beast. Experiments in this direction by the United States Department of Agriculture are reported as follows:

> To many palates the grain sorghums more nearly resemble buckwheat in flavor than they do corn or wheat. The flavor is quite generally regarded as agreeable, and the grains are conceded to be wholesome. Though their protein is less completely assimilated than that of corn or wheat, they are nevertheless, with the exception of kaoliang (one of the Chinese sorghums) a fairly good source of this nutrient. Furthermore, the sorghums are a good source of carbohydrate and furnish this important food constituent in a form very completely available to the body. The use of the grain sorghums in general offers variety to the diet, and in regions where other cereals are not so successfully grown they may contribute materially to the supply of materials suitable as human food.*

* Bulletin 470, p. 30.

CHAPTER VI

POTATOES—STARCH FOOD OF THE NORTH

If at any time any one fears the early approach of serious food shortage, let him consider the potato and take comfort. This article of food is second only to wheat in the number of times per year that it is eaten in America, and in Europe it probably stands first. Analysis shows that it is very close to wheat in actual food value; but it contains so much water that we have to eat four times as much potato as wheat in order to obtain the same amount of nourishment.

So far as land resources are concerned, Europe may raise many more potatoes than it now grows, and North America can easily multiply its potato area thirty-fold and then double the average yield per acre. Furthermore, this increase can be made without reducing the amount of grain crops, milk, or meat produced.

The potato has revolutionized Europe; it raised Germany from a third-rate power to a world menace, and if need be it may revolutionize the economic status of a great section of central North America from central Ohio to the forests of the Ontario highlands, and from Newfoundland to Michigan, Manitoba, Alberta, and Alaska. Indeed, so nourishing is this food of which North America may multiply its crop sixty-fold, that Professor Graham Lusk, of the Cornell University Medical School, reports a case of the entirely satisfactory support of a human being on nothing but potatoes and vegetable fat.*

The potato, which is chiefly a starch food, shows the ingenuity with which plants store away their wealth much after the fashion

* "A remarkable experiment on the effect of a potato diet has been reported by Hindhede. An individual partook of a diet of between four and one-half and nine pounds of potatoes daily, with some vegetable margarine, during a period of nearly three hundred days. The rule was to eat only when hungry and then the potatoes could be taken at the rate of an ounce a minute. During the last three months (ninety-five days)

of men, who lay up treasures in banks or storehouses. Starch is really the surplus nutrition which the plants store within themselves for future needs or for their offspring. Sometimes it is packed in the seeds, as in the grains; or in the roots, as in sweet potatoes; or in the tuber, a peculiar underground stem, as in the white potatoes; or even in the trunk of the tree, as in the sago palm. At some later time of need it makes the plant grow, or, if we eat it, it helps to make fat and heat to keep the body warm and gives energy for work.

The potato is a native of the elevated valleys of Chile, Peru, and Mexico. It was brought to Europe by Sir Walter Raleigh in 1586, but did not come into general use on the continent until the middle of the eighteenth century. For two centuries it was grown in many localities for fodder, the people objecting to eating it and only adopting it when grain crops failed. It should be said in defense of these conservatives that potatoes were not so good then as they are now, since they have been greatly improved by deliberate breeding. We owe much to the Rev. Chauncey E. Goodrich, of Utica, New York, who greatly improved potatoes and created several new varieties.

The creation of new varieties is very simple. The ordinary method of crop growing is to cut up a tuber and plant the pieces, which sprout and establish themselves with the starch they contain. Thus the potatoes produced are in a sense a continuance of the parent potatoes, and are of the same variety, whereas the seeds, being hybrids with other plants, differ so that all one needs to do to establish a new variety is to plant seeds and raise plants, each one of which is a new variety. One out of a few hundreds or thousands will be worthy of reproduction.

Since the potato yields twenty to thirty times the weight of wheat, barley, or oats, its importance as food supply in densely peopled regions is at once apparent. Next to corn it is the greatest food plant we have, and outside the corn-belt it is without a rival in North America, Europe, or Asia. Its use was so

of the experiment severe mechanical work was performed and the total food intake for the latter period amounted to 770 pounds of potatoes and 48 pounds of margarine. What could be more simple than stocking the cellar with coal, potatoes, and a tub of margarine! Who then would worry about the complexities of modern life?"—*Food in War Time*, Professor Graham Lusk, pp. 15-16.

extensive in Ireland in the middle of the last century that upon the outbreak of blight in 1846, the almost total destruction of the crop resulted in a famine from which, together with the accompanying pestilence, 600,000 people perished within a year. This blight soon spread to America, and continues there, greatly interfering with potato production. While the blight can be partially controlled by systematic spraying, it is true that the potato was more important in America before 1840 than it has ever been since. It was one of the means by which New England, rocky, cold, and none too fertile, was able to support so many more farming people in 1818 than in 1918.

The potato is very widely distributed throughout the United States as well as other parts of the north temperate zone. A recent census showed that it grows in every county in the United States, save one at the tip of Florida, two above the limit of profitable agriculture in Colorado, and several in the driest parts of Texas where irrigation has not been established. In Europe it is but little less common.

There are several reasons for this wide distribution:

1. It is a hardy, short-season crop, maturing farther north and at higher altitudes than any other food crop except barley.

2. While hot weather at the time the plant is making the tubers interferes with a large crop, the short season that it requires for growth enables the plant to make a good crop in the South during the late winter and early spring months, so that Florida, the Canary Islands, and Algeria can send new potatoes in January as a luxury to the cities of the then frozen North.

3. Because of many varieties and times of planting, the potato may be grown with fair success on a great variety of soils, provided they are well drained and sufficiently moist.

4. Being mostly water, the potato is difficult to transport because of the large bulk and the resultant low price per unit. Transport is made yet harder because heat and frost alike injure this watery but useful tuber. Potatoes cannot be kept from season to season as can many foods. Consequently we do not have a world market for potatoes as we have for wheat or even meat, butter, or beans. Because of this difficulty in transporta-

tion, each locality is likely to grow at least a part of its own potatoes.

5. Its wide-spread use as food naturally leads people to try to grow it wherever they can. It is so common in the farm and village gardens almost everywhere, even where it is not a commercial crop, that merchants in many country towns in the United States do not keep potatoes for sale because each family raises its own supply.

6. It is a valuable crop to grow: for the great yield offsets its low food value per pound.

For some or all of these reasons its growth is common in all Caucasian lands. It appears occasionally even in Africa, but was not introduced into conservative China until about 1875. In the rice-growing parts of this empire the potato is held in contempt, but in the mountainous and northern parts it is diligently grown. The potato has certainly established itself as the great cool climate starch food, but its growth as a money crop is quite restricted, offering in this respect a marked contrast to wheat. The potato and rice are rivals in supplying starch to the tables of Europe and America, but rarely does a farmer raise both rice and potatoes. The recently discovered art of making potato flour has given the otherwise perishable tuber a new means of competing with rice; but thus far the flour has not met with very wide use outside of Germany, where it was first manufactured. One of the results of the Great War will probably be the establishment of the dried potato as a permanent part of the world's dietary, to the great increase of the food supply.

Almost the only soil in which the potato does not do well is heavy clay, but it grows very well on sandy loams and even sandy soils, which tend to make the potato mealy. As it also prefers cool weather and endures moisture as well as sand, it does well in regions that produce rye. It thus attains its greatest importance on the cool sandy plains of north-central Europe from the English Channel to the Ural Mountains through northern France, Belgium, Holland, Germany, Poland, and Russia. (See table, The Food of Nations, p. 175.) In these countries the potato corresponds to corn in the American corn-belt or rice in the Orient. Despite the fact that the potato originally came from America, nine-tenths of the crop is grown in Europe, because there are the people who are willing to eat it. This does not mean that nine-tenths of the eaters are in Europe, for the European population is approximately four times that of Anglo-Saxon North America; but the people in America have corn, wheat, and other cereals, which, because of their greater wealth, they eat instead of the more humble potato which becomes in America a supplementary article of diet. In Europe it is a staple.

QUALIFICATIONS OF A POTATO COUNTRY

The regions that best meet the conditions for potato growing are the northern and northeastern portions of the United States, Canada, northern Europe, Alaska, and Siberia. Most of the southern hemisphere is too dry to make good potato land. The climate is also milder than the same latitudes in the north, so that most of this part of the world is too warm for the potato. Hence, as the population in these regions is very scanty, the potato is relatively unimportant, except in New Zealand, where it thrives. There is a small area of potato climate at the tip of South America, but it is a land of rocky forests or sheep ranches.

North of the Alps the potato reaches its greatest importance, as the region combines coolness with much sandy soil and a large population. South of the Alps the dry summer of the Mediterranean climate checks its cultivation. Thus Sweden, with five and one-half million people, grows as many potatoes as Italy, with thirty-five million people. In southeastern Europe, as in the American corn-belt, the potato offers little competition with corn. Hungary with its hot summer is a great corn grower, while Austria, with its summer too cool for corn, is a great potato grower, producing from thirty to seventy per cent. more potatoes than the United States.

A table of the world's food just before the war gives many interesting statistics concerning man's relation to the earth which supports him—among them the great per capita growth of potatoes, barley, and rye in northern Europe where corn is not grown; and the small growth of these three northern crops in southeastern Europe, southern Europe, and the United States, where much corn is raised. The figures for Austria (including Bohemia, largely in the Baltic Basin) and Hungary (in the Black Sea Basin) illustrate the contrast between northern and southern crops. The figures of United States potato production show these same differences quite as sharply for the various regions of this country. For the three years, 1915 to 1917, Maine averaged 172 bushels of potatoes per acre, Maryland 97, and Florida 81. The total production of the three states was respectively 22,000,000, 4,000,000, and 1,500,000 bushels. Per capita Maine had 29.6, Maryland 3.1, and Florida 2. bushels.

As the bulky tuber yields on the average five to ten times as many bushels per acre as does wheat, and provides much more food value, it is of great value in enabling land to support dense populations. A ten-year average yield per acre in the United States is: wheat, 14.3 bushels; corn, 26 bushels; potatoes, 92 bushels. But the German yield is 190 bushels of potatoes, the Belgian yield in 1912-13 was 305 bushels, the Dutch yield was 295 bushels, and the Danish yield was 216 bushels.* Owing to the laborious method of preparing the expensive seed, the fertilizers necessary, the need of continuous cultivation and of protection from insects and fungi by spraying, and the picking up of the thousands and thousands of tubers per acre, the potato crop requires more labor than a crop of any of the grains. Hence potato fields are smaller than grain fields, and the crop is well fitted to serve where a small area must, by much labor, be made to yield a large product. The potato harvest, towards the end of summer, leaves the ground in excellent condition for the fine crop of winter grain which usually follows it. The potato may therefore usually be added to the agriculture of any district without in any way reducing the total production of the other crops. It may reduce the total average amount of food produced per man, but not per acre. The potato also responds well to intensive cultivation, as is shown by the higher average yield in Europe than in America.

The potato is important to the French (population 40 million); their crop of over 500 million bushels (1912-13) is far

* In 1916, seven American potato-club boys, working under guidance, produced an average of over 400 bushels per acre, and one boy produced 612 bushels per acre.

ahead of that of the United States (100 million people, 390 million bushels potatoes). The uncertainty of yield is well illustrated by the French crop of 1910, which was 313 million bushels, less than that of the United States. The Dutch and the Belgians make their small countries produce a surprising amount of potatoes. The production in Belgium per square mile is about sixty times that of the United States; the population per square

FIG. 51.—The calcareous wheat and beet lands of northeastern France interrupt a potato-belt of great extent. The potato does not relish lime. (Finch and Baker.)

mile is about twenty times as dense. North Germany with her cool sandy plains finds the potato one of the best crops she can grow; accordingly Germany is the greatest potato-producing country in the world, having 14 per cent. of her crop land in this crop, while the United States has but 1.2 per cent. Along with Holland, Belgium, and the north of France, Germany normally exported some potatoes to England, where, because of the general neglect of agriculture, the home supply has for some time been insufficient under peace conditions.

Russia and the three Scandinavian countries with their cold climate and areas of sandy soils are relatively heavy growers and

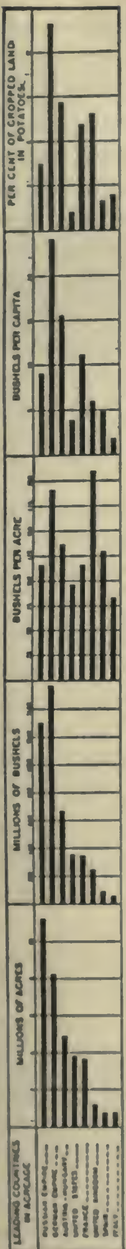

FIG. 52.—The insignificance of the potato in American agriculture is manifest. (Finch and Baker.)

consumers of the potato, Russia with her vast numbers to feed being second only to Germany. Even Switzerland grows nearly forty million bushels a year and usually supplies her own needs, despite the fact that her 16,000 square miles of area include the stupendous Alps and that she has 3,600,000 people to feed—another evidence of the value of the potato in intensive agriculture. Switzerland even suffers at times from overproduction of potatoes.

In Germany about sixty million bushels a year of a particularly large flavorless potato unsuitable for food but of abundant yield are grown for the sole purpose of being distilled into alcohol for fuel or drinking purposes. Thus Germany makes use of her chemical skill to eke out her insufficient supply of petroleum. The same practice also prevails, to a lesser extent, in Holland and Belgium. Germany's total crop before the war was 24 bushels per capita; after making allowance for distillation and export, she had 20 bushels of potatoes per capita per year (1911-13); Belgium had 15.2; Sweden, 12.2; Austria, 15.4—in comparison with less than 4 in the United States and 1.8 in Italy and 2.3 in Chile (a South American country with [in part] the Mediterranean climate of hot dry summer, to which the potato is ill suited). The abundance of potatoes in a country with favorable climate may, to some extent, be taken as a sign of scarcity of land, with its resultant intensive agriculture. And conversely, the fact that North America might increase her potato crop sixty-fold is a sign of our present per capita wealth. A few years ago some people were inclined to laugh at Professor Simon N. Patten, when he said that the potato had made a great power of Germany and had enabled her to overthrow France, who had been her superior in the days when wheat was a more exclusive basis of man's support than it was after the potato had become general in the agriculture of northern Europe. Every one now agrees with Dr. Patten, for it has been shown that the German nation has been sustained during the Great War by the potato, just as the United States has been supported by corn. But the German potato has been of greater service than the American corn. Germans were eating 7.3 bushels per capita before the war, they were feeding 40 per cent. of the crop to farm stock, chiefly swine; they were using one-tenth for alcohol and potato flour. During the war the cutting off of the foreign trade has pushed the potato into greater prominence in the German dietary, so that it is well within the facts to say that the failure of the potato crop in any season would have brought the nation to her knees.

Before the war it is estimated that the Germans were drying 800,000,000 bushels a year for swine food and human food. In 1917 it was reported that there were 1,350 factories for drying potatoes, and it is believed that great stocks of dried potatoes were stored away in Germany before the war as a preparation for it. The drying of the potato is an easy and successful process, and it is an example of our economic profligacy that we have not made more use of it.

J. Lawrence Laughlin, in his book *Credit in War Time,* shows its importance by saying that in France the potato equals wheat and rye as a food for the people, and wheat and rye are about equal to each other. In Germany the potato is three to four times as important as wheat and rye, while in the United States it is but one-half as important as wheat and rye.

Experimental dryings of potatoes have been made in the United States.

Some of the best hotels in the country have tried the dried sliced potatoes, some of the best restaurants, some of the most fastidious people, some of the best cooks, and the general verdict is that when properly processed and properly cooked they are almost indistinguishable from the fresh product, either as mashed potato or when French-fried.

After most careful trials the army has learned how to use them successfully, and one of the largest navy cooking schools has reported most favorably on them. In food value, in appearance, and in flavor they are the equal of any but the potato fresh from the hill. But how many of us get them fresh from the hill?

Under these circumstances and in the face of hundreds of analyses and dietetic tests which have been made, is it the patriotic thing to wonder and hold back and hesitate as to whether we can learn to use dried potatoes? *

During the war Holland was in almost the same food situation as Germany. She too gave the dried potato a position of prominence. It has been reported that a single factory made 33,000 bushels of fresh potatoes into flour each day. At the beginning of 1918 the Dutch reported 30,000 tons of potato flour on hand. Of course there is no gluten in potato flour to stick it together, but the food value is there. It can be mixed with wheat flour, used as soup, and eaten in other ways. There are two substances called potato flour:

One is the natural potato flour, which is made by washing and slicing and cooking and then drying the potatoes and later grinding them and bolting the flour, much as wheat is bolted. This process retains all of the mineral salts.

The other product is known as potato starch flour, and is made by first grinding the potatoes, pumping the pulp on a screen, which takes out the coarse fiber and skin, and then by dropping this pulp into vats, where, by means of running water, all of the remaining fiber and much of the protein and mineral salts are washed out, leaving only the pure starch.

This is the starch which prior to the war was used by the clothing manufacturers for the sizing of their fabrics. Now, when wheat flour is scarce, it has come into use for the making of high-class pastries. It has not, of course, the nutritive value of the natural potato flour.*

THE POTATO IN THE UNITED STATES

The United States has not developed the possibilities of potato production, in comparison with Europe, and thus far she has been able to get along comfortably with a scanty supply. The simple fact is that Americans do not have to eat potatoes—much. The quantity and cheapness of their corn is the basic cause of neglect of the potato. In the United States corn meal as a stock food has been cheaper than dried potatoes; consequently there

* Fairchild, David: "Forming New Fashions in Food," *National Geographic Magazine*, April, 1918, p. 362.

has been no steady outlet for the surplus of the potato crop. In Germany conditions are different. A surplus of potatoes is regularly made into alcohol, pig feed, and flour, all of which keep. For pig feed there is in any country an almost indefinite demand. Hence the German farmer knows that the price of potatoes will not go below a reasonable figure, and he can therefore grow the crop with some security. In the United States, on the other hand, potatoes are grown only as food for man. If, at the end of the season, from March to June, there is a scarcity, the price rises to unreasonable figures, such as $3 to $4 a bushel in 1917. If there is plenty, the price falls to equally unreasonable figures —forty cents a bushel (as in 1918). In a recent five-year period there was a price fluctuation of twenty-seven cents per bushel in Berlin, and of $1.34 in Chicago.

This seesaw of big crop and little price, little crop and big price, has gone on in the United States and Canada for forty years. Every potato grower, to his sorrow, knows all about it. Therefore the American former is afraid to grow potatoes because of the danger of overproduction, and our total potato crop bears no more definite relation to our total potato possibilities than the amount of water sold bears to the amount of water produced in the springs and mountains of the country.*

Owing to the previously mentioned difficulties of transport, potatoes are usually grown near the place of consumption. In fact, a map of potato production in the United States would enable us to locate most of the cities of the country. There are, however, a few centers of heavy production away from cities; one is in the eastern counties of Virginia and Maryland, which have the advantage of cheap water and excellent railroad transportation to Baltimore, Washington, Philadelphia, New York, and Boston. Similarly western Michigan has cheap lake transport to Chicago. Central Wisconsin is not far from Milwaukee and the Chicago district. An important district northwest of Minneapolis yields all the produce markets will take and sometimes more. Aroostook County, Maine, has New England for

* "It will be remembered that in response to the appeal made last year by our Government there was harvested in California an increase of 30,000 acres over the year before. The experience was not satisfactory to the growers; hence the acreage this year shows a falling off of 12,000 acres."—California Development Board—From *Monthly Bulletin* for July, 1918.

its market, and carries on an important seed business with other sections of the country, especially along the Atlantic Coast.

The maps of production show how distinctly the potato crop is separated from the corn crop. None of the first ten corn states,* save Minnesota in 1917, is among the first six potato states,† and the seventh potato state, Ohio, is also the eighth corn state, because it raises potatoes in the high and cool northeastern part, and corn

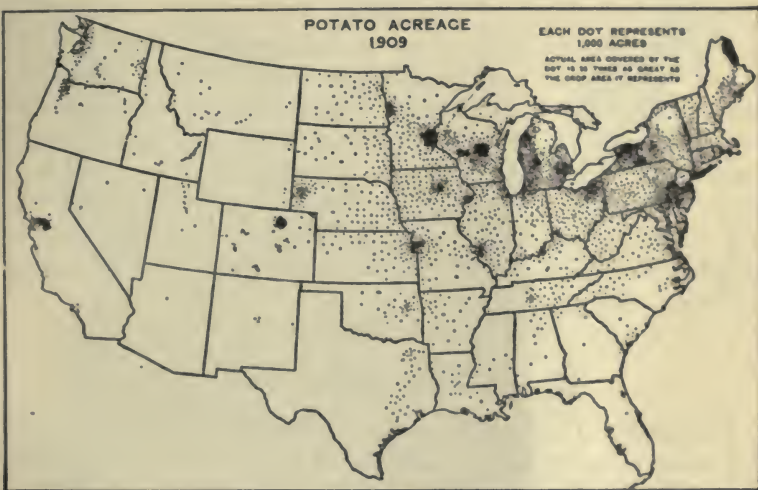

FIG. 53.—Potato centers, showing city locations in some cases and good agricultural locations in others. (O. E. Baker, *Year Book* of U. S. Dept. Agr., 1915.)

in the western and southwestern part. Minnesota gets into both groups by having one part of the state in the corn climate and another part in the potato climate. Michigan has a good corn-belt in the southern end of the lower peninsula and an important potato production in the rest of the state. Potatoes and corn do not belong on the same farm because they both claim the farmer's attention and his horses at the same time.

Growing potatoes as a money crop is for the most part concen-

* Illinois, 418 million bushels; Iowa, 410; Missouri, 252; Nebraska, 240; Indiana, 203; Kansas, 128; Kentucky, 122; Ohio, 150; Tennessee, 111; Minnesota, 90.

† New York, 38 million bushels; Michigan, 36; Wisconsin, 35; Minnesota, 34; Pennsylvania, 29; Maine, 20.

trated in certain districts. In Aroostook County, in the St. John River Valley of northern Maine, agriculture, which had greatly declined, has suddenly revived on account of the rapid rise of the value of potatoes as an export money crop for that district. Similarly, Monmouth County, New Jersey, between New York and Philadelphia, has become a potato center, shipping to these two great cities as much as 600,000 barrels in a single season. Much of the sandy soil of the Atlantic Plain from the eastern end of Long Island to Florida is better suited to potatoes than to grain crops; and on eastern Long Island, as in the only two counties of Virginia that lie east of the Chesapeake, the shipments of potatoes have within a decade made the farmers very prosperous. In nearly every case these concentrations of production are in large part due to co-operative associations of growers, which have greatly assisted their members in the marketing of their product as well as in the purchase of supplies, and the spread of technical knowledge how best to grow and pack the crop.

THE SUPPLY OF EARLY POTATOES

The supply of early potatoes for northern markets from southern lands is an important industry in many parts of the world. For instance, Algeria derives a large income from potatoes which reach Paris in thirty-five to forty hours. Egypt sends the first potatoes of the season across the Mediterranean to northwestern Europe. The Isle of Jersey in the English Channel, and St. Malo on the nearby coast of France, send early potatoes to England, and Cornwall can send potatoes into London several weeks earlier than the eastern part of England can supply them. In American cities the earliest supply of new potatoes comes into the market before Christmas from southern Florida and the islands of Bermuda, situated 600 miles from New York, in the latitude of South Carolina, in the frost-free climate furnished by the Gulf Stream. The more even temperature of the oceanic as compared with the continental climate thus becomes the basis of Bermuda's chief export, 80,000 to 100,000 bushels a year. The next potatoes for the northern cities of the United States are from northern Florida, where there is but little frost and potatoes can grow throughout most of the winter. Then, as the spring advances northward, potatoes come from other accessible points in the Atlantic Plain, such as Savannah, Georgia; Charleston, South Carolina; New Berne, North Carolina; and southeastern Virginia near Norfolk.* With the coming of June, pota-

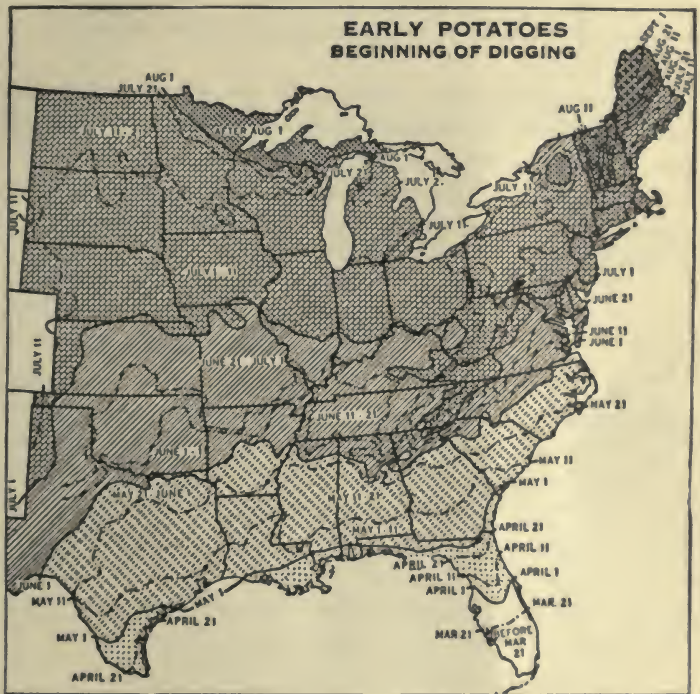

FIG. 54.—A good explanation of the reason for north and south trade. (Finch and Baker.)

toes are harvested on the peninsula east of the Chesapeake Bay; then southern New Jersey and Long Island in their turn send carloads and trainloads of new potatoes to the Northern and Western States. As spring moves up the coast from Florida to Long Island, the price of new potatoes in Northern cities steadily declines, and each locality holds the market but a short time. Yet this warm, coastal plain is not the ideal place for

* The reclaimed swamp lands near the Dismal Swamp are excellent for potatoes, and one grower there has produced 25,000 barrels in a season.

the potato; and the whole plain from end to end does not produce as many potatoes as the state of Maine. To keep the potato plant from degenerating, the coastal plain crop is regularly grown from seed potatoes produced in Maine, where the species maintains the desired vigor and rapidity of growth. The plants grown from Northern seed seem to step lively for a generation or two in the more leisurely Southland. Then they find out that there is no hurry, and the grower must send for fresh seed.*

The main supply of the country for the winter months comes from the Northern potato districts between Maine and Minnesota.

The potato is also important in the irrigated lands of the Rocky Mountains and Pacific States where the cool nights forbid the growth of corn and the expense of irrigation demands a crop with heavy yield.

THE POTATO IN FOREIGN TRADE

Because of the great bulk and weight of potatoes in proportion to their value, and because of their perishable nature, they are far less important in international trade than in home production. In general, they have a tendency to become a national supply crop, just as in the United States they are a semi-suburban supply crop, with their commercial opportunities limited to emergencies and early supplies. When, as occasionally happens, there is a shortage in the United States, supplies come by the hundreds of thousands and even millions of bushels from Canada, Ireland, Scotland, Germany, and Egypt. One reason why the price of potatoes in America in the spring of 1917 rose to such famine heights was the impossibility of lowering the price by importation. In a similar period in 1911, 12,000,000 bushels had been imported, a quantity which would have materially lowered the price of 1917.

Considered in relation to the total value of the crop, the sta-

* The varieties of potato now cultivated are derived from the wild potato of cool plateaus in South America. At 10,500 feet elevation on the road from Lima to Oroya in the Andean plateau the traveler passes through an extensively cultivated potato district. Those in low-lying tropic lands have thus far been neglected. Here is an interesting possibility for warm lands.

tistics of foreign trade in potatoes are conspicuous for the small and irregular amounts:

United States	Potato exports million bushels	Potato imports million bushels
1907	1.20	.40
1908	.76	8.38
1909	1.00	.35
1910	2.38	.22
1911	1.24	13.73
1912	2.02	.33
1913	1.79	3.64
1914	3.13	.27
1915	4.01	.20
1916	2.48	3.07

These figures show that the potato production is limited by the home market and not at all by the land possibilities. The 4,100,000 acres of American and Canadian potato fields are an insignificant patch. Multiplied by thirty, they about equal the corn acreage of the same countries. These 120,000,000 acres of possible potato land lie in a broad belt from Newfoundland through maritime Canada, through New England, New York, and Pennsylvania, the Lake District, both American and Canadian, and thence along the upper edge of the spring wheat-belt, whence, except for small breaks, they may possibly extend almost uninterruptedly into the Yukon Valley, where, beneath the glow of the almost continuous sunlight near the Arctic Circle, potatoes have been found to thrive amazingly. This cooler belt in North America is now so sparsely peopled chiefly because there is no great demand for the crop it can best grow. There is no reason why the region may not in future decades produce other Denmarks, Finlands, Swedens, Norways, with many potatoes, and hardy, keen, and vigorous men. Already in northern Ontario there has been organized a potato growers' association which is trying to overcome the disadvantages of distant location by developing a specialty of seed production, after the fashion of Aroostook, Maine, but that merely serves to show the meagerness of the market.

On Prince Edward Island the potato crop is about seventy to eighty bushels per capita. In northern Minnesota the professors of agriculture say that the potato is one of their finest crops, that it does splendidly in rotation with wheat and clover, but that they can also do equally well with a four-year rotation of wheat, corn, (silo) clover, and potatoes, combining potato growing with dairy farming. In the light of Professor Lusk's previously mentioned example of the man who lived on potatoes and vegetable fat, this Minnesota (or it might be Wisconsin, or Michigan, or Ontario, or Yukon) farm, producing potatoes, milk, butter, or cheese, offers a complete ration to the followers of the simple life. Numerous experiments have shown that milk and potatoes are an ample but no doubt monotonous means of support for a man in good health.

Potatoes are most easily grown on that dead level, stoneless, treeless lake bed that we now call the Red River Valley of the North, stretching from the tip of South Dakota through North Dakota and Minnesota and far into Manitoba. The spring wheat climate is also the potato climate, and the perfectly smooth and level soil permits the maximum use of machinery, so that, despite high wages, it is said that before the war potatoes could be grown for twenty-five cents a bushel. Of course there was no demand for any large quantity, nor is there any immediate prospect of such demand, but the resources are there, should the need arise.

The wheat shortage during the Great War has caused the building of potato flour factories in a number of locations rather remote from city markets, in Maine, Michigan, Wisconsin, Minnesota, Idaho, Oregon, and California. Six carloads of fresh potatoes come into the drying factory, perishable, ready to spoil from freezing or from heat; but one car takes them out dried, ready to ship to the far end of the world and keep through desert heat and Arctic cold for five years if necessary.*

In addition to this large potato area of the North, there is also the possibility of extensive potato growing if need be in much of the South. From the Chesapeake Bay around through all the South Atlantic and Gulf States into Texas, a crop of early potatoes can be followed by a crop of the great standby, corn, and in the corn can be grown cowpeas, velvet beans, or some other legume, which enriches the ground for the next year's winter crop of potatoes, thus giving a three-crop rotation with

* The United States had forty thousand pounds capacity of potato flour per day December 15, 1918.

two great food crops within the space of a single twelve months —and with actual improvement of the humus and nitrogen content of the soil, and considerable pickings for pasturing animals.

We may also reasonably expect improvement in varieties by breeding, for which purpose explorers have been sent to Peru to get hardy wild plants. By breeding, Germany has doubled the starch content of her potatoes.

THE SWEET POTATO

The white potato has a partner—the sweet potato, a member of the morning-glory family, probably a native of the American tropics. In the more humid warm temperate and tropical regions it corresponds to the white potato in the humid, cool temperate regions. It has one advantage over the white potato: it grows on the sandiest and poorest soils. Commercially it suffers from a great handicap. We have been unable to utilize the sweet potato to anything approaching its proper extent, because it rots when exposed to temperature below 45°.* Nevertheless it is already the second vegetable in importance in the United States, nearly a million acres being devoted to it in 1917.

Land capable of producing a bale of cotton, worth, say $40, will readily yield 300 bushels of potatoes, at half the cost for cultivation, worth, at 20c. per bu., $60. This the planter would gladly take, at harvest time, but there is then no market at any price. Yet six months later he cannot supply the demand at 60c. or $180 per acre. These figures are conservative. Even on poor soil, producing 500 pounds seed cotton (one-third of a bale) per acre, the yield in sweet potatoes (100 bushels, a very small output) could be sold in the spring for $60 were it possible to successfully keep the tubers through the winter. Many succeed in so doing, and reap the reward, but it is still an unsolved general problem.*

It seems even more advisable to dry the sweet potato than the white potato, because it promises a more appetizing addition to our food-supply.

Dried sweet-potato slices form one of the most successful of all dried vegetables, for they "come back" when soaked, retain their sweetness and flavor, and can be fried or candied in a most appetizing

* Bailey, L. H.: *Cyclopedia of American Horticulture*, p. 1755.

way. The longing of our Southern boys in France for their favorite vegetable could be easily met by the use of these dried sweet-potato slices. . . .

While the sweet potato has not as much protein as the white potato, it has much more sugar—towards the close of the storage season it has as much as 27 per cent, reckoned on the dry substance. It is richer in carbohydrates, and produces flour of such excellence that the following comments have been gathered from experienced cooks, who have tried it: "It makes just as good ginger-bread as any"; "Better muffins than Graham ones"; when used with corn-meal, "Delicious griddle-cakes"; "The best I have ever tasted in whole-wheat bread"; "It gave no new flavor and saved adding so much shortening"; "In pastry we found it most satisfactory."

For almost a year, the director of the Tuskegee Institute writes, the baker of the institution has saved 200 pounds of white flour a day by the use of sweet-potato flour (one-third sweet-potato to two-thirds wheat flour), and the resulting bread has not only become the favorite among the pupils, but among the citizens of Tuskegee as well.

When one considers that the sweet potato crop takes fifteen per cent. less potash fertilizer than the white potato; that the seed is much cheaper; that there are two planting seasons possible; that the yields on poor soils with little humus are large, as high as 100 bushels—even 700 bushels are recorded; that it grows in the region of our cheapest labor, and that that labor understands its culture; and then combines these facts with the experience of those who have dried the sweet potato and actually made a fine flour out of it, one is forced to the conclusion that only a demand for the dried sweet-potato product is necessary in order to establish the industry firmly.*

The sweet potato is a perennial where there is no frost, yet it will make a crop in the warm summer as far north as Iowa or New York, and is consequently a crop of considerable importance in American agriculture. Fortunately the sweet potato requires even lighter and sandier soil than the white potato and is, therefore, extensively grown on the sandy lands of the coastal plain in New Jersey, Maryland, and Virginia, where it is largely produced for shipment to the northern states. Similar sandy spots in Iowa, Illinois, and the North-Central States render similar service for the interior of the United States and western Canada. This crop is also very widely grown throughout the Southern States as a local food supply, where the people have the alternative of rice or sweet potatoes as their chief starch food

* Fairchild, David: "Forming New Fashions in Food," *National Geographic Magazine,* p. 361.

in addition to corn bread. Millions of acres of Southern land lie almost waste because they are poor and sandy—but they are prime sweet-potato soil.

The ability of the sweet and white potatoes to serve as substitutes for bread is shown first of all by the analyses of bread and of potatoes. Most persons have at least observed those who eat no bread at a meal at which they eat potatoes. It cannot be emphasized too strongly in this connection that our food is largely a matter of habit. If we are in the habit of eating bread, we probably want it for a time at least, regardless of the dietary sufficiency of a substitute food which it has not been our habit to eat. The vital thing, however, is that we get certain elements of nutrition which we must have, and can get from great numbers of different articles of diet. It is also important that we put a certain amount of material into our digestive tract. After that it is chiefly habit, not need. In parts of southern Virginia one may see educated people at a picnic contentedly feasting with a piece of fried chicken in one hand and a cold sweet potato in the other—protein and carbohydrate, meat and a bread substitute. During the flour shortage of the Great War the hotels in Porto Rico served slices of sweet potatoes in place of bread. It is of course well known that many millions of people in Europe have of late had almost no bread at times, but have subsisted on potatoes in its place. From personal experience I know that white potatoes and corn meal make muffins that are excellent when eaten hot.

If we had to choose between doing without bread or potatoes, many people, perhaps even the majority in some localities, would go without the bread. Only those who have overlooked the potato can talk of impending famine in North America. The greatest of all fears for the American potato grower, as for the grower of many other foods, is of a big crop throughout the country which will put his price down to the point where he makes no profit, or suffers actual loss. Agricultural overproduction, not famine, is the problem of thousands and thousands of American farmers.

CHAPTER VII

STARCH FOODS OF THE TROPICS

THERE are hundreds of millions of people who do not eat bread, but that is no sign that they are savage, barbarian, or even heathen. They get carbohydrate and protein, but they do not get them in bread because the climate in which they live produces carbohydrate and protein most easily in other forms. The tropic regions are often said to have great possibilities for the support of human life. One evidence for this statement is the great abundance of starch-producing plants that are bread substitutes. Throughout the length and breadth of the damper part of the tropics several easily grown plants afford foods which are the essential equivalent of the bread so dearly beloved by the Western World that two thousand years ago it got its place in the most widely used prayer in Christendom.*

One of these tropic bread substitutes is the sweet potato, which in the temperate zones is merely an interloper, an exotic, growing for a short season between frosts, while in its tropic home it lives on from year to year, producing crop after crop, and causing the tropic denizen to have small regret that the white potato will not grow there. The sweet potato differs from the white potato only in its greater amount of sugar and other nourishment, and in its habitat. Columbus, on his return to Spain, presented a sweet potato to Queen Isabella, and today it is an important root crop in Spain and one of the principal food plants of the Madeira Islanders. The Portuguese seamen took it to Japan when they were the great and powerful foreign-

* Even the prayers of religion reflect man's environment, and the collection of the food references in the prayers of mankind would doubtless afford an interesting variety. When missionaries tried to translate the Bible for the native of Greenland, they got no response until they substituted seals for sheep, which at once enlivened many a previously dead passage in the Old Testament, that great book of a pastoral people.

ers in the eyes of the Japanese. Today the sweet potato forms one of the principal crops grown on the upland fields of southwestern Japan, and is a most important food of the poorer classes. But it is in the torrid zone that it reaches its greatest importance. Here its growth is almost universal, whether in South America, Central America, the West Indian Islands, the coasts of Africa, or the Malay Peninsula.

Very similar plants called yams produce roots large enough to weigh 40 to 50 pounds (occasionally 100); but they have almost no importance in international trade because of their many rivals in the tropics, the universal ease of their production, and the fact that there are few tropic cities large enough to furnish a great market for agricultural products. Mr. David Fairchild, of the United States Department of Agriculture, thinks that the only reason we do not import yams is because we do not know them; he says a baked Jamaica yam of the "yampie" variety is better than our baked potato. In the winter, fully forty per cent. of the black women one meets walking to Jamaica markets with baskets of produce on their heads are carrying yams, the staple food plant of the Jamaica black, and an important vegetable for the whites. The common method of growing the yam is to let the vines run on poles, and carefully to remove the big fleshy roots from time to time without disturbing the plant. The fact that it grows at high altitudes gives it a place of importance among the eventual food resources of the world.

CASSAVA

Cassava, one of the tropic rivals of the sweet potato, helps to fill the local need in many lands, and far exceeds the sweet potato in importance in international commerce by producing for the peoples of the temperate zone the dried starch product called tapioca. The United States imported sixty million pounds of cassava and tapioca in 1911 at an invoice cost of 2.3 cents per pound—a low figure which indicates the great value of the plant to man. Like the sweet potato, cassava is grown for its starch-producing roots. The plant reaches a height of 8 or 10 feet, and develops roots about 2 inches thick and sometimes 6 feet long (usually much less). The raw root contains the deadly poison prussic acid, which, fortunately for man, is destroyed by heat, so that boiling the root renders it entirely harmless. The native then grates and dries it, making of it not only a nutritive equivalent of bread, but actually a piece of bread, although it is not the light bread to which the Northern

FIG. 55.—Girl selling cassava cakes in native market, Hayti. Office crop acclimatization. (U. S. Dept. Agr.)

world is accustomed, but a thin, stiff cake, rather insipid to the wheat-eating palate.

Cassava is native to America, but it is distributed throughout the tropics and is extensively used for food in many regions, especially in Brazil, Guiana, the West Indies, West Africa, the East Indian Islands, and the Malay Peninsula. The Congo natives eat cassava as the principal breadstuff. It requires fully nine months in which to mature, quite as long as wheat, and longer than any other of our ordinary foodstuffs—its cultivation furnishes an example of sustained industry that does not accord with some of our notions of the "savage."

In Jamaica, one of the few tropic territories of which we have statistics, cassava ranks third among the ground provisions which are the principal articles of food among the natives, yams coming first, and sweet potatoes second.

In all these lands, cassava cakes and boiled or baked cassava roots are standard articles of diet for the natives, partially taking the place of the corn bread of the American negro, the boiled

FIG. 56.—Sweetmeat,—ground root of cassava sweetened with coarse, unbleached sugar called rapadon, purchased in market of Las Cahopas, Hayti, 1917. (U. S. Dept. Agr.)

potatoes and rye bread of the European peasant, and all the other breadstuffs of the temperate zone.

Experiments along the Gulf Coast seem to indicate the possibility of extensive cassava growth in this section of the United States if the demand should arise.

The limited space given to discussion of the cassava should not cause one to overlook the fact that its importance as a human food is probably several times that of the potato of North America or the wheat imports of Britain. The possibility of importing the cassava product into the temperate zone is limited only by the desires of the inhabitants of that zone. If it had had a price of five cents a pound before the war, its importance in world trade might have been several times as great as that of wheat. Mr. Wm. Stuart of the United States Department of Agriculture quotes the Trinidad Department of Agriculture to the effect that cassava is more productive on the average than potatoes in the United States.

THE DASHEEN

The dasheen serves as an instance of the food possibilities of the world, and of our ignorance of the foods of distant peoples.

FIGS. 57 and 58.—Plants and roots of the edible dasheen. The ruler shows the size of the roots. One hill produced the twenty-three pounds, of which five weighed 11¾ pounds, eight weighed 2½ pounds, and forty-nine weighed 8¾ pounds. (U. S. Dept. Agr.)

We usually think of the caladium, or common elephant's ear, merely as an ornament that waves its leaves on our lawns. Yet when white men discovered Hawaii, they were amazed at the size of the brown men, who often weighed 300 pounds and whose fat was due to eating poi, their favorite dish, made from the taro plant, one of the hundred cultivated varieties of the elephant's ear or dasheen. This plant thrives in wet lands. In food value it is the brother of the white and the sweet potato. In contrast to them, like rice, it thrives in the swamp. It has been introduced into the United States, thrives over large areas in the South, and has been reported good by those who have eaten it. It may some day be one of our important crops. Certainly it will be if there is any prospect of food shortage.

THE BANANA

The banana is another great starch food, a bread equivalent, and tropic rival of the potato, the sweet potato, rice, and cassava. It has been cultivated so long that it has ceased to produce seed. Wherever the climate is always warm and the rainfall suffices to support a dense tropic forest, the banana is at home. The banana belt extends round the world and slightly into the temperate zones. With its great bunches of fruit the banana is almost without a peer among nature's gifts to man. Wheat, corn, rice, and the potato are produced by arduous labor and tillage of the soil; but if the root of a banana tree is thrust into favorable tropical earth and nearby rival plants are given a few blows with the machete (a sword-like knife very common in the tropics) to keep the young banana plant from being overgrown, in a few months it gives its great gift of fruit. For years thereafter the shoots which the original plant sends up continue to furnish food throughout most of the year. It is reported * that in Paraná, the southern state of Brazil, banana plants have stood for thirty years with this slight care, and still produce bunches of seventy bananas each. Banana plantations are sometimes started by chopping down the forest, burning all the smaller growth, and planting the banana shoots among the logs, which the white ants kindly eat up in a few months.

The amount of food produced per acre is greater than that

* See Fawcett, W.: *The Banana, Its Cultivation*, London, 1913

from any of our favorite bread grains, though far less than is often reported. It about equals that of the potato. Two hundred to three hundred bunches per acre (U. S. Con. Rep., 1911) are considered a good crop in Jamaica,* and the drain upon the soil is less than that made by a small crop of wheat. The elimination of plowing reduces to a minimum the waste of soil by erosion, which has nearly destroyed the productivity of the ancient world, and which is destroying much of the United States at an even more rapid rate.

More than any other plant, the banana helps to make life easy in the tropics. In parts of the Congo Basin and other humid portions of central Africa, where the climate is bad for the white man, the nutritious banana is said to be the main article of diet for many, probably scores of millions, of the negro race. It corresponds to the potato of the north European peasant, and the rice of the southern Chinese.

Stanley, in *Darkest Africa,* refers to specimens of plantains, a close relative of the banana, that were "12 inches long, 2½ inches in diameter, and nearly 8 inches round, large enough to furnish even Saat Tato, the hunter, with his long-desired full meal." †

Stanley also says that he found a clearing beyond Yambuya in the great forest, "three miles in diameter, abounding in native produce. Almost every plantain stalk bore an enormous bunch of fruit, with from 50 to 140 plantains attached." He mentions several other places where the plantain groves were extensive.

Scores of varieties of bananas and plantains are grown throughout the East Indies, southern China, much of India, many of the West Indian Islands, Central America, the Philippines, and other tropic lands from Mexico to Argentina, from Cairo to Natal, and from Hong Kong to Queensland.

The banana has the advantage over all its starchy rivals in being good food without cooking. Its close relative, the plantain,

* The United Fruit Co. reports an average for a period of years as follows: Caribbean mainland, 128-150 stems per acre, average weight 60-65 pounds; Jamaica, 150-200 stems, average weight 50-60 pounds.

† Mr. Felix Reina of the Porto Rico Food Administration says: "A 12-inch plantain will feed two persons at a meal when it is used instead of bread as was the case in hotels when the wheatless days were in force here. A Peon for dinner usually eats two with dry codfish."

FIG. 59.—Flourishing banana plantation in Costa Rico. Some of the plants have the unusual height of forty feet (*The Conquest of the Tropics*, by F. U. Adams)

with fruit larger than the banana, must be cooked. It, too, is very important in many parts of the tropics. The banana has a commercial blessing in its method of ripening off of the stalk and in its thick skin. It comes to us wrapped in a thick germ-proof skin, which makes it one of the safest and cleanest of fruits to eat, being in this respect superior to the apple, peach, or pear. It is a fruit easily transportable because of its thick skin and its ability to ripen after it has been picked. Thus it can be taken green and hard from the tree in the tropics, to be used one or two weeks later in another clime. In this respect it has a great advantage over many other tropic fruits, which, while delicious, nutritious, and productive, cannot be transported any great distance, if at all, without great cost.

BANANAS IN COMMERCE

The banana, however, cannot easily be shipped; it has only recently entered commerce, for it must be moved with such speed that it has only had wide dissemination since the invention of artificially cooled ships driven by steam and artificially heated cars driven with great speed. Owing to the necessity of quick transportation, it has not long been known to many people in the temperate zone. This gift of the tropics, delivered to the temperate zone by the coal-driven steamship, is a forerunner of many other valuable but perishable gifts. For the thirty years prior to 1899 the consumption of this fruit in the United States was doubled every five years. Since that date its use has steadily increased, because under normal conditions it is in many places the cheapest food that can be bought in America. It competes, to a limited extent, with our home-grown fruits, with the cereals, and with the potato, of which it is almost a duplicate in nutritive content. (See table of food values.)

Because of the difficulty of transportation, only certain favored locations in the tropics have developed the exportation of bananas. The supply in Europe is inferior to that in the United States because the part of the tropics lying nearest Europe is the Desert of Sahara, where the banana cannot grow. The European supply has for a long time come from Madeira, the Cape Verde, and the Canary Islands off the western coast of North

Africa. Banana cultivation on these islands is carried on in an intensive and costly way, which is profitable because of their location near Europe and also on the path of steamships going to Europe from Africa and South America. On the island of Teneriffe (Canary Islands), with its high volcanic peak, the industry is centered in the famous valley of Ortava, to which water for irrigation is brought from the rainy side of the island by aqueducts and tunnels. In some cases it is pumped up a thousand feet, and in all cases it must first be obtained by driving tunnels into the fissured lava formations. One of these tunnels is a mile long and discharges 3,000,000 gallons a day, in rainy and dry seasons alike, from the melting snow on top of the mountain. When the war broke out new tunnels were being dug for the enlargement of the industry.

The island of Madeira (latitude 33°) is Teneriffe's counterpart in this exotic culture. This, too, is a volcanic island in the trade-wind zone, with a rainy, steep northeast side, and more land on the drier southwest, to which the water is carried by long cement-lined aqueducts (levadas) around the side of the mountain. These were built by negro slaves under Spanish masters more than a century ago, but are now for the most part owned by English planters employing Portuguese labor, and producing bananas for the north European market. England attempted to get West Indian bananas in the early years of this century by subsidizing a line of steamers, but the attempt was not a success. It is probable that the ultimate supply of bananas for the European market will come from the wet west coasts of Africa; the nearest location in this zone is French Guinea, where the banana, entirely at home, yields fruit in ten months instead of eighteen months, as at Teneriffe. Yet the land in Teneriffe, where there is water to irrigate it, is worth $1,000 an acre. This circumstance furnishes a good example of the influence of nearness to market, for more productive land not under irrigation lies unused in the West Indies, Central America, South America, and the coasts of Africa.

Southern Brazil sends bananas to Buenos Ayres, and Queensland sends this tropic product to cooler Australia.

IMPORTANCE IN CARIBBEAN COUNTRIES

The United States is so near to the steaming hot plains bordering the Caribbean Sea and the Gulf of Mexico that bananas can readily be supplied to that country, and in no other cool region are they so generally used. On account of the unwholesome climate along the Central American coasts, nearly all the people live on the more healthful interior plateaus, so that the best banana lands have long lain idle. The comparatively new banana commerce, however, has caused recent rapid growth of settlements, mostly by West Indian negroes, with a corresponding increase of trade along the low eastern coasts. This commerce is a good example of industrial production in the tropics, accomplished by organization, enterprise, and capital brought by the more energetic denizens of cooler lands. American fruit companies began by buying fruit. Then they established steamship lines; then they started plantations, and built railroads to reach them; then they built wharves from which to load their steamers, then hotels in which to entertain the people whom they persuaded to travel on their steamers. They carry thousands of Jamaican negroes on contract to work plantations in Honduras, Guatemala, Costa Rica, Boca del Toro in Panama, and Santa Marta in northern Colombia, whither the industry spread as the lands of Jamaica became inadequate. The companies that carry on this international commerce in a great food staple are also often accused of operating governments and revolutions at will in Latin America, and controlling the fruit market in the United States.

When the shiploads of bananas reach our ports they are hurried on express trains to the interior. From New Orleans, latitude 30°, whole trainloads are sent northward and northwestward into the lands of cotton, corn, and wheat, and across the continent to the Pacific Coast, where they compete with the bananas that come to San Francisco and Seattle from Hawaii. As a result of this highly organized international trade a hungry man on the streets of many American cities could be better fed before the war on three cents' worth of bananas (usually two or three bananas) than on three cents' worth of bread. The scarcity and high price of bananas in 1918 was due solely to the ship shortage, and not to any shortage of fruit. It rotted on the Caribbean shore.

This comparatively new trade has had effects little short of revolutionary on industry along the Caribbean. The four and one-half million bunches, worth a million dollars, exported from Boca del Toro in 1911, constituted almost the entire export from the large territories of Panama. There is plenty of room on the Caribbean for more plantations to meet increased demand.

DIFFICULTIES OF BANANA GROWING IN THE HURRICANE BELT

The people who live on the shores of the Caribbean and the Gulf of Mexico have two reasons for depending on the banana: it is to them a great supply crop because it is a standard article of food, and to many of them it is also a very important money crop. Jamaica illustrates its importance as a money crop. Fruit exports of that island, chiefly bananas, have risen from $15,000 in 1869 to $350,000 in 1879, $1,500,000 in 1889, $4,000,000 in 1899, and $7,500,000 in 1909. The very large native population on this small mountainous island will probably prevent much further increase in the export of so staple a food. But the banana is an uncertain crop where the tropic hurricane occasionally rages, north of 15° north latitude and south of 15° south latitude. In February, 1899, when a fearful hurricane swept across the West Indies, the farmers could not save their banana trees, which, with their heavy burdens and weak stems, were an easy prey to the furious thrashings of the storm. The million inhabitants of Porto Rico who were supporting themselves almost entirely by agriculture on a hilly territory less than half as large as New Jersey, found, when sunshine returned after the storm, that their bananas were beaten to the ground. As a consequence the island was on the verge of famine for nearly a year, until another banana crop could spring up from the roots of the old plants. Yet the Porto Ricans then as now exported few bananas. They were used as a supply crop for their own food while they produced coffee, sugar, and tobacco for the foreign market. Similar storms occasionally destroy the bananas in Jamaica, and the lines of steamers that carry the fruit to the

United States have to be discontinued for some months, pending the growing of another crop. In Bermuda, which often comes under the influence of several tropical hurricanes a year, the wind is so strong that the bananas can grow only in a few lime-stone sink holes which, like protecting walls, shelter the plants on all sides.

The possibilities of the banana as a food resource for the temperate zone have only begun to be developed. Already it is the cheapest food in the United States, and its use is spreading rapidly to country districts throughout the land. In the tropics it is often cooked, baked, boiled, fried, made into chips, and French fried. In some countries, Peru, for example, it is converted into flour and used with butter. Very suggestive is a Hawaiian discovery, a war bread now manufactured and sold in all bakeries, made of thirty per cent. banana pulp and sixty per cent. white flour—the invention of a pastry cook in a Honolulu hotel. Perhaps the future bakers of Chicago and Christiania will for a part of their mixture roll out a cask of banana pulp, frozen in a fruit preserving factory on the banks of Congo or the shores of Papua or Albert Nyanza. The food value of banana flour, which will keep almost indefinitely, bears a surprising resemblance to that of wheat flour; its somewhat small proportion of protein makes it almost the exact duplicate of rice in the food analysis.

According to the eminent English dietetic expert, Dr. Robert Hutchinson, in *Food and the Principles of Dietetics,* we find:

The unripe banana is dried and used to produce banana flour or meal. A sample of such a flour had the following percentage composition:

	Moisture	Proteid	Fat	Carbo-hydrates	Mineral matter
Banana flour	13.0	4.0	0.5	80.0	2.5
Wheat flour	13.8	7.9	1.4	76.4	0.5 *

The banana is particularly valuable for giving us a large amount of needed mineral salts. In this respect it exceeds the much-praised onion. It is apparent that most people in the temperate zones do not know stages of ripeness at which ba-

* Prescott, Dr. S. C.: "The Banana: A Food of Exceptional Value," *The Scientific Monthly*, January, 1918.

nanas should be eaten. For cooking they should be taken a little green, before the starch is turned to sugar. They are not ripe enough to eat until the skin shows black spots, when the starch is much more easily digestible than the cereal starches to which we are accustomed.

The commercial banana supply of the present is derived from the mere fringe of the banana territory. On the coast of Guiana or the Amazon Valley the banana acreage could be multiplied many fold; and, if we should extensively adopt the use of banana flour, bananas produced in remote valleys of the East Indies or Central Africa might be brought to us in imperishable form in quantities beyond the apparent need for many generations.

DRIED STARCH

Most of our starchy food is taken in combination with the other parts of the plant that produce it, but sometimes we separate it from the plant in which it grows, and utilize it in purer forms. Manufactured starch serves many uses among civilized men and is produced by similar methods from a great variety of starch plants. As starch can easily be washed out of finely divided pieces of the starch-producing substance: a plant is simply torn to bits, the starch washed out in water, and allowed to settle. After a few washings the starch is ready for market. By this means the starch is separated from cassava; it is then collected into lumps by being slightly heated, and is sold as tapioca. This industry might be carried on almost anywhere in the moist region where the labor supply is sufficient for the work. The chief supply comes from the Straits Settlements of the Malay Peninsula and is for the most part produced by Chinese workmen living under the British rule. Brazil, with a large population of negroes and Portuguese in and near the coast cities, is another important tapioca producer.

Starches from different plants have differently shaped grains and serve different purposes. In some of the New England States, New York, and Wisconsin, much starch is manufactured from potatoes simply by washing the potatoes, grating them into small bits with rapidly revolving machinery, and soaking out the starch. This variety is used chiefly in sizing; that is, in holding together the fiber ends in the manufacture of textile goods.

Laundry starch is made from rice. A small amount of starch for use in dyeing textiles is made from wheat. The form of starch most commonly manufactured in the United States is derived from corn, and there are starch factories in many towns in the corn-belt states. This corn-starch is used in American cookery, more especially as the raw material for the manufacture of glucose, as mentioned in the chapter on corn.

In the Far Eastern tropics a form of starch is produced from the sago palm tree and extensively used as a local food in Java, Borneo, Celebes, and adjacent islands. When a sago palm tree is about fifteen years old it blossoms profusely and produces a large amount of fruit. Before the blossoming, all the material for the production of this fruit, the accumulation of years, is stored in the trunk of the tree in the form of starch. To get this hoard, the Malays, just before the tree blossoms, chop it into pieces two or three feet long, soak out the starch, dry it, and make it into flour for cakes, or into the "pearled" rounded masses which are bought in grocery stores as sago.

FUTURE SUPPLY OF CARBOHYDRATES

When we consider the wide variety of climates and soils, and of plants yielding carbohydrates—bread and bread substitutes—wheat, barley, rye, oats, buckwheat, corn, sorghum, millet, potato, sweet potato, yam, dasheen, cassava, banana, the palm, and others not mentioned here, the fear that we shall lack bread seems unnecessary. When we think of this list and of the added fact that the tropic resources are scarcely touched by modern scientific enterprise, it is plain that there is no scarcity of starch foods in sight.

In the main the supply of these foods of the tropic world have been little influenced by the Great War except that they, like our own breadstuffs, were cut off by ship shortage. This same ship shortage also cut off some of the importation of breadstuffs to the tropics, and thereby made it necessary to increase home production in some cases to meet home needs.

CHAPTER VIII

MEAT, MEN, AND LAND

PERHAPS some reader of this book, seeing statements of the great and in some cases almost indefinite possibilities of increase in breadstuffs and bread substitutes, has come to the conclusion that the author is an incorrigible optimist, touched perhaps with unreason. Let him take comfort in the statement that meat will become more and more scarce. Furthermore, it will become more scarce as the production of these other foods increases. We cannot have both indefinite increase of bread and indefinite increase of meat from land animals.

The coming scarcity of meat is by no means so great a calamity as many people think, for meat is far less important than bread.

Meat is good; it is very good. It furnishes protein and is a great muscle-making food; but it is not as important as our appetites make us believe, because it is partly a food and partly a stimulant. We always like stimulants when once we have become used to them. Hundreds of millions of people do not eat any meat at all. Most of these vegetarians are in India, China, and Japan, but enough of them are in every country to show that meat is not an absolute necessity, although it is very good in itself, and is so palatable that its use increases our enjoyment of other food.

Meat does two things: it nourishes and it serves as an appetizer. As an appetizer it is like salt or pepper; we get used to it as we do to pepper, coffee, tobacco, or alcohol, and then we dislike to abandon it, although we may taper off and use much less. We do not need the bacon with the eggs, but it makes them taste fine. So does salt, yet the salt has no food value to us. All the salt in our blood comes from the bodies of animals and plants that make our meat or vegetable food. Yet without the mineral salt as an appetizer the meal would seem almost inedible. People who do not eat meat use other flavoring, pepper and other spices, to season their food. Pickles and sauces serve the same purpose. The Japanese make very skilful use of meat and fish as appetizers, so that their meal may consist chiefly of rice (energy food) and beans (muscle food), with a little fish for flavoring.

The Orientals also use soy bean sauce, in some localities, ten quarts per adult person per year. It is made of soy beans and wheat, and a tablespoonful or so is used at a meal. Like good beef gravy, it makes potatoes or rice satisfying.

The skilful cook in America who is trying to save meat or to cut down the cost of living can greatly reduce the meat consumption if once he recognizes the fact that meat is an appetizer. A dish of soup gets the flavoring of meat from scraps and bones, and, thickened with potato flour, it may be as nutritious and satisfying as wheat bread or meat itself. In Europe today all left-over food goes into soup to make it appetizing. It is also true that a small amount of salt meat satisfies just as well as a larger amount of less highly flavored fresh meat. Convincing demonstration may be had by mixing a small amount of thinly sliced, finely cut dried salt beef with scrambled eggs. Because of its flavor value a pound of salted ham goes further than two pounds of chicken, and a pound of bacon goes as far as three pounds of beefsteak.*

Another reason why meat is used by those who can afford it is its aid in concealing poor cooking. The savoriness of meat enables a poor cook to make a passable meal when without meat the results would be almost inedible. Any one eating at restaurants in the United States is likely to observe how hard it is to order a suitable meal without taking meat to make the flavorless

* "The flavor of meat is such that it lends itself to the easy preparation of a palatable meal, but this flavor could undoubtedly be as well obtained if the present consumption of meat were cut in two. It is a question of habit, but with the present reduced supply of meat one must adopt new habits. It would be highly desirable if the grain now fed to fatten beef were given to maintain herds of milch cows.

"Indulgence in meat is due to the desire for strong flavor. With the increased distribution of wealth, the demand for meat grows. Its consumption by all classes had vastly increased in all prosperous countries prior to the war. It is well, however, to remember that its use has been excessive and unnecessary, and its price can be cut by wholesale voluntary abstinence. The British people have suffered no hardship in the recent reduction of their meat ration."—Lusk, Graham: *Food in War Time,* pp. 18-19.

THE FOOD OF NATIONS

World Crop Comparisons for the Three-Year Period, 1911-13.

	Pop. per Sq. Mi.	Pop. per Sq. Mi. of Improved Land	Wheat Bu. per Cap.	Wheat Yield per Acre	Rye Bu. per Cap.	Rye Yield per Acre	Potato Bu. per Cap.	Potato Yield per Acre	Corn Bu. per Cap.	Corn Yield per Acre	Barley Bu. per Cap.	Barley Yield per Acre	Oats Bu. per Cap.	Oats Yield per Acre	Total Grain per Cap.	Cattle per 100 Pop.	Sheep, Goats per 100 Pop.	Swine per 100 Pop.	Horses Mules Asses per 100 Pop.
United States	26.6	222.	7.5	14.7	.4	17.8	3.7	102.	28.5	24.8	2.1	25.8	12.2	30.5	[j]50.8	[a]65.5	[a]60.	[a]67.6	[a]30.2
Canada	1.9	124.8	32.7	21.4	.3	15.9	11.1	163.	2.5	59.	6.7	30.5	5.5	38.7	47.7	97.	32.	41.5	30.
British Australasia	1.5	195.	33.3	13.7	.04	14.8	4.9	121.	2.6	28.9	.9	25.8	6.2	25.	43.	30.4	2401.	29.6	65.7
Argentina	6.9	84	21.5	10.3	......	.....	4.8	139.	21.	31.	.....	.....	9.7	29.9	34.9	360.	1074.5	37.	123.7
Netherlands	504.	1020.	.8	35.3	2.6	27.7	21.3	304.	.....	.....	.5	50.1	2.8	50.8	6.7	[b]34.4	[b]10.8	[b]21.7	[b]5.2
Belgium	652.	1200.	2.3	38.9	3.2	34.6	16.2	292.	.....	.....	.6	51.4	5.4	63.	11.5	25.	......	17.5	3.
Denmark	178.	495.	2.	37.1	9.2	28.8	18	238.	.....	.....	8.2	37.7	1.5	42.3	20.9	[c]89.	[c]10.9	[c]71.3	[c]4.8
Germany	310.4	637.	2.5	33.1	7.1	29.6	26.5	206.	.....	.....	2.5	42.2	9.3	54.7	21.4	[d]31.6	[d]16.	[d]35.9	[d]7.2
Austria	247.	682.	2.2	20.6	3.9	22.2	15.6	145.	.4	18.1	2.5	29	5.	31.7	14.	[e]31.7	[e]12.7	[e]22.3	[e]8.7
Hungary	166.	368.	8.3	19.9	2.4	24.8	9.	180.	7.9	27.7	3.7	27.	6.6	33.2	28.9	[f]28.8	[f]35.6	[f]31.8	[f]10.4
Russia in Europe	70.	302.	5.3	10.	7.2	12.7	9.3	114.	1.9	19.6	1.6	16.6	2.1	21.9	18.1	[g]28.1	[g]35.4	[g]9.7	[g]18.9
United Kingdom	375.	......	1.3	32.2	.02	21.	5.8	259.	.....	.....	1.4	34.	4.	44.5	6.7	[g]26.	[g]64.5	[g]8.5	[g]5.5
France	189.5	404.	8.3	30.2	1.2	18.8	12.8	128.	.5	21.	1.1	25.5	7.9	31.2	19.	35.3	44.6	17.4	8.3
Italy	326.5	433.	4.6	12.5	1.4	16.5	1.8	97.	2.9	25.	.27	16.	1.	29.9	10.2	[b]17.9	[b]40.1	[b]7.2	[b]6.2
Spain	102.6	465.	6.1	13.2	1.2	12.6	4.5	145.	1.3	26.5	3.5	20.6	1.2	21.	13.3	12.8	94.	12.6	11.3
Japan	206.	2572.	.5	26.5	......	.....	4.6	147.	.6	25.3	1.7	28.8	.....	.....	[j]5.	2.6	.2	.5	2.9
British India	223.	744.	1.5	12.2	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	[j]45.9	47.2	24.6	[i]7.5	1.3
Saskatchewan	1.9	......	33.8	21.1	.1	27.2	2.1	173.	.....	.....	5.7	31.9	2.	40.9	41.6	125.	22.9	45.8	91.
Prince Edward Island	42.9	78.6	6.4	19.1	......	.....	66.	171.	.....	.....	1.4	28.5	66.9	34.9	78.0	118.	107.	47.2	37.1

[a] Data for 1910, 1912, 1913
[b] Data for 1910, 1913, 1915
[c] Data for 1909, 1914, 1915
[d] Data for 1907, 1912, 1913
[e] Data for 1911, 1912
[f] Data for 1911, 1913
[g] Data for 1910, 1911, 1912
[h] Data for 1908
[i] Buffaloes
[j] Including Rice

Careful study of this table will do much to explain the differences in the wealth of nations, especially the total tables showing grain and animals per capita, and the second table, population per square mile of improved land.

and almost spoiled vegetables go down.* Good cooks can easily use less meat, as this table of comparative values shows:

Calories Per Ounce

	Protein	Fat	Carbohydrate	Total
Lean beef	40.9	4.54	0	45.6
Potato	2.6	3.	21.5	27.1
Milk	3.8	11.	5.8	20.6
Peanut kernels	29.2	99.2	27.6	156.
Cheese	32.0	95.	4.	131.
Walnut kernels	19.4	169.4	18.2	206.8
Dried lima beans	21.1	4.	76.9	102.
Oatmeal	18.8	19.2	78.8	116.8

Among most peoples of the world meat is becoming more and more a luxury. Some are even forbidden by their religion to eat flesh. An examination of the above table of food values shows the sufficiency of vegetable foods, a fortunate fact for the many millions of the human race in Asia and Europe who are so poor that they can rarely afford to eat meat. It is a luxury used chiefly in lands where the sparse population makes meat cheap. In such countries man always has the choice of eating plant products directly or, since land is cheap and plant products abundant, of feeding them to animals and then eating the animals. The latter course is much the more expensive, for the making of a pound of meat requires the grass from much land, or five to ten pounds of grain, the equivalent of eight to fifteen one-pound loaves of bread. When men are hungry enough, they prefer seven pounds of corn meal to one pound of dressed

* "I predict that there is going to be an era of better cooking in America after this war. Our soldiers, returning home, are going to demand a tastier and more diversified fare than many of them enjoyed before they put on khaki and went overseas; and they are going to get it too. Remembering what they had to eat under French roofs, they will never again be satisfied with meats fried to death, soggy vegetables, with underdone breads. For all we knew—or cared—the meat she put into her pot might have been horse meat and the garnishments such green things as she had plucked at the roadside; but the flavor of the delectable broth cured us of any inclinations to make investigation as to the former stations in life of its basic constituents. I am satisfied that, chosen at random, almost any peasant housewife of France can take an old Palm Beach suit and a handful of potherbs and mingling these together according to her own peculiar system, turn out a ragout fit for a king. Indeed, it would be far too good for some kings I know of."—Irvin S. Cobb in *Saturday Evening Post.*

pork. In densely peopled regions, where there is not food enough for both man and beast, man eats the food and does without the beast.

In the United States and Canada, but especially in the United States, the chief object of agriculture is not to feed men, but

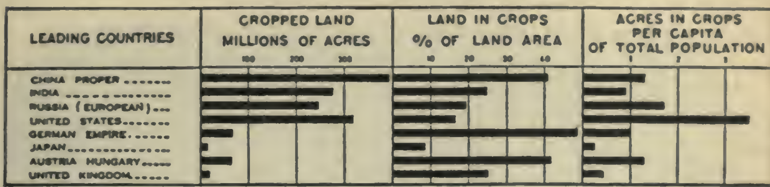

FIG. 60.—One of the good measures of national wealth. (Finch and Baker.)

to feed beasts. This was true even in the food crisis of 1918. We now raise altogether about 5,191 million bushels of grain, as follows:

	1916-17 Average
Corn	2,863 million bu.
Wheat	643 " "
Oats	1,422 " "
Rye	54 " "
Barley	195 " "
Buckwheat	14 " "
	5,191

Of this great total the American people ate less than 550 million bushels of wheat when unrestricted, 180 million bushels of other grains, and the total export of grains, 341 million, brought the amount used for human food up to about 900 million. The rest, 4,300 million, went to our four-footed brethren, who outnumber us and whose food requirements, because of their greater size, are several times our own.

In addition to the grain, they get all of the 85,360,000 tons of hay grown on 54,618,500 acres. They also roam over millions of acres, eating all the grass. It is therefore plain that more than four-fifths of the produce of American agriculture, even in 1918, went to feed the beasts. This condition is an indication of the riches of the people of the United States, a people relatively few in number in a land of unparalleled natural resources. We can best appreciate the poverty of some Oriental peoples by noting the small number of domestic animals which they are able to support. (See table, Food of Nations, p. 175.)

RELATION OF MEAT ANIMALS TO DENSITY OF POPULATION

Japan probably presents the most extreme example of a people who maintain a high civilization with few animals. With the exception of the northern island of Hokkaido, the whole country has a population of from 400 to 500 people per square mile; and the rough and steep country permits only a sixth of the land to be cultivated. Room for pasture does not exist, because of a "dense growth of bamboo grass wholly unfit for food and impossible to eradicate." The effect of this absence of pasture and pressure of population in limiting the production of domestic animals is marked. The empire has nearly fifty millions of people, and of horses and cattle combined but 5½ per cent. of that number, while the number of sheep and hogs is but 5/8 of one per cent. of the number of people. These numbers are utterly insignificant in comparison with those of the United States (95 and 156 per cent. respectively, 1913), or even with those of Europe. It is needless to say that nearly all of these people are vegetarians, except for fish. In the graphic words of Professor George T. Warren, of Cornell, "In Japan, the man is a beast of burden, and lives on hay."

Denmark is an agricultural country where some meat is eaten and animal products are an important factor in commerce. This country (74 per cent. fields and pastures) has four or five times as much of its area suitable for farms as has Japan; Denmark has passed the limit of the number of animals it can support on native food; cattle foods such as wheat bran, cottonseed meal, linseed oil cake, and other grain products have been imported in large and increasing quantities from the United States, Argentina, and Russia. When the United States entered the war and began to help England starve out Germany, cattle food supplies were cut off from Danish and other neutral European countries. Slaughtering of cattle and a great decline in the number of cattle almost immediately followed. Before the war the Danish population was 167 to the square mile, and there were ninety per cent. of that number horses and cattle, while the number of sheep and swine reached about the same percentage. The state of Iowa, practically all arable, a strictly agricultural state in

FIG. 61.—Italian woman carrying fresh grass from field to farm animals—a common scene in densely peopled lands.

the midst of the corn-belt, is far better fitted than Denmark to support livestock; but it had fewer per square mile (1913) than Denmark, with but forty persons to the square mile; the ratio of horses and cattle to this population was 257 per cent. and the ratio of sheep and swine to the population was 475 per cent.

Holland and Great Britain are countries whose density of population has carried them beyond the condition of Denmark over toward the condition of Japan. The population is 550 to the square mile in England and Wales, 150 in Scotland, and 136 in Ireland. There were, before the war, 31 per cent. of that number of cattle and horses, and 74 per cent. of that number of sheep and hogs. Ireland, with a relatively sparse population for western Europe, exported a rather large amount of meat to England; the ratio of horses and cattle to population was 132 per cent., and of sheep and swine, 107 per cent., thereby also far exceeding Iowa in actual numbers per square mile. Yet the people of the United Kingdom are the greatest meat-importing nation of the world, because they can afford to be.

On each square mile of the fertile and well-tilled Holland land there were, before the war, 504 people, with cattle and horses 39.6 per cent. as numerous, and the sheep and swine but 32.5 per cent. One of the spectacular sights of the war was a string of Dutch steamers that lay in New York harbor from January to July, 1917, rocking at anchor, loaded to the water line with 50,000 tons of wheat, bran, and cottonseed meal, waiting permission to sail; this was finally denied them, and the Dutch cattle went to the butcher's block and the cow feed to the New England dairy farms. Before the war, meat was imported into Holland, although the Dutchman eats less meat on the average than does the Englishman. Intensify agriculture as we may, dense populations inevitably find meat scarcer than do sparse populations, and turn ever increasingly to vegetable food.

MEAT ANIMALS IN SPARSELY PEOPLED LANDS

In a country with sparse population, the opposite condition prevails—cheap and abundant supplies of meat for home use and a large surplus for export. In the United States the average population is about thirty to the square mile; the number of cattle and horses is 89 per cent. of the population (1917, also 1913), the number of sheep and hogs 115 per cent., 1917 (125 per cent. 1913). The high ratio of animals to men has made the United States a great exporter of meat products, but the countries to which we send meat exceed us in the number of animals per square mile. In the United States there are on the average about thirty-five cattle and horses per square mile. In Great Britain and Ireland there normally are (1913) 116, and in Denmark and Holland 194 per square mile.

The decline in the ratio of meat animals to man in the United States, as shown by the table below, is rapidly raising the price of meat and has, according to some estimates, cut in half the per capita meat consumption in the United States since 1840. Most of the increase in price has occurred since 1901. In the next eleven years the United States lost nearly one-third of her per capita supply of cattle, two-fifths of her per capita supply of sheep, and one-fourteenth of her per capita supply of swine. The figures do not show the facts of meat shortage with perfect accuracy, because the average size of the slaughtered hog has declined and there has been absolute increase in the number of milch cows at the expense of beef cattle. So rapid has been the change in the American meat supply that importation of meat, more than 200,000,000 pounds a year of beef, largely from Argentina, had been established, when suddenly the war, with its increased demand for meat, caused us again to export it in large quantities. This export from an already reduced supply sent American meat prices to the astonishing figures of 1918. In a short time dressed pork that had sold for 8 to 10 cents a pound (whole carcass) sold for 20 to 24 cents, and other prices rose proportionately.

POPULATION AND ANIMALS IN THE UNITED STATES, 1870-1917

	Population, millions	Cattle of all kinds 1,000	Per cent. of population of United States	Hogs 1,000	Per cent. of population of United States	Horses and mules 1,000	Per cent. of population of United States	Sheep 1,000	Per cent. of population of United States
1870	38.6	25,483	66	26,751	69	9,427	25	40,853	106
1880	50.2	33,258	66	34,034	68	12,930	25	40,765	80
1890	62.9	52,801	83	51,602	82	16,544	26	44,336	67
1901	77	62,333	80	56,982	75	19,648	25	59,756	77
1912	93	57,959	62	65,410	70	24,871	27	52,362	56
1917	100	63,617	63	67,453	67	25,765	25	48,483	48

The Southern Hemisphere, with its newer and sparser settlements, furnishes the most striking examples of animal abundance. Argentina is half as large as the United States, but the

FOOD PER ACRE OF VARIOUS CROPS

A comparison of the food produced annually by an acre of land when utilized in the production of various food crops and live-stock products.— All but last column from Farmer's Bulletin 877, U. S. D. A.

Food products	Yield per acre		Calories per pound	Pounds protein per acre (digestible)	Calories per acre	Percentage of Food Value in comparison to Corn
	Bushels	Pounds				
Food crops:						
Corn	35	1,960	1,594	147.0	3,124,240	100.0
Sweet potatoes	110	[1] 5,940	480	53.5	2,851,200	91.0
Irish potatoes	100	6,000	318	66.0	1,908,000	61.0
Rye	20	1,200	1,506	118.8	1,807,200	57.5
Wheat	20	1,200	1,490	110.4	1,788,000	57.1
Rice, unpolished	40	1,154	1,460	55.4	1,684,840	54.0
Rice, polished	....	1,086	1,456	50.0	1,581,216	50.5
Soy beans	16	960	1,598	294.7	1,534,000	49.0
Peanuts	34	524	2,416	126.2	1,265,018	40.5
Oats	35	[2] 784	1,600	89.4	1,254,400	40.0
Beans	14	840	1,337	157.9	1,123,080	36.0
Cowpeas	10	600	1,421	116.4	852,600	27.0
Buckwheat	24	[3] 600	1,252	34.5	751,800	24.0
Dairy products:						
Milk	....	2,190	325	72.3	711,750	22.8
Cheese	....	219	1,950	56.7	427,050	13.6
Butterfat	....	98.55	3,605	1.0	355,273	11.5
	Live (pounds)	Dressed (pounds)				
Meat:						
Pork	350	273	2,465	22.7	672,945	21.5
Mutton	205	113	1,215	14.7	137,295	4.3
Beef	216	125	1,040	18.5	130,000	4.1
Poultry: [4]						
Meat	103	66	1,045	12.7	68,970	2.2
	Dozen	Pounds				
Eggs	73.8	110.7	720	14.8	79,704	2.5
Total	....		....	27.5	148,671	4.7
	Live (pounds)	Dressed (pounds)				
For poultry meat alone	267	171	1,045	33.0	178,695	5.7
	Dozen	Pounds				
For eggs alone	122.4	183.6	720	24.6	132,192	4.2

Notes on opposite page.

population, less than that of New York or Pennsylvania, averages only 6.9 people per square mile, and only 18.2 per square mile in the best agricultural province. The number of animals is astonishingly large in comparison with the number in Japan, Europe, or even the United States. The ratio of cattle and horses to population is 500 per cent. (1912), and of sheep and swine combined 1,000 per cent. The guacho, or Argentina cowboy, has as his ration five pounds of beef or mutton per day, and he eats little or nothing else. It is interesting to note that travelers returning from journeys in the desert of Mongolia report that this also is the ration and diet of their Mongol caravan drivers in that land where agriculture is impossible and pasturing the only industry.

Australia shows conditions similar to those of Argentina. The continent has nearly three million square miles, and while much of it is a desert, there are large areas suitable for keeping animals. The sparse population of about 1½ per square mile has for each 100 people 304 horses and cattle, and 1,780 sheep and hogs—chiefly sheep. These figures show why meat and other animal products make up such a large proportion of the exports of these sparsely peopled countries of the south temperate zone.

The ratios of animals to men demonstrate the great differences in man's relation to the land in the East and the West, in the sparsely and the densely populated country. The American farmer grows corn and feeds it to cattle and then eats the cattle; but one ox eats as much as five men * and requires five times as

* For example, the ox used as the standard in the table above given, ate daily 15.64 pounds of corn, 1.66 pounds cottonseed meal, 20.5 pounds of corn silage, 2.74 pounds clover hay, 7.29 pounds corn fodder. On such a ration he gains on the average about 2¼ pounds per day, and of this a considerable proportion, more than a third, disappears as inedibles or waste in the process of slaughter.

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[1] 54 pounds per bushel.

[2] Hulled kernels.

[3] Flour.

[4] The first section under "poultry" assumes that poultry are kept under ordinary poultry-farm conditions, the pullets being raised and the old hens and young males being used for meat. What eggs are not needed for hatching purposes are used for food.

The data for "poultry meat alone" assume the purchase of day-old chicks, which are grown to a 4-pound weight and utilized as food.

The data for "eggs alone" assume the purchase of hens and their utilization for the production of eggs alone.

much land for his support. Consequently the numerous Orientals often omit the animal-feeding stage and grow rice and vegetables to eat rather than for feeding to animals. Room for great increase in population would result from the adoption of an essentially vegetable diet plus dairy products and the raising of animals only for milk and work.* The ox that consumes as

FIG. 62.—Flier's view of roads, villages, and the small fields of northern France and Belgium. (From *The Camera Man.*)

much as five men lives at least two years and does not produce more than 750 pounds of meat. Thus an ox represents 150 days' rations for the Argentine cowboy, and 3,650 days' rations (ten years) for the Oriental. This difference illustrates one of the many striking results produced by difference in density of population.

The wastefulness of meat production from the standpoint

* "Lacto-vegetarianism should not be confused with strict vegetarianism. The former is, when the diet is properly planned, the most highly satisfactory plan which can be adopted in the nutrition of man. The latter, if strictly adhered to, is fraught with grave danger unless the diet is planned by one who has extensive and exact knowledge of the special properties of the various foodstuffs employed."—E. V. McCollum in *The Newer Knowledge of Nutrition,* p. 52.

of national resources is well stated by Armsby, probably the foremost authority on animal nutrition, who has for weeks and months kept oxen, pigs, dogs, and men in his great glass calorimeter so that he could measure the last calorie of their processes of nutrition:

It may be roughly estimated that about 24 per cent. of the energy of grain is recovered for human consumption in pork, about 18 per cent. in milk and only about 3.5 per cent. in beef and mutton. In other words, the farmer who feeds bread grains to his stock is burning up 75 to 97 per cent. of them in order to produce for us a small residue of roast pig, and so is diminishing the total stock of human food. . . .

The task of the stock feeder must be to utilize through his skill and knowledge the inedible products of the farm and factory, such as hay, corn stalks, straw, bran, brewers' and distillers' grains, gluten feed, and the like, and to make at least a fraction of them available for man's use. In so doing he will be really adding to the food-supply and will be rendering a great public service. Rather than seek to stimulate livestock husbandry the ideal should be to adjust it to the limits set by the available supply of forage crops and by-product feeding stuffs while, on the other hand, utilizing these to the greatest practicable extent, because in this way we save some of what would otherwise be a total loss. . . .

The hog is the great competitor of man for the higher grades of food, and in swine husbandry as ordinarily conducted we are in danger of paying too much for our roast pig. Cattle and sheep, on the other hand, although less efficient as converters, can utilize products which man can not use and save some of their potential value as human food. From this point of view, as well as on account of the importance of milk to infants and invalids, the high economy of food production by the dairy cow deserves careful consideration, although of course the large labor requirement is a counterbalancing factor.

At any rate, it is clear that at the present time enthusiastic but ill-considered booming of livestock production may do more harm than good. If it is desirable to restrict or prohibit the production of alcohol from grain or potatoes on the ground that it involves a waste of food value, the same reason calls for restriction of the burning-up of these materials to produce roast pig. This means, of course, a limited meat supply. To some of us this may seem a hardship. Meat, however, is by no means the essential that we have been wont to suppose and partial deprivation of it is not inconsistent with high bodily efficiency. Certainly no patriotic citizen would wish to insist on his customary allowance of roast pig at the cost of the food-supply of his brothers in the trenches.*

* "Roast Pig," *Science*, 1917, XLVI, 160.

As a way out of the meat shortage, Dr. Lusk points to the importance of milk and vegetables:

If one takes milk with other foods, meat may be dispensed with. Thus Hindhede advocates as ideal a diet consisting of bread, potatoes, fruit, and a pint of milk. Splendid health, both of body and mind, the peasants' comparative immunity to indigestion, kidney and liver disease, as well as an absolute immunity to gout, is the alluring prospect held out by the following dietary:

Graham bread	1 pound
Potatoes	2 pounds
Vegetable fat	½ pound
Apples	1½ pounds
Milk	1 pint

This bread-potato-fruit diet gives a very excellent basis of wholesome nutrition. The potatoes yield an alkaline ash, which has a highly solvent power over uric acid, and, therefore, a good supply of these valuable tubers is needed by the nation.*

This meatless diet will doubtless seem like phantasy to many an American working man used to meat three times a day, unaware of the force of dietary habits, and sure that his meat makes his strength—as others have thought that their alcohol made their strength. But Lusk goes on:

The well-known work of Chittenden has shown that when the protein intake is reduced by one-half or less of that which the average American appetite suggests, professional men, soldiers, and athletes may be maintained in the best physical condition. One of Yale's champion intercollegiate athletes won all the events of the year in which he was entered while living on a reduced protein or Chittenden diet. Upon such a diet, or less than that, the people of Germany are now living today. The principle involves eating meat very sparingly, taking half a piece where one would have formerly been taken, and using it only for its flavor. The wing of a chicken has little meat on it and yet if eaten together with vegetables it gives the meal a different quality than it would have had without it, and to this extent its use is warranted. The muscles are active when hard labor is done, but the muscles do not need meat for the performance of their work. A fasting man may have considerable power. The popular idea of the necessity of meat for a laboring man may be epitomized in the statement: a strong man can eat more meat than a weak one, hence meat makes a man strong. The proposition is evidently absurd.

* Lusk, Graham: *Food in War Time*, p. 14.

There is one more thing about meat that more people should know and act upon. Digesting meat makes us hot. This effect does not indicate the heat value of the food, for the heat is not energy available for work. The process just makes us hot as a fire does. It is better to compare it to the friction of a machine that makes a hot bearing. The meat increases the production of heat in some cases as much as fifty-five per cent. in a resting man, and a large proportion of the nutritive value of the meat is thus wasted.*

If we work in hot weather we must give off the heat of labor, and the extra heat of digesting any meat we have recently eaten. The lesson for daily life is plain; at least we can select the time of day to eat our meat. I have personally tried it in the appalling heat of July, 1918, in Washington, D. C., and it worked—*I think*, but this is not evidence. I have no measure.

* "About forty per cent. of the energy content of protein is not available for the maintenance of the life of the cell on account of this extra heat production which is induced by the products of protein metabolism."—Dr. Graham Lusk, letter, July 10, 1918. Dr. Lusk calls this the "specific dynamic heat" of meat.

CHAPTER IX

FORAGE AND DRAFT ANIMALS—THE BASIS OF WESTERN CIVILIZATION AND FOOD SUPPLY

Civilized mankind is largely dependent upon domestic animals for both food and clothing. It may even be said that the formation of a highly organized society is almost impossible without their aid. Domestic animals do five great things for us: (1) they work—plow our ground, till our crops, bear our burdens; (2) they give us milk, without which so many of us would perish in infancy; (3) they give us meat, less vital to our welfare than milk, but more generally prized; (4) they give us leather; (5) they give us wool. The American Indian, really an intelligent and capable person, probably failed to build cities to match Rome, Paris or London, five hundred years ago, chiefly because he lacked suitable domestic animals to work with him, and supply him with necessary capital. If Europe and America were suddenly bereft of domestic animals the whole structure of society would be changed and men in large numbers would probably perish from starvation. Even India, so largely vegetarian, has many millions of work animals. It is evident, therefore, that the food supply of our animals is bound up with our own supply.

The food (forage) of domestic animals may be divided into two classes: (1) grain, in which we may be said to share our food with the animals, in that they eat food we may eat; (2) roughage or coarse forage, which man cannot eat. This classification suggests an interesting division of agriculture into the production of food for men and food for beasts. In America and western Europe no such sharp line is drawn, but some day it may be. I was first brought to see this point by the native manager of an English-owned estate in Portugal. Joao was showing me around the place, worked by the slow and inefficient oxen. Several times I raised the question why he did not get rid of the oxen and use the more active mule. Finally the explanation came. "It is this way, señor. The mule eats grain, so do people. The ox lives on hay and straw, which people do not eat, and then we eat the ox and we do not eat the mule." He was right. In a land where farm laborers were getting thirty to fifty cents a day (American gold), and where, because of a vicious tariff system, everything was twice as expensive as in the United States before the war, and men lived almost entirely on corn bread and cabbage, with a modicum of olive oil, it was plain that they had to use the animal that does not eat man's food.

In America most of the animals eat large quantities of grain good for human food. As the population of the world increases agriculture must work more and more toward the production of grain and meat, and our animal industry must be devoted more and more to the animals which do not eat our food. The Bedouin of the desert's edge, following flocks and herds as did Job and Jacob, has this kind of an animal industry. His flocks now, as in Moses' time, are chiefly of sheep, goats, camels, donkeys, and cattle, usually very few of the last. All of these animals live on the herbage of the semi-arid land. What little grain there is comes by hard labor and is eaten by man. In the time of famine, the sons of Jacob rode far to the great oasis at the mouth of the Nile for a few sacks of breadstuff.

RELATION OF HAY TO THE ANIMAL INDUSTRIES

"All flesh is grass," says an Old Testament writer. This is the slightly figurative statement of a man who did not know Indian corn, nor the silo, but it was literally true for his land, as grass is a natural food for most of our domesticated quadrupeds. Pastures or grass fields where animals can feed in summer are the commonest feature of American farms; and they are found in every European country because there is some land too stony, too broken and steep, or too wet for tillage. This is pasture where the flocks gather the grass—the least efficient of all our crops. Hay, the dry product of the pasture, kept in barns or stacks for winter use, is almost equally common. In the harvesting of this crop we see one of the direct results of the climate that allows only intermittent growth. It is not necessary to make hay in lands where grass will grow the year round, as it does in many parts of the torrid zone and in a few localities of the temperate zone.

Hay is usually a supply crop, to be eaten by the animals of the farm and either used or sold in the form of work, meat, butter, cheese, milk, wool, or hides. Practically all of the pasturing animals except the reindeer can get along well on hay. It is relished at the zoo alike by the elephant whose native food was the fresh green of the tropical jungle, and by the camel who at home contented himself with the bushes, the harsh grasses, and the young thorns of the desert. The deer and the moose also like it, although in their native homes they nourish themselves in winter almost entirely upon the twigs and branches of bushes which project above the snow, and such forage as they can get by digging in the snow.

HAY AND CITY DWELLERS

It may seem that this supply crop of the farm is of little value to city dwellers, and not part of a discussion of our own food supply, but nearly all city people are indirectly dependent upon hay. Every time one eats beef, mutton, butter, milk, or cheese, he uses a commodity that could scarcely have been produced in commercial quantities without hay; and when there is a shortage in hay, dairy products and meat are high in price. Bread also is usually the product of the labor of hay-fed beasts of burden, and though the motor truck is displacing the horse in the city delivery business, it remains true that most of the world's food products are still hauled to the railroad station by a team of quadrupeds, like those which helped produce them.

NATURAL HAY

In the semi-arid regions, like the Great Plains of the central part of North America, from Alberta to Texas, nature herself makes good hay. Here the rain comes in the early summer, making the grass grow rapidly. With the increasing dryness of late summer, the grass dries and stands, rich and nutritious, for months. The best kind of American grass for natural hay is the so-called "buffalo grass," which for uncounted centuries furnished an important part of the food of the vast herds of buffaloes, antelopes, and other wild animals of the trans-Mississippi region. This natural hay, the product of a typical climate, is also found in other semi-arid regions: Argentina, Australia, Siberia,

FIG. 63.—By the use of these devices alfalfa hay is cut, gathered, and thrown upon the rick without wagon or pitchfork, or the force of human muscle. (United States Reclamation Service.)

Arabia, and north and south Africa. Human life depends on this wild hay when tribes live through the long dry season, as do some of the Arabs, by moving with their flocks from place to place in search of pasture.*

* This great dependence upon wild hay is said to have found expression in law among some tribes. In the dry season of the year a fire once started in the dry grass will destroy it for miles. The fire itself may overtake flocks or camps and also destroy them. As there can be no more pasture until months later when the rains come again, the person who starts the fire may thus bring starvation to herds of animals and loss of human life among the people who depend upon them. As every people punishes most severely those offenses that tend to destroy society, death is the penalty for the Arab who starts a grass fire. No matter how accidentally the disaster occurred, no matter how well-meaning he may have been, no matter if he be the son of the chieftain himself, he has

DISTRIBUTION AND PLACE OF THE HAY INDUSTRY

The cultivated hay crop is general in the north temperate zone and also in parts of the south temperate zone, except on the pasture plains above mentioned, and even there it is rapidly increasing in irrigated sections. In the United States, Canada, and Europe it is a very important crop. In the United States it normally exceeds the wheat crop in value, and about equals it in area. In value, corn always, and cotton sometimes, far exceeds it. In Manchuria, Japan, and China it is much less important because of the small number of animals to be supported. The hay crop is usually much more productive than the pasture crop. The time of the pasturing animal has no cash value. The harvest is therefore without cost. The hay crop requires work animals, machines, and men. It must have a substantial yield to pay these costs. For this reason, grasses with heavy yield are usually chosen.

Cultivated hay is usually made of clover and (in the United States) timothy, the only one of a thousand native American grasses * yet domesticated. Throughout large parts of the United States, and to some extent in Europe also, the common practice is to sow the grass seed in the fields of wheat, oats, rye, or barley when these small grains are sown, or in the early spring when the freezing, thawing, and drying of the ground open little cracks to receive the seed. The grass starts in the grain and fully-establishes itself after grain harvest. In America it is a common practice to sow both clover and timothy. The clover, which grows quickly and vigorously, matures first, yielding a hay crop the year after the grain crop. In the next year or two the timothy takes possession of the ground. In this way several hay crops or pasture crops may be gathered if the farmer so desires, before the grasses die out and the field is again plowed for grain.

In the United States the corn-belt is also the great hay center. Indeed, zones producing only one farm crop are not common.

committed the unpardonable offense of imperiling the life of the community, and like the traitor, he must make the supreme payment—such is the influence of environment upon ideas.

* A striking instance of the possibilities yet awaiting American agriculture in an age of scientific industry.

The corn-belt farms frequently consist of the original 160 acres or one-quarter of a square mile which the government gave away to settlers from forty to seventy years ago. They are often divided into four fields of about forty acres each, one of which is planted to corn, another to oats, wheat, or barley, the remaining fields in grass, one for pasture for the cattle in summer, the other for hay for the cattle in winter. Sometimes the proportion of grain is larger. The cattle and hogs are fattened, it is true, largely upon corn, but the horses, cattle, and sheep are by nature grass eaters, and can no more live entirely upon corn than we can live entirely upon meat; they must eat also the more bulky foods such as hay. This is the reason for the system of mixed farming (cattle and grain) that so commonly prevails in the corn-belt, in the whole northern section of the United States, and in western Europe.

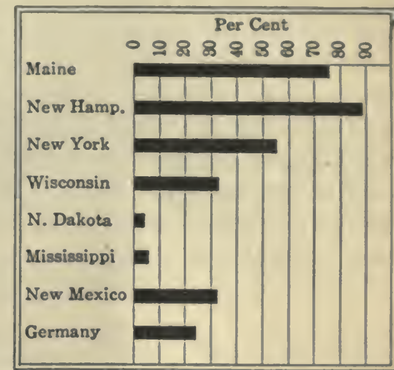

FIG. 64.—Percentage of total crop area in hay, 1913.

METHODS OF MAKING HAY

Methods of making hay have greatly improved through recent inventions of machinery. The mowing machine today cuts a swath five, six, or seven feet in width as fast as the horses can walk. If the team averages only two miles an hour for ten hours, the man and the two horses cut about fifteen acres in a day. The work is easy and swift in comparison with the two acres which, by arduous labor, a man cut with a scythe in 1850. Maud Muller no longer uses her own muscle to rake the meadow sweet with hay as she did when Whittier poetically described this feature of New England haying. The modern woman farmer saves time and strength by operating a big wheel rake drawn by one or two horses, or, to hasten the drying process, she drives a horse-drawn tedder with many kicking feet, which stirs the hay much faster and better than the old-time hand pitchfork. A kind of elevator called a hay-loader is often attached to the wagon, to pick up the hay and put it on the top of the load by the force of its own driving wheels. Upon reaching the barn or stack, the hay is lifted off, hundreds of pounds at a time, by a large fork or sling operated by the horses pulling on ropes. So great is the saving of labor that, in some of the alfalfa fields of the West, it is said that hay could be made before the war at a labor cost of $1.00 per ton, even though the wages were about the highest paid anywhere in the world. This low unit cost made hay the cheapest of animal foods, with the result that productive alfalfa land brought a very high price among American farm lands.

HAY IN COMMERCE

The bulk of hay in proportion to its value makes it comparatively unknown to foreign commerce. In normal times a small quantity, 50-70,000 tons per year, about 0.1 per cent. of the American crop, is compressed into bales of small bulk and shipped to western Europe, where the large number of animals required by the meat and milk-consuming and horse-using populations of manufacturing districts makes necessary the importation of stock food. Alfalfa hay is at times sent from Chile to England, but European forage imports are closely restricted in times of peace to large amounts of the more easily transported grains or concentrates. During the Great War the Allies used prepared food for their cavalry horses, the basis of which was alfalfa meal ground in a California mill. To offset the lack of hay the Europeans grow root crops for stock-feed—mangel-wurzels, turnips, and rutabagas, in quantities unknown in the United States. In Canada also root crops are extensively grown. Ontario had nearly 100,000 acres in turnips in 1917, and the yield was 430 bushels per acre. Root crops are the cool climate counterpart of silage, the finest stored forage in the world. Rich is the land that has it—America! Handicapped is the land that has it not—Europe!

Domestic commerce in hay in the United States is much larger than the foreign commerce. Hay is regularly sent from the corn-belt to the cotton-belt, where in a region that might produce all its own forage and a surplus for export, the people have long devoted themselves so exclusively to cotton growing that they frequently buy food for their work animals. Hay is also of considerable importance to local commerce in various parts of America where horses work at lumbering and mining in mountainous or forest regions. To the city horse also it is evident that hay must be sent. Consequently, in the aggregate, there is a large internal commerce in hay. Because the many cities of New England and the Northeastern States make that region the greatest American hay market, the farmers of New York and New England find the selling of hay more profitable than do the farmers of other states. In many districts of New England it is almost the only crop grown for sale. The soil in many localities

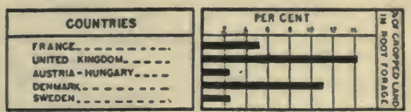

FIG. 65.—This laborious crop is the cold-climate substitute for silage. (Finch and Baker.)

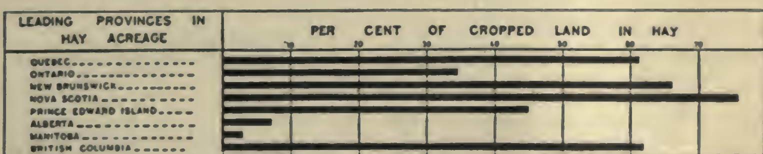

FIG. 66.—Hay is much more important in the rocky northeast than in the level grain country of Manitoba. (Finch and Baker.)

is so rocky that it is difficult to plow, but when the ground has been sown with grass and the surface stones picked up, hay can be cut year after year, with the result that, in the New England States, hay is by far the most important crop grown, occupying more land in some states than all other crops together. The total hay crop of New England is, however, much smaller than that of an equal area in the corn-belt, because of the much smaller proportion of the land under cultivation, and the low yield of old fields. Some hay is also bought by Eastern dairy farmers who find that they can afford to pay freight on hay because of the advantage of producing milk close to a market.

HAY IN IRRIGATED COUNTRIES AND IN EUROPE

The best of all hay plants is the alfalfa, a very deep-rooting clover which lives for many years, can slumber through months of drought, spring into rapid growth the very day that water is applied, and can produce five or six tons of hay per acre each season in three or four cuttings on rich irrigated land. In sub-

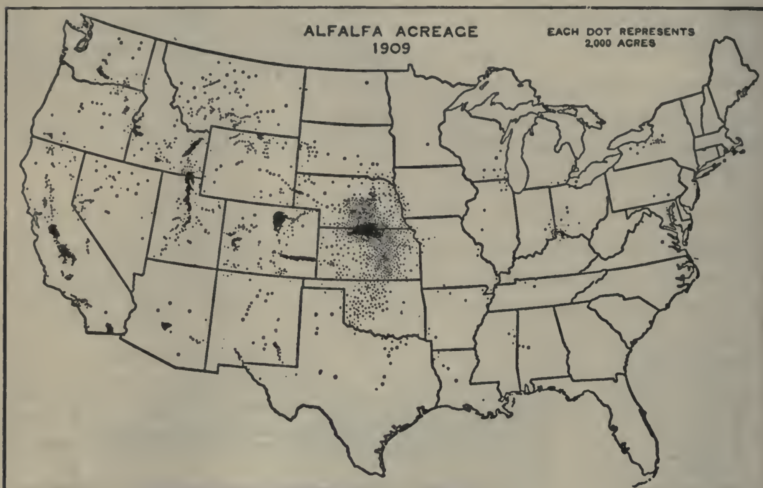

FIG. 67.—Alfalfa is the king crop of the region of irrigation. We can trace river valleys by its distribution. It is also important in the transition region of Kansas, Nebraska, and Oklahoma, but has not yet succeeded extensively in the more humid East. (Finch and Baker.)

tropic climates such as Egypt, the oases of the northern Sahara, and the very similar oases of Arizona and southeastern California, this plant will grow for at least eleven months of the year, and yield eight or nine cuttings (ten or eleven are sometimes claimed). To crown its virtues, alfalfa hay is rich in protein, richer than wheat flour. Hay, therefore, reaches perhaps its greatest relative importance in the irrigated districts interspersed among the arid and semi-arid lands of the American West, where alfalfa alone makes satisfactory stock-raising possible. As alfalfa is a plant of almost world-wide distribution, the same procedure is common in other arid regions, such as Chile, Argentina, and many parts of the Old World. A typical scene in all the irrigated regions of North America is that of cattle or sheep that have come in from the nearby dry range feeding on the stalks of alfalfa in a season when pastures have failed. Great benefit to the farmers in the Mississippi Valley is expected from the new and hardy varieties of alfalfa recently introduced from Turkestan and Siberia. Upon the plains of the Po in northern Italy where the irrigation water, sometimes rich with the mud ground by glaciers from the Alpine cliffs, is turned upon the fields, it is said that as many as nine crops of hay per year are gathered; on this account the district is able to export butter and cheese to less favored sections.

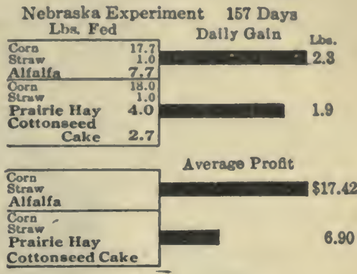

FIG. 68.—Showing profit in feeding alfalfa with corn and therefore its usefulness in the corn-belt. (From Holden, International Harvester Company.)

As a whole, hay is more important to European than to American animal husbandry. Europe has more cattle to the square mile, and since European cattle are rarely pastured, a larger proportion of European land is in hay. Europe has so little pasture because of its comparatively low yield. The best pasture lands of France or England or Illinois yield about 150 pounds live weight of meat per year, whereas if the same land is planted in grain and hay and the produce fed to the animals, the meat yield can go up to 300 or 400 pounds per acre. In Sweden the hay crop is so vastly important and the climate so unfavorable for harvesting it that the poor peasant must actually

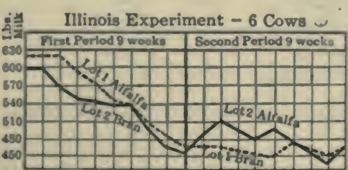

FIG. 69—Note that figures do not begin at zero. Decline in first period explained by very cold weather. Two lots of cows fed on constant quantities of corn silage and corn meal received their protein from bran and alfalfa in equal amounts. The source of protein was changed in the midst of the experiment, and in each case the better yield in milk went with the alfalfa, home-grown and cheaper than bran. (From Holden, International Harvester Company.)

spread the grass out under sheds to protect it from the rain until it dries, and then shelter it for winter use. It is at times brought down to the barn from heights on trolleys that travel on wire cables. Such laborious conditions of agriculture explain the emigration of Scandinavians to America; we can readily see why people who had been able to live in such a country quickly

FIG. 70.—The universality of the European hay crop shows why her animal numbers exceed those of the United States.

prosper in roomy America, with its more favorable climate and its many opportunities.

To the Icelanders, hay is a necessary feature of a hard existence. Wool is one of their chief money crops, and, in order to feed the sheep through their arctic winters, they literally shave their hummocky hay fields with scythes.

As eastern Europe resembles America's plains, Russia with its great plains, long cold winters, and millions of cattle and horses furnishes the region of greatest hay production. Before the war, part of the Russian crop found its way to the London market in the form of ever-increasing quantities of butter shipped from places as remote as central Siberia.

Pasture, hay, and such grain as we can spare, or they must have, are the food of all our useful beasts except the dog, and, because of our dependence on draft animals, they may be called raw material for nearly all the rest of our agriculture.

OUR DEPENDENCE UPON BEASTS OF BURDEN

Although man dominates the earth, he is physically weak in comparison with the brute animals he has captured and enslaved, and he has been able to possess the earth only by bringing their greater strength to his aid. The taming of these great beasts until they obey and serve was one of the great achievements of the race, a great debt that we owe to the past, for the most part indeed to the prehistoric races. Some animals were tamed so long ago that there is still dispute among the scientists as to their original parentage. Our domestic cow is an example. Had there been less room for roaming, and more natural protection for settlements and property in the United States, the bison might have been domesticated here as were the reindeer and the yaks in Asia. This result is by no means certain, for the bison has a rather bad disposition which makes him at times turn upon his keeper and rend him. Draft animals seem necessary to the ascent of a people toward civilization, although in parts of Japan and China it has been shown that need of them can ultimately be reduced to a minimum.

Man has often praised the intelligence of his animals, especially the horse. We should equally praise his splendid stupidity. Fortunately, while strong enough to work and intelligent enough to be trained, the horse is ignorant of his powers and thus obeys us and is continually deceived by the flimsiest pretenses. The horse or the ox will stay hungry within an inclosure fenced by loose rails which he could push down with one-tenth of the energy that he daily exerts against his collar or yoke in doing his regular task. Not all animals, however, are thus easily domesticated. Some of them insist on exerting their powers, so that we cannot use them. All the animals of great use to man went in droves or herds and were accustomed to obedience to a leader, so that the authority of man probably replaced, in their small minds, the authority of the leader of the herd with which their ancestors ran. That very intelligent animal, the cat, which for ages past has individually and stealthily lain in wait for his prey, sleeps by our fire, eats our food, but refuses to be our servant, while the pack-hunting dog will die for us as did his wild ancestors for the pack. By some strange chance all of the animals capable of effective domestication were originally found in the Old World; the New World suffered under the great handicap of the lack of such animals save the relatively inefficient llama and vicuña of the central Andes.

Most of man's work has been done by ten animals, five of them of almost world-wide distribution—the horse, ox, ass, mule, and dog—and five of very special location—the camel, elephant, reindeer, yak, and llama. Our methods of using them vary according to the nature of the work, climate, and roads, but our dependence upon them is absolute. Despite all our improvements in machinery, we yet depend upon the muscles of trained animals for the production of nearly all the food used both in Europe and America.

GROUP I. DRAFT ANIMALS OF GENERAL DISTRIBUTION

1. THE HORSE. The horse, the aristocrat of draft animals, probably does as much work as all the other draft animals. Horses are used throughout the temperate zones except in the most extreme deserts, the tropic forests, and the snow-covered polar regions, and even there they are sometimes of value, as shown by the surprising efficiency of Manchurian ponies in an English antarctic expedition of 1908-09. Chiefly because of the attack of insects, horses do not flourish so well in the more humid parts of the tropic and sub-tropic regions as in dry climates. They are largely confined to the territory occupied by the Caucasian race. Thus the United States (24 million), Canada (2.3 million), Europe (44 million), and Asiatic Russia (10 million) have about 80 million out of the 99 million horses reported in the Year-book of the United States Department of Agriculture, 1913. By contrast, India had 1.6 million horses, 78 million cattle other than dairy cows, and 17 million buffaloes—convinc-

ing proof of the superiority of cattle over horses in the tropics. Note the close relation of the number of Indian bovine to the world's horses: 95-99.

The best and most famous horses are those of Arabia, which live in story books.

For many centuries the Arabian horses, fed partly upon the barley of the oases, were supposed to be the best of all breeds, but several importations of the best Arabian steeds throughout the nineteenth century have shown them to be inferior in speed, strength, and endurance to the breeds of western Europe. Partly Arabic in their origin, the latter have for several hundred years been bred with great care by the selection of only the best parents for each new generation, with the result that the horse of the West now surpasses his distant cousins in the old home in Asia. The English especially are great lovers of the horse, and for several hundred years have been the leaders in the improvement of the breeds.

There are three general types of horses: First, the stocky draft horse to draw heavy loads, which originated in the good agricultural lands of western Europe; second, the thoroughbred or running horse, a product of England's race courses; and third, the driving horse. Of the last there are many kinds, including the trotting horse, or roadster, developed in America. There are various sizes and minor classifications under each of the three classes. The automobile has wrought such sad havoc to the popularity of the driving horse that the breed is in danger of degenerating; the United States Government has actually gone into horse-breeding in order to assure itself enough cavalry mounts.

As an industry, the production of horses for sale is always carried on in regions that are good for the production of cattle: for both animals have the same physical and climatic needs. The farmer with his hay and his pasture grounds has the choice of selling his crops of grain and hay in the form of cattle, or in the more valuable form of horses. The form he selects depends largely upon his skill and taste and the district in which he lives. A given amount of forage will usually be of more value when converted into a horse than when converted into a bullock or cow, but owing to the nervous, sensitive, high-strung character of the horse, and his tendency to excitement,* it takes more care, watchfulness, and labor to bring him to maturity without the accidents which so often reduce or destroy his market value.

THE BREEDS AND GROWING OF HORSES IN EUROPE

In northwestern Europe many horses are raised, but, as with cattle and sheep, their number is insufficient to meet the needs of the people. Britain has two heavy draft breeds, called the Shire and Clydesdale. Liège in Belgium was a famous market for the heavy Flemish draft horses grown in that vicinity. The north of France also produced many horses of the Belgian breed, and also the Percheron, named from the French department De Perche. This breed, because of an infusion of Arabian blood, is the quickest of the heavy draft animals, and was long used to draw the omnibuses on the streets of Paris, until in January, 1913, the last one was replaced by the automobile. During the war which raged for more than four years over most of the French and Belgian heavy draft horse region, the stock was almost entirely exterminated, or carried off to Germany. But fortunately it can be restored by breeding animals from other parts of France, and if need be from the United States.

In Germany the greatest horse-raising region is the grassy country near the North Sea. In northeastern Prussia the raising of cavalry horses was an industry encouraged by the German Government as part of its system of developing the army. Denmark has been an important exporter of heavy draft and cavalry horses to Germany and England, but the Danish farmers are finding that they can get better returns from their oats, barley, and hay by converting them into dairy products. In Hungary horses and mules are allowed to run in large herds on the level plain which constitutes most of that country, and which in the central part is rather too dry for grain, though excellent for pasture land. Russia, with a hundred million people and half

* If a cow gets her foot caught in barbed wire, she will carefully take it out the way she got it in, and go unharmed upon her way. Under the same circumstances a horse will plunge and kick, saw through every muscle to the bone, and cripple himself for life—a stupid, floundering, and needless suicide.

the area of Europe, including an enormous region of level pasture plains, has produced quite half the horses of all Europe, and recently had more than any other country in the world; at the opening of the war she had about the same number as the United States. Russian horses are most extensively raised in the central, southern, and southeastern parts of the country. In the region of the Caspian, the Cossacks have for centuries lived in a range country like the plains of Texas and New Mexico, too dry for agriculture, but favorable for flocks and herds; the Cossack is really the cowboy of Russia.

THE AMERICAN HORSE INDUSTRY

Horses of the European breeds early made their escape from the Spanish settlements in Mexico and ran wild on the western plains and mountains for three centuries until, with the buffalo, they almost vanished before the American settler in the last quarter of the nineteenth century. A few bands have survived into the twentieth century in New Mexico and Colorado. These wild or half-wild horses, usually called Indian ponies or cayuses, had degenerated in size, but had developed wonderful endurance in their search for food, water, and safety from man and the wolf pack. After the first settlement of the plains, they ran on the range and were cared for like range cattle, being caught at intervals, branded, and sold when ready for the market. Like the similarly wild cattle this breed has now almost disappeared on account of admixture with the larger European breeds brought from the Eastern States.

One of the best-known centers of American horse production is the blue-grass region of central Kentucky, with the city of Lexington as its center. This plain of eight or ten thousand square miles is underlain by a bed of limestone, which upon exposure to the air breaks up into a soil of great fertility where blue grass grows to perfection. This is one of the best of pasture grasses, especially for horses, one of the chief money crops of this region. Trotting and carriage horses were until recently the chief kinds produced; the horses from the Lexington market have pranced through every fine city park in the United States and many of those in Europe. The small area of the Kentucky blue-grass region causes it to be of far less total importance in horse production than is the corn-belt.

Throughout the whole extent of the corn-belt, beside the farms where some men are fattening pigs and others fattening cattle, still others have droves of colts, usually of the heavy draft breeds —Percherons, Clydesdales, Shires, or Belgian breeds originally brought from France, Scotland, or Belgium. When four or five years old, these horses are sent by carloads to the Eastern cities and to many agricultural districts where the farmers find it more profitable to raise crops suited to nearby markets and to buy their horses, which can easily come from afar.

There are occasional horse ranches on the Great Plains of the United States from Canada to Mexico, whence horses are sent to the mining and timber camps of the mountains, as well as to the farms of the new settler or to the Eastern market.

The raising of a few colts is a widely scattered supply crop and an occasional money crop on some farms in almost all parts of the United States. It is of greater importance in the Piedmont section of northern Virginia than in any other district east of the Appalachians. Excellent cavalry horses are produced here; the United States Government maintains a remount station at Fort Royal.

The industrial depression in the United States in 1894-97 was particularly severe in the horse market. The use of the bicycle and of the electric trolley car was rapidly increasing, with the result that horses were so cheap that a five-year-old would sometimes bring no more than he had been worth as a six-months-old colt. At that time American horse dealers sought a market in Europe and began to export horses, chiefly to markets in England, Germany, Holland, and Belgium. This foreign trade still continues; in it Canada also participates, the farmers of Ontario and Quebec supplying nearly one-third of the horses exported to England. The number of horses in Europe is at the present time greatly depleted for several reasons. Scarcity of shipping has made it difficult to import them. The war killed them by hundreds of thousands, and food has been too scarce to keep up the usual increase in production. With the coming of a stable peace, there will doubtless be a large exportation of ordinary work animals from North America to Europe.

1. THE PONY. Where the horse has been long in regions of scanty food supply, he has degenerated in size. Ponies have thus been produced, the breeds usually bearing the name of their place of origin—Russian, Manchurian, Welsh, Iceland, Orkney, Shetland, Zacatecas—and many of them show pronounced adaptation to their environment. The Zacatecas pony from the Mexican state of that name is of Spanish stock, sleek of coat, short

FIG. 71.—The Shetland pony with its short legs and long coat is an interesting response to an environment, the cold raw, damp Shetland Islands. (Photo C. S. Plumb, Columbus, O.)

of hair, long of limb, and fleet from the climbing of high mountains and going far in an arid country for his food and water. The slow, short-legged, coarse-maned Shetland pony with his tub of a body, his long and shaggy coat, has been produced by the humid, raw, and cold climate on the heather-clad hills of Shetland near the latitude of southern Greenland. His hair is a veritable thatch roof. It turns water like sealskin. His mane and foretop almost inclose his head like a hood; his projecting ear is full of hair. His luxuriant tail is a long overcoat enveloping his hind legs, and with his back to the wind he can come dry and warm through the biting damp northwester from out the Greenland seas. A sleet may sheathe him in ice like armor, beneath which his fur is as warm and dry as a nest of kittens. Grant this breed pasture, hay, and a shed in Iowa, and it increases in height ten per cent. in the first generation.

2 and 3. THE MULE AND THE DONKEY OR ASS. The mule, which has a donkey for a father and a horse for a mother, is in some respects a better draft animal than either parent. The donkey is conspicuous among the common draft animals for its strength, its extreme hardiness, longevity, and ability to thrive like a goat upon rough food and under poor conditions. The wild ass is still found in the most desolate parts of Turkestan, where his fleetness and hardiness enable him to survive even in the home of the wild camel. From this parent the mule inherits long life, a hard small hoof, sure-footedness, and the ability to thrive on little food; in all of these respects it excels the horse, from which it inherits size and strength. The chief reason why the mule has not more generally displaced the horse is pride on the part of the owner. Men love their horses and admire them; but the mule, with his big head, long ears, his noisy bray, and the superior intelligence which makes him resent abuse with his heels, is not so much loved nor so popular. The inability of this hybrid animal to reproduce has also had much to do with his limited popularity in good countries. For nearly all kinds of service he is really the superior animal, yet the world's horses are six times as numerous as the mules and asses combined.

THE DISTRIBUTION OF DONKEYS AND MULES

The mule and the donkey (especially the donkey) prevail where conditions of life are hard. Thus Asiatic Turkey and India have nearly half the donkeys of the world, and Spain, Italy, and Algeria have a fourth. The north of France, with its rich pastures, produces the fine, fat Percherons and the French coach horses. But southern France, with the drier climate of the Mediterranean, has poorer pastures, where mules and donkeys are bred. The drier the district in Spain, the greater is the preponderance of donkeys. Spain furnishes half the mules of Europe, and from its arid plateaus exports to all the world the finest asses to be used in the breeding of mules. Spanish horses are but one-fourth as numerous as the donkeys and mules. Throughout the desert region from Morocco to Pekin the mule and the donkey climb the hills, thread the mountain passes, browse on the arid plains in companionship with the camel, that braves the worst desert, the ox that draws the creaking cart, and the horse that bears the proud chieftain. The horse is the only member of the party that gets much or any grain, and horses of the desert are much more numerous in poems and story books than in real life. The Arab much more often rides the thorn-eating camel than the grain-eating horse, and the donkey also carries many a burden and many an Arab on the desert's edge.

In the mountains of every country and every state between Alaska and Patagonia, the mule and the donkey are of great relative importance. They serve wherever work is difficult, as in climbing the mountain trail, hauling cars in mines and loads of logs in lumber camps. They toil alike upon the fearful trails beneath the equator from the ocean to the Andes; or before the mine car filled with gold ore in Colorado, with coal in Pennsylvania, or with lead in the Altai Mountains of Siberia.

Good mules are raised and used in Manchuria and north China and even exported from Tientsin for service in the British army in India. In Pekin the mule has the favored position of the chosen driving animal of the government officials as they travel about the city in their "Pekin carts"; this is one of the few places where the mule has the luck to be in style. But the automobile is invading even this domain.

The ability of the mule to resist a more humid climate than the horse gives him predominance over the horse in the tropics and in the southern part of the United States.* In Illinois, Iowa, and Kansas the mules comprised five per cent. of the four and one-fourth million of equine draft animals; but more than half of the one and two-fifths million in Alabama, Mississippi, and Louisiana are mules. Some of the cotton states show a greater number of mules than do the mule-producing states, for almost all cotton cultivators are mule-drawn. The mule often stays in the state of

* There is a saying in certain humid localities of the Southern States, that "This place is hell for women and horses, but heaven for men and mules."

his birth only two or three years, and then plows cotton for twenty years.

THE AMERICAN MULE INDUSTRY

The finest mules in the United States are grown in the horse belt of Kentucky and adjacent districts of Tennessee, where the mothers are of the driving-horse breed. Missouri is probably the greatest mule-producing region of the United States; under a single roof in St. Louis five thousand mules are sometimes for sale. From this market, and from Kentucky and Tennessee, they are distributed over a very wide area in the United States and in foreign countries. War brings a demand for mules to bear the army burden. When Spain was at war with Cuba, she bought American mules for the use of her armies in that island, and during the three years of the Boer War in South Africa our mule export was six times the normal figure. The English dependence upon American mules was so great that officers of the British army opened headquarters in all the American mule markets, bought mules by the thousands, sent them from New Orleans to Cape Town by shiploads, and so reduced the number in America that their price for years was higher than that of horses. These mules made such a reputation that the Johannesburg Corporation imported 124 mules in January, 1911, stipulating that they should all be bred in Missouri.

In the twelve months before the outbreak of the European war, the United States exported 22,000 horses and 5,000 mules. In the next year, the first year of the war, the horse shipments reached 289,000, the mule shipments 65,000. In 1917 the increasing ship scarcity had reduced the horse shipments a little to 278,000, but the mule shipments had more than doubled, 137,000. If there had been ship space, it is probable there would have been a couple of million animals taken over, so great was the need for them in European battlefields and grain fields.

There is little doubt that with the increasing cost of horse feed in the United States the good qualities of the mule are being more generally appreciated and his use is becoming more extensive. From 1896 to 1912 the number of horses increased about thirty-five per cent. and that of mules about ninety-five per cent.; from 1912 to 1918 the increase in horses was five per cent., in mules ten per cent.

4. THE OX. The ox easily comes next to the horse in the total amount of work done for man. In almost all cattle-keeping countries oxen are used, to a slight extent at least, as work animals, though not so much as in past periods, because of competition with the more efficient horses, mules, and donkeys. Among the peasants of northwestern Europe, even the cow that supplies the family with milk is at times harnessed to the wagon to help with the farm labor. Although very slow, the ox is unquestionably stronger than the horse, and, deep in the mud of a swamp, will pull where a horse would not even make a try. If the load does not move, the horse and mule tend to make a plunge and quit, but the ox will throw his weight against the burden and pull steadily, a quality that has its advantages in trying places, but is of small value on good roads. Consequently, the most general use of oxen in the United States is to haul logs in the woods; they are also of value on the rocky lands of New England, where they are more common than in any other part of the United States. In the muddy sugar-cane fields of Cuba and on the very bad roads in parts of tropic America the ox-drawn cart is generally used because it is the best wheeled equipment for meeting the special conditions, which often resemble those of the morass or lumber camp.

OXEN AND AGRICULTURE

The general use of oxen in agricultural labor usually indicates an industrially backward people who are willing to content themselves with slow helpers or who must take advantage of the factor of cheapness arising from the fact that the ox eats little grain and can eventually be sold as beef. Such a combination of oxen with primitive agriculture we find among the Armenians, Bulgarians, Turks, Rumanians, and other peoples of southern and eastern Europe, and in places throughout central Asia to Pekin and Manchuria. The Boers of South Africa, whose dry country has grass without grain, still continue to use teams in which several spans of oxen at a creeping pace draw a wagon of enormous size.

In India it is probable that there are more oxen (a part of them buffaloes) used than in all the rest of the world. The hundreds of millions of people there use almost no other beast of burden. Man eats the grain of wheat, barley, rice, millet, and sorghum of many varieties. The ox contents himself with the straw and fodder. As cattle can survive the tormenting tropic insects better than horses or even mules, oxen are probably the most common agricultural work animal of the tropics. In Porto Rico, for example, they are the mainstay of agriculture. On the muddy roads and in the muddy rice fields of the Philippines, a part of India, and southeastern Asia, the carabao or water buffalo, an economic duplicate and a zoologic cousin of the ox, is the prevalent beast of burden, although his slowness probably makes him the least efficient of all the larger draft animals. He is called the water buffalo because, like the hog, he seeks refuge from the heat and insects by burying himself in mud and water in the hot season whenever he is not busy gathering food. India's seventy-five million cattle other than dairy cows make that country far and away the leading cattle country of the world, without counting the seventeen million buffaloes that really belong in the same economic class.

5. The Dog. Least important of the general draft animals is the dog, rival to man in his ability to live in all climates and eat all foods. He goes wherever man goes, living on a diet of meat and fish if upon the shores of the Arctic Sea, corn pone and persimmons in Georgia, beans and bananas mixed with a little meat in equatorial Africa. As a draft animal he is to the snowy parts of North America what the reindeer is to Lapland. He draws the sledge of the Aleut and the Eskimo, the Hudson Bay fur trader, the explorer of the Barren Grounds, beyond Hudson Bay, and the gold prospector of Alaska and the Klondike. He performs the same service in some of the colder parts of Europe and Asia, but probably is most used in the densely peopled agricultural regions of northwestern Europe. In the north of France, Holland, Belgium, and western Germany, regions where the horse predominates, it has long been common to see a team of two, three, or four muscular dogs hitched to a surprisingly heavy cart, taking to market a load of milk, vegetables, or other farm products. It is not uncommon to see a peasant woman on one side

of the wagon tongue and the dog on the other. This hard labor is due to poverty, and the poverty is due to the density of population, which leaves only a small patch of land for each family, so that they cannot feed any larger work animal than the dog. In parts of Germany the pet dog has been heavily taxed, but the work dog has been left untaxed. In Japan, where

FIG. 72.—In densely peopled Saxony the peasant women and the dog are draft animals. Factory labor is abundant.

the population is still greater in proportion to resources, man is of necessity his own beast of burden, using wheelbarrows, handcarts, or a pole with two burdens balanced across his shoulders.

GROUP II. THE DRAFT ANIMALS OF SPECIAL LOCATION

The five draft animals of special location are in most respects inferior to the horse and the mule, but have some peculiar adaptation to environment that enables them to work in places where the horse and mule are less efficient, or unable to survive.

1. THE REINDEER. The reindeer is a specialist in surviving cold and a poor diet, such as the moss which grows on the otherwise bare ground of some almost continually frozen arctic plains,

called tundras. Over this bleak, treeless, and uninviting Arctic region the caribou and other species of the reindeer family are widely distributed. Two domesticated kinds of reindeer are used by the sparse population from the Atlantic Ocean in north Norway to Kamchatka and Bering Straits on the Pacific; the southern limit in central Asia reaches almost to the Amur River and Lake Baikal. In this vast region, where the population is very sparse, the inhabitants use the reindeer chiefly as a sled animal, although they occasionally ride him. Reindeer are essential to the life of many of these people: for in addition to acting as beasts of burden, they furnish milk, skins, and meat to the herdsmen, who count them as their sole wealth. The recent introduction of reindeer into Alaska and Labrador, countries similar to the land of their origin, has met with success; their number in Alaska has rapidly increased, and in a short time they will probably be distributed throughout the arctic and sub-arctic regions of North America. The first commercial shipment of reindeer meat reached Seattle from Alaska about 1912.

2. The Yak. The yak, a close cousin to the ox and the buffalo, is a native of the Himalaya mountain regions and is adapted to high elevations, scanty food, and especially to deep snow. The under parts of his body have long thick hair reaching nearly to the ground, so that he can lie on this natural mattress with warmth and comfort on the deep snows of high mountains. This animal is at present used only in Tibet and the adjacent high regions of central Asia, where he draws carts and carries burdens on his back. Mr. Ernest Thompson-Seton, the naturalist, has pointed out that large areas of Canada, not well suited to ordinary cattle, might well be given over to yak pasturage. The yak has shown his fitness by thriving for six generations in an English park.

3. The Llama. The llama of the highlands of Peru and Bolivia performs, though less adequately, in the Andean region the service rendered by the yak in the Himalayas. The llama is a small animal resembling both the sheep and the camel, and is used only for carrying packs not exceeding a hundred pounds in weight. He does not have to contend with much snow, but for sure-footedness in climbing the exceedingly precipitous Andean heights the llama has no superior; however, his great-

est advantage is his camel-like ability to pick his living where the picking is poor. It is possible that the llama, as well as the yak, might be profitable in other mountainous regions. He has, however, two habits that do not endear him. If his load does not suit him he will lie down, and you may beat him to death before he will move. If he dislikes you he may at any time spit in your face.

4. The Camel. The camel is well known as a specialist in surviving in comfort for several days without food or water, and living upon the harsh vegetation of the desert. From unknown antiquity this animal has been distributed from the western Sahara through Africa, Arabia, and central Asia to eastern Mongolia, and has lately been introduced into the Australian desert. There are two kinds, the one-humped and the two-humped or Bactrian camel. The latter is found all the way from the Crimea in southern Russia to Pekin, and from the trans-Siberian railroad to northern India, where it crosses the territory of the yak. Without the camel many parts of the desert region of Asia and Africa could not be inhabited and many deserts over which caravans have passed for ages could not be crossed. The largest heavy draft camel can slowly carry a pack of from 700 to 1,000 pounds, the fastest saddle animals can take a man a hundred miles a day; and they can carry these burdens for several days, living the while upon the accumulated fat which has been stored in the humps on their backs. This storage of energy in the camel's hump is like that accumulated by the pig and the bear in autumn to enable them to lie for days contentedly in their beds when the winter season makes hunting for food difficult. The camel, on the contrary, uses his surplus to carry him over a hard region rather than a hard season. One attempt was made to introduce the camel into the southwestern part of the United States, but it was interrupted by the Civil War. There is no apparent reason why he should not thrive and be useful there, as in Australia.

5. The Elephant. The elephant has a restricted field of usefulness because he lives only in the tropical forest regions of Asia and Africa. He is an enormous feeder, eating in proportion to his weight more food than any of the other work animals, so that he can be used only where the humid tropic climate

makes forage most abundant. Only Asiatics have been energetic enough to domesticate him in modern times. Many of the work elephants are caught wild in the forests, and then, with the assistance of tame elephants, are laboriously broken to do the work of man. They draw plows and wagons and carry passengers on their backs, but are most useful in lumber yards, where with great skill and dexterity these live cranes lift and pile logs which a dozen men would have difficulty in handling. In times of war they have even carried, lifted, and placed cannon for artillery regiments, and are a regular part of the British army equipment in India.

Two thousand years ago the Carthaginian armies invaded Roman territory with war elephants. Today the African elephant is wild, and is pursued with relentless vigor into ever farther fastnesses and slaughtered at the rate of sixty thousand per year; his extermination is threatened for the sake of his valuable ivory. In this region, where none of the other domestic animals can live because of climatic conditions and where land transportation of necessity falls upon the backs of men, it seems that the moderns, if possessed of any spark of appreciation for resources, might copy the good work of the ancients, retame the native elephant, and give to central Africa the most powerful of all beasts of burden where it now has only the least efficient—man.

Parts of Africa have some hope of acquiring a beast of burden as a result of probable climatic fitness of a new hybrid, the zulebra, a cross between the horse or ass, and the zebra—an equine that resembles the horse quite as closely as does the ass. The African tsetse fly kills all the domesticated equines, but four species of zebra are native and immune—possible bases for the production of an efficient new work animal. Several million square miles of middle Africa are sadly in need of this animal, of which a small number has already been produced.

Undoubtedly the world's food supply may be materially increased if man will devote as much time and thought to the production of better work animals as he has expended on the production of race horses. The great land reserve of the world is in the tropics, where agriculture must await the coming of good work animals. It is true that the farm tractor is on the way, but it has less prospect of displacing the work animal in food production than the automobile has of driving the work horse off the road. Up to the present time the automobile has been supplementary to the horse, and despite the fact that the horsepower of automobiles in North America far exceeds the actual number of horses, this increase represents, not substitution, but merely an increase of wealth and power. The total number of horses has increased from 21,040,000 in 1910 to 21,563,000 in 1918. The same relation of engine to beast will probably prevail on the great plains of Brazil, Venezuela, Bolivia, Sudan, equatorial Africa, and other unused tropic lands after we have succeeded in putting to work tame African elephants and new crosses of the zebra and other animals on these now unused billions of acres.

CHAPTER X

THE DISTRIBUTION OF CATTLE

CATTLE ON THE FRONTIER

The world's beef supply is furnished in part by the fat cow after she has served her time as a milk producer. The beef is then only a by-product of the dairy industry. The beef industry proper depends on steers raised for their meat only, and is rarely followed on a dairy farm or in dairy regions. The steer is a far less efficient utilizer of food than the cow with her rich product of milk. (See table of acre yields, p. 182.) He is a less efficient meat producer than the sheep, which has also the additional harvest of wool. Nevertheless he is one of the most widely distributed of domestic animals. Wherever there are wide spaces of untilled grass lands we are likely to find cattle. They are the advance guard of production for world trade. They were pioneers during the nineteenth century upon the vast plains that the white man won from the wild animals and defenseless natives in North America, South America, Australia, and central Asia. On account of their size, strength, and speed, they can combat dangers, or, if necessary, flee from them. Their ability to withstand heat and moisture has enabled them to thrive in lower latitudes and wetter climates than sheep. With the exception of the humid plains of the Amazon and central Africa and a few places in the Oriental tropics, they are to be found from the Straits of Magellan to Hudson Bay in the Americas, and from Tasmania to Kamchatka and Finland in the Old World.

In the first stage of the occupation of new plains, before transportation has been well developed, the only export products cattle can furnish are the non-perishable hides and tallow. Fifty years ago the half-breed Indians and a few white men on the plains of Argentina were producing these commodities at the

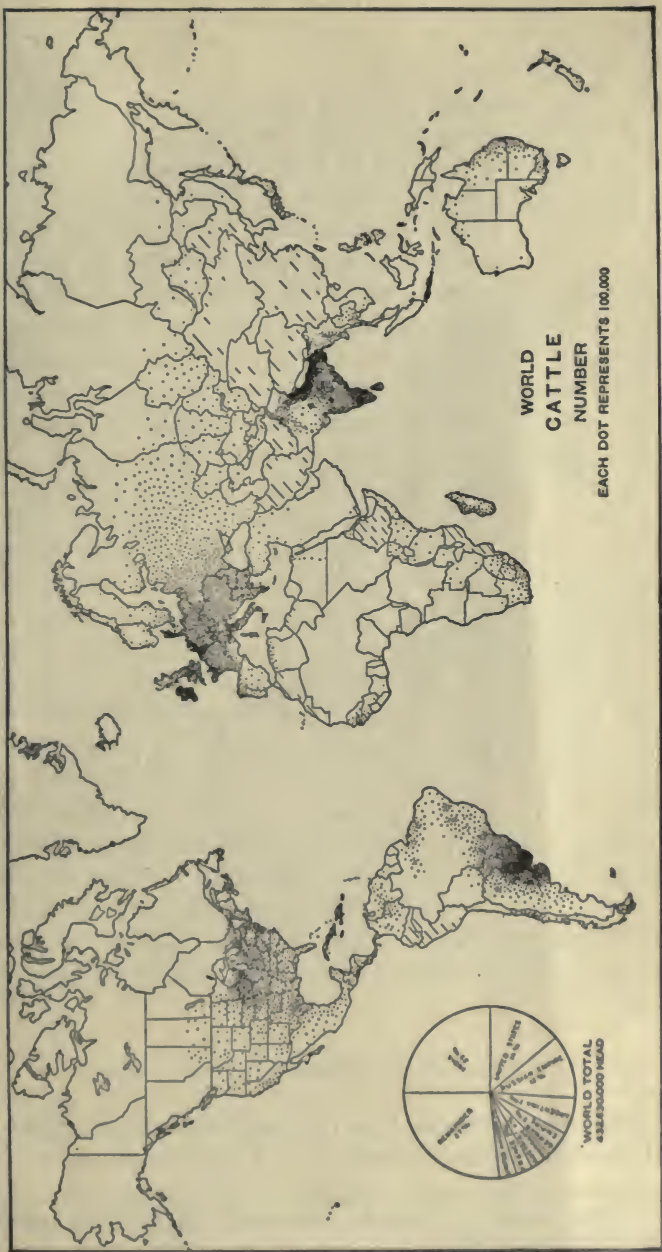

FIG. 73.—In examining this map it should be noted that we have no figures from China. (Finch and Baker.)

same time that the American Indian and frontiersmen were killing buffaloes (bison) for their hides upon the great American Plains reaching from southern Texas to Lake Winnipeg and beyond. This vast plain of North America was a splendid pasture and had been occupied by the bison, a close relative of the ox, for an incalculable period of time. These animals wintered in the warm lands from Oklahoma to Mexico and each spring went north across what is now northern Texas, western Kansas, Nebraska, the Dakotas, and on into Canada. With the approach of winter they migrated south, the herds often covering the plains for miles in such great numbers that they actually stopped the progress of trains when the first railroad was built across the plains from Omaha in 1868. This railroad brought to the bison his doom. In the next four years, many millions were slain for sport or for their skins, or from the sheer desire to kill. Men with high-power rifles fired into herds of bison from passing trains, and now this splendid animal is practically extinct, except for a few herds in National Parks, private reserves, and zoological gardens. There is still one small wild herd of perhaps three hundred animals that have escaped slaughter by fleeing to the inhospitable region around Great Slave Lake, and staying there.* The bison's place on the plains was promptly taken by the long-horned Texas cattle which had run wild with him for the three centuries since their ancestors had escaped from the early Spanish settlers. While living with the buffalo on the plains they had become well adjusted to the conditions of life there. Their long horns furnished admirable defense against wolves and bears, their long legs and muscular bodies were efficient in flight. But they were not very good for beef, and consequently have been improved almost completely out of existence by crossing with better breeds brought from England.

CATTLE ON THE GREAT PLAINS OF NORTH AMERICA

The large open plain west of the one hundredth meridian in central North America, has remained a great cattle range. It

* The interest of constructive zoologists is at last being given to the scattered bison remnants. They are increasing and may yet become a breed of commercial cattle.

is too dry for good farming of the kind to which we have long been accustomed; therefore the pioneer farmer could not take it, as he took all Iowa and the eastern parts of Kansas and Nebraska. The United States Government, which owned the land, would not sell it, for fear of great estates and land monopolies. Although it was excellent pasture for a few cattle per square mile, no one could afford to take it even as a gift, under the homestead law which gave one hundred and sixty acres to each settler, but limited his acquisition to that amount and required that he live on his holding. In a land fit only for scanty pasture, a man needs hundreds of acres. So this vast area of the plains, larger than any European country except Russia, remained every man's land, as the government would not sell, give away, or lease it so that it could be fenced off in square leagues after the fashion of Texas with its great Spanish grants. So the owner branded his cattle, turned them out upon the plain in great numbers, and then, after an annual round-up when all the cattle in a large area were brought together, each man took the cattle that had his brand and sold them. When the cow was lassoed and dragged from the herd, her young calf followed her, to receive his master's brand and be turned loose until he in his turn was harvested one, two, or three years later.

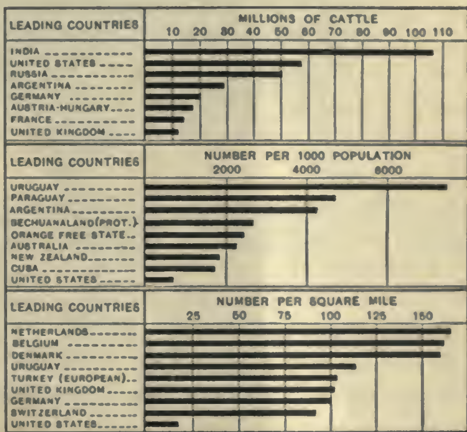

Fig. 74.—It is interesting to study the place of the United States in these graphs. (Finch and Baker.)

This was a very cheap way to raise cattle and very profitable for the cattle companies. It made cheap beef for market and, along with the settlement of new corn lands further east, it led to the high figures for animals shown in the table of animals in relation to population on p. 221. The freedom of the range naturally led to overstocking. It is to be noted that sheep, which can crop the grass closer than cattle, have in places superseded the cattle, and the sheep have in turn been crowded out by goats, which can crop even closer than the sheep. The grass, especially in periods of drought, was eaten so close that it could not produce seed, and in many places it died out. As a result, the plains now support twenty-five per cent. fewer cattle than formerly, and are being greatly injured by both wind and water erosion and by the advance of weeds which no animal can eat. The care of the government range lands is one of the tasks in which the United States greatly needs a more sensible policy. Careful pasturing, with opportunity for the grass to seed itself, has resulted in marked increase of output in places where it has been tried.

A similar policy on all the range now open would doubtless increase our meat supply by several million head of cattle, but the difficulties of applying a scientific policy have thus far been too great for that awkward body of not too highly intelligent politicians, the American Congress. The homesteader fears the land monopolist so much that he steadily votes against even a leasing policy. The poor man is also against the leasing policy because he fears that the rich man will lease all the land and put him out. Thus the range goes from bad to worse. But plainly a good leasing policy is much better than the present scheme, so far as the meat supply and the care of land are concerned. It is also doubtless better for society than granting permanent possession of great areas. The size of the farm necessary to support a family can be better appreciated when we know that some of the range in New Mexico (Jornada, on Rio Grande, fifty miles from the Mexican boundary) requires sixty acres to support a steer. Thus a farm of fifty cattle would need nearly five square miles—as much land as in the fields of Japan supports thirteen thousand people.

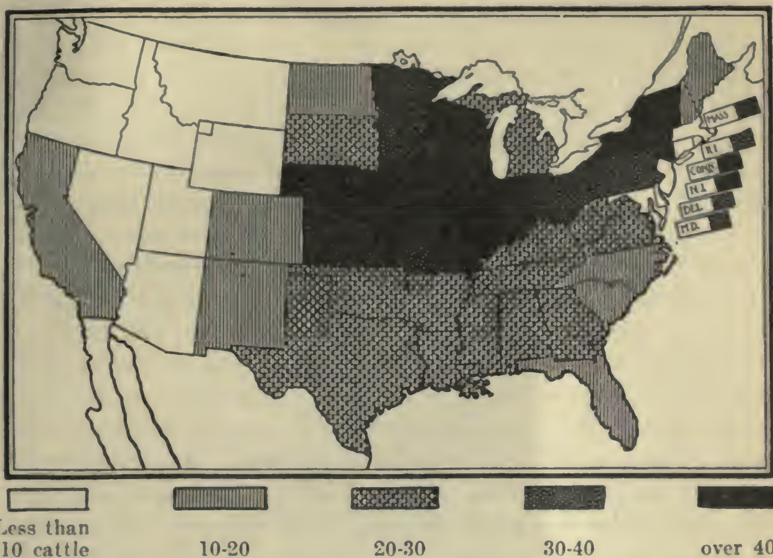

FIG. 75.—Cattle per square mile in the United States by statee, January 1, 1918.

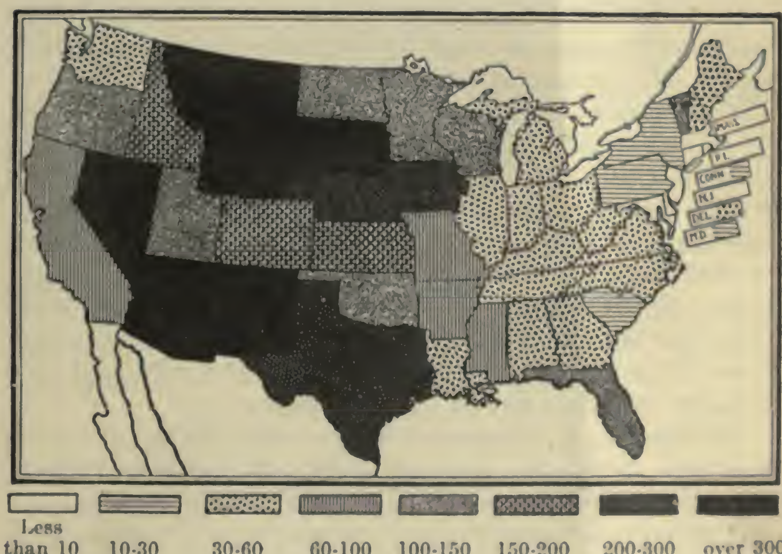

FIG. 76.—Cattle per one hundred inhabitants in the United States, January 1, 1918.

THE MIGRATION AND SHIPMENT OF BEEF CATTLE

The range cattle spend one, two, or three years on their native plain, living on grass, and are then shipped into the corn-belt, where the farmers keep them for a few months, fattening them on corn, corn fodder, hay, and cottonseed meal before sending them off to the great markets for slaughter. Some of these cattle are fattened on the farms of Pennsylvania and other eastern states, as many as sixty thousand a year being distributed at the city of Lancaster, Pennsylvania, among the fertile and well-cared-for farms of that district, where, en route to the shambles, they pause and fatten themselves, converting all the roughage of the farm into great heaps of manure for the fattening of grain and tobacco fields. To a smaller extent this same process of emigration is repeated in the Southern highlands. In the hilly country of southwestern Virginia, northeastern Tennessee and West Virginia, there is a section of good grass country where young cattle are raised and sent to the farm lands of the Shenandoah Valley and the Piedmont sections of Virginia and Maryland for fattening. This movement of the cattle from the range country to the land of better forage is more or less world-wide, for every continent has some dry range which produces lean cattle easily, but fat cattle with great difficulty.

A spectacular example of migration of animals is the sea journey each year of half a million lean Icelanders to the United Kingdom. Another is found in the southern part of the Andean region where Argentine cattle cross a corner of the Bolivian high plains to reach their market in the mining camps of the Chilean nitrate works on the western sides of the mountains. This is a fearful journey for the poor beasts, who must travel for three days and nights without food or water across deserts, high plains, and mountain passes that are freezing cold at night. But they cost no freight charges.

Irrigation in the American West is important to the cattle industry. Beef is the chief commodity shipped from most of the irrigated districts of the United States and Canada, and alfalfa, the chief irrigated crop, is the finest of forage. Fortunately for our beef supply, the irrigable valleys suitable for the growth of alfalfa are widely scattered throughout the cattle range from Canada to Mexico, and from western Kansas to western Oregon, so that these alfalfa fields are really scattered oases in the scanty and semi-arid pastures. During winter and the seasons of drought, alfalfa hay supplies the cattle from the ranges with abundant food and fattens them for market.

During the last thirty-five years there have been great improvements in the handling and marketing of meat. Formerly

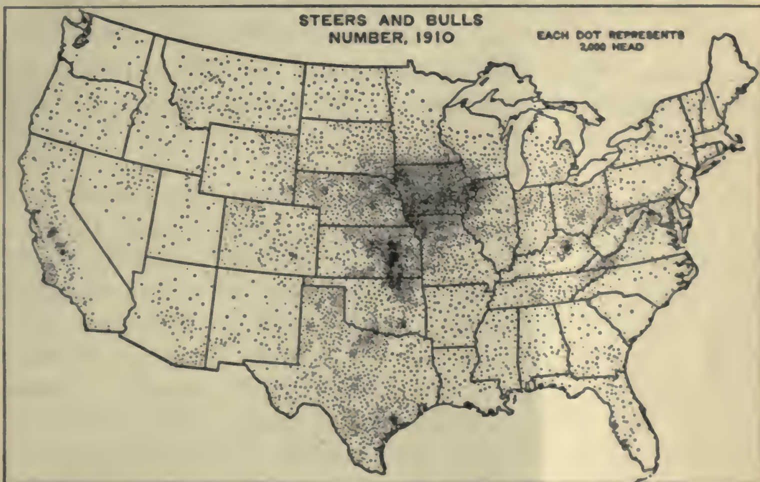

Fig. 77.—Distribution of cattle in the United States—the most widely distributed of our meat animals. (Finch and Baker.)

live cattle were carried in trains from Kansas to Chicago, and on to New York and Boston for slaughtering to supply the Eastern market. About 1874 we began to ship live cattle to Europe. In normal times some of this long-distance movement of animals still continues, on account of the preference of the British for beef slaughtered in their own country. Steamers from Boston, New York, Philadelphia, Baltimore, and Montreal annually conveyed thousands of live cattle to Great Britain. They were at times even taken alive from Argentina to England. It is, however, much more expensive to transport live animals than slaughtered ones, because the animals occupy more space alive than dead, some die on the way, all must be fed, and they always lose weight. The dangers and hardships result in such losses that hogs are not exported alive at all, and sheep only in small numbers. Much more important is the shipment of chilled and frozen meat, which has been an important factor in revolutionizing the meat trade of the world.*

THE EFFECT OF IMPROVED METHODS OF SHIPPING AND PRESERVING MEAT

The invention of artificial refrigeration has done much to make possible the slaughtering of animals near the place where they are raised. About 1875 the refrigerator car made it possible to send dressed beef from Chicago to Boston more cheaply than the live animals could be sent. In 1879 was discovered a sure method of hermetically sealing meat in cans so that it would keep for a long period, which gave further incentive to locate the slaughtering industry at the great cattle markets rather than at the consuming markets. Attempts, however, to operate packing plants upon the Great Plains where the cattle themselves are produced have resulted in failure, on account of the lack of a market for many of the by-products and less desirable portions of meat, which the varied market of a large city will consume. Consequently, packing plants are located in the great city nearest to the places where the cattle are fattened. Cincinnati and Chicago were the first packing-house centers, but Omaha, Kansas City, and, to a lesser extent, Minneapolis, have now become great centers. Plants have been established also at Fort Worth and Waco in northern Texas, but Chicago is yet, as it has long been, the greatest meat-packing center in the world. With the assistance of these two great storage devices, refrigeration and canning, a world trade in meat has developed, so that the inhabitants of Boston or London have become almost as dependent upon cities hundreds and even thousands of miles away for their meat as they have upon other cities for their bread. In 1913 London had storage for 865,000 carcasses of beef.

During the year 1913 the United Kingdom imported more than 9,000,000 cwts. of beef, by far the greater proportion of which was chilled, and nearly 5,500,000 cwts. of mutton, practically the whole

* At present the quarters of beef are carefully stripped from the bone and sent boneless across the Atlantic, to a great saving of space.

of which was frozen. To this must be added hundreds of thousands of rabbits from Australia, fresh fruit from Canada, South America, and South Africa, milk from France and Holland, cream from France, and fish from British trawlers which had spent a month or six weeks at sea. Such food-supplies are rendered possible, not only by refrigerating machinery on ships, but also by cold stores on land, which enable perishable commodities to be kept until they are required. They avoid waste by rendering it unnecessary to destroy food or to sell it at a loss; they prevent shortage; they maintain prices at a more uniform level, and, by preventing fluctuations, they contribute towards the stability of trade.*

The war shut off temporarily much of the British meat import and reduced the consumption, but with no injury to the welfare of the people.

THE PACKING INDUSTRY

The modern meat-packing plant, handling cattle, hogs, or sheep, according to the demands of the market, is one of the most wonderful existing examples of speed, mechanical perfection, and the use of by-products. A procession of live animals goes through a gate and in a few seconds their lifeless bodies are hanging on a little trolley on which they travel past a long row of men, each of whom has his special work to do. In a surprisingly short time every particle of the animals has been taken for its particular use and the chief part of the carcass has been rolled into the cold-storage room. So perfect is the utilization of the refuse that absolutely nothing is wasted. Bones are made into knife handles and buttons, and the small pieces and chippings are ground for fertilizer; the hair goes for mattresses and plastering; the intestines for sausage casings; the hoofs are made into gelatine and glue. Even the blood is used for buttons and other industrial purposes. The total number of inedible products of an animal is over one hundred. Grease not fit for culinary use is made into soap. All other parts not otherwise used go for fertilizer. The meat products of the packing house go out as fresh, salt, smoked, canned, and pickled meat.

The packing plant, with its numerous products and the means of selling them, has rapidly developed into one of the most aston-

* Cressy, Edward: *Outline of Industrial History*, p. 75.

ishing industrial units that world industry has thus far produced. Three or four American companies constitute what is commonly called a meat trust, and from time to time are officially so declared by some United States Government investigators. In a booklet put out in their own defense, Armour & Company, the largest firm of this group, maintain that in the year 1916 they produced three thousand different articles, including grape juice, fertilizer, leather, banjo strings, evaporated milk, and Hawaiian canned pineapples. They reported:

Total number of employees	45,000
Number of killing plants	16
Number of branch houses	416
Ground area all plants (acres)	500
Floor area all plants (square feet)	20,000,000
Number of fertilizer plants	36
Refrigeration capacity, all plants (tons per day) ..	17,126
Tons of coal consumed annually	785,183
Barrels of oil consumed as fuel annually	715,215
Tons of salt used annually	90,000
Pounds of sugar used annually	900,000

Their enormous growth and the taking over of many industries has been quite natural. Thus, having refrigerator cars for their meat, they were in a position to handle a few carloads of fruit now and then; they therefore went into the fresh fruit business, then into the fresh vegetable business, then into the canned vegetable business, then they naturally became dealers in and manufacturers of many other kinds of food. Producing two or three of the raw materials for fertilizer, it was natural that they should buy other raw materials and make a complete fertilizer, then a list of fertilizers. And so they have grown * until their activities include a great variety of products that in some way were allied to some of the articles made in the careful utilization of all the waste and minor products of the slaughtered animal.

Owing to the development of cold-storage and refrigerator

* An article in the *New York Journal of Commerce*, 12/13/18, said that the packers in Chicago control salmon canneries on the Pacific Coast, milk condenseries in the dairy-belt, gave an order for 800 cars of raisins in the summer of 1918, and are said to control 25 per cent. of important canned goods trade.

cars, an ever-increasing proportion of fresh meat is now distributed from the great packing centers to cities and small towns, chiefly in the northeastern part of the United States. It is also regularly put into the chilled chambers of the ocean steamers at the Atlantic ports, and sent to Liverpool, London, Antwerp, and Hamburg to feed the dense populations of Europe. Pork is exported to the West Indian Islands and other tropical countries. For this trade pork has the advantage of being relatively cheap and keeping well. Also the West Indian negro is content with the poorer parts of the animal.

THE EUROPEAN CATTLE INDUSTRY

While the exportation of meat and by-products to western Europe has long been an important but declining part of American trade, the production of meat in Europe is much more extensive. The total number of cattle in the United States, Canada, and Mexico before the war was eighty-three million; Europe had one hundred and twenty-nine million, but not enough for its own use. The herds are greatly reduced now by the war. In many sections of Europe cattle are normally an important money crop, and, as in America, the outlying districts send them to the more populous regions; for instance, before the war Hungary and Galicia used to send stall-fattened cattle to Switzerland. Owing to the heavy rainfall and luxuriant growth of grass, Ireland and the western part of England before the war were very important cattle-raising districts and the English farmer gloried in his fine fat cattle. The moist low-lying lands along the Baltic Sea and English Channel are admirably located for the production of grass and the keeping of cattle, and a previous discussion has pointed out the great development of the industry there. The well-tilled north of France possessed many cattle. Denmark is a model cattle country which long exported beef to Great Britain before the rise of the more intensive dairy industry. The upland pastures of southwestern Germany and the mountain pastures of the Alps are also famed for their cattle. Most of the cattle of western Europe live in barns and have their food brought to them in the form of cultivated crops, which are more productive than pastures. In a day's railroad journey across Germany fifteen years ago I saw no cattle at pasture except in three places, and then on land unsuited to the plow. The same conditions prevailed in France and Italy, but not in England, which, at the beginning of the war, was neglecting grain growing in the interests of rare roast beef and mutton chops. The common practice of keeping cattle in the stable and carrying their food to them is the explanation of the larger number of cattle per square mile in Europe than in America.

FIG. 78.—Distribution of cattle in various countries, 1914.

Russia, the greatest cattle country in Europe, and the second in the world, has vast plains, parts of which, like those of our Western States, are too arid for any use save as pasture. In eastern Russia there are districts so remote from good transportation that cattle are kept largely for their hides and tallow, as they were years ago in Argentina, but before the Great War, the building of railroads was fast bringing this epoch to a close there as in most other out-of-the-way corners.

CATTLE IN OLD WORLD ARID BELT

Countries having the dry summer of the Mediterranean climate do not possess good pasture, so that in those countries cattle are not so important as in northern Europe. In the dry climate, animals better adapted to poor herbage such as the sheep and goat, are substituted for cattle and horses. For this reason Italy, Spain, and Portugal have fewer cattle than Austria, and Italy's percentage of cattle to people before the war was only seven. Cattle are, nevertheless, widely distributed in the arid region and are to be found in limited numbers from Spain to Palestine, Persia, Turkestan, and Manchuria. In Mongolia the scanty pastures furnish some of the exports of the Chinese Empire. In this wide zone of Mediterranean climate and little rain, which finds its closest counterpart in the American cattle ranges between the Sierras and the Rockies, the methods and the difficulties of the industry are shown by the following excerpts from a United States Consular Report from Harput, Asia Minor (June 17, 1911): "A great portion of the cattle, sheep, and goats are owned by nomad tribes of Kurds that wander about this whole country with their flocks and herds. This last winter, however, was the most severe ever known in this country; the snow extended south even down into the sub-tropics, and over this winter-grazing land the snow was several feet deep and lasted throughout the entire winter. The people were helpless to provide against such conditions. There was no food procurable for the livestock and little for the inhabitants, twenty per cent. of whom and seventy to eighty per cent. of the livestock starved to death." Freezing and starving are by no means uncommon fates for cattle in the United States, Canada, and other parts of the world where men try to make them live through the winter without stores of forage. Irregularities of rainfall are as sure as rain itself, and a given range that will support eighty cattle this year may support one hundred next year and seventy-five the year after. Returning spring often finds dead cattle on the range all the way from Texas and Arizona to Alberta.

THE CATTLE INDUSTRY OF THE SOUTH TEMPERATE ZONE

The refrigerator ship, the refrigerator car, and the cold-storage plant have made possible the carriage of meat to market half-way around the world and more if need should arise, so that the ranchers of the south temperate zone need no longer keep cattle for their hides and tallow alone. With these inventions a new prosperity came to Argentina, New Zealand, and Australia—countries admirably adapted to pastoral industries. Packing plants like those of Chicago and Omaha now stand at Wellington, New Zealand; at Sydney, Brisbane, and other places in Australia; at Buenos Ayres and Rosario, in Argentina; and at Paysandu and Fray Bentos, across the Plata River in Uruguay. From these plants, the frozen carcasses of cattle and sheep are wheeled by the thousands into the freezing chambers of the ships which carry them across the entire torrid zone to deliver them, still frozen, at the cold-storage warehouses of Antwerp, Southampton, Liverpool, London, Glasgow, Lisbon, Naples, Genoa. Hence they are distributed to the butchers' carts of a hundred English and continental towns. Although this method insures cheaper food to the European and better prices to the farmer of the south temperate zone, it has not sufficed to keep down the price of meat. The high price of meat causes marked industrial changes. The Argentinians now pay tremendous prices (at times over $5,000 per animal) for prize-winning breeding stock of the English cattle shows and turn them out to increase on the fine level estancias (ranches); they fatten the progeny of these animals on the alfalfa which is becoming so important a crop in that country. The possibilities of the extension of meat production in the Paraná Valley appear to be very great. Alfalfa has proved to be especially well adapted to large areas and its use is rapidly spreading. It increases from three to six fold the number of cattle that the land will support. A few years ago an American, writing from his sixty-thousand-acre alfalfa ranch in the southern part of the province of Córdoba,* said, "You can buy a league (6,672 acres) for $11,000 ($1.65 per acre) and, by spending as much more in putting it into alfalfa, have a ranch that will carry three thousand cattle and keep them practically fat all the year round with very little risk from drought or severe winters. (The south temperate zone has almost no winter.) These provinces that grow alfalfa so easily (Córdoba, Santa Fé, San Luis, and western Buenos Ayres) are the future grazing lands of Argentina. It is astonishing what large areas are taken up every year and turned into alfalfa." The four provinces mentioned have an area larger than Kansas, Nebraska, Iowa, and Ohio combined; but those states cannot keep an ox on two and one-third acres of land, for they are not such natural alfalfa land as are the silt plains to the west of the Paraná. The open winter of Argentina, like that of Texas, makes cattle raising easy because it is unnecessary to build barns.

* United States Department of Agriculture, Report No. 77. Alfalfa Production in Argentine, 1904.

Before the invention of refrigeration the cattle industry of the Paraná (River Plate) countries had already advanced beyond the shipments of hides, tallow, and bones, by the manufacture and export of tasajo jerked beef and beef extract. Tasajo is a peculiarly well preserved, salted, and dried beef cured in the sunshine of the great pasture plains (pampas). It will keep indefinitely in such hot humid climates as Cuba and Brazil; transportation is therefore easy. For many years it has had a wide distribution over tropic America. In 1910 Uruguay slaughtered 537,000 cattle for tasajo, in 1916 but 61,000. Plants for freezing and canning beef had come to Uruguay and the tasajo plants had fled to the interior of Brazil.

FIG. 79.—(Finch and Baker.)

Beef extract is a convenient means of putting a big roast into a small bottle. Its manufacture is therefore an industry that can afford to go to the farthest corner of the globe for cheap beef. Almost every drug store in the world keeps a well-known brand of beef extract that has for some decades been manufactured on the banks of the lower Paraná from the cheap beef of Uruguay and Argentina.

American meat-packing firms from Chicago have opened branches in Argentina and Uruguay and now compete with the meat extract manufacturers in the purchase of fat cattle; they sell the meat in Europe in competition with the product of North American farms. At the end of the first decade of this century trial shipments of beef and mutton were made from Argentina to the United States. The steady decline of beef animals in this country brought about such a price that beef was imported to the extent of 270 million pounds, mostly from Argentina, before the war entirely upset normal trade and made the United States once more an exporting nation. It is probable that the restoration of peace and a return to normal prices will again bring South American beef to New York.

CATTLE IN TROPIC AMERICA AND TROPIC AFRICA

The cattle of American countries north of Argentina and south of the United States have only slightly affected international trade, save for their hides; but they are locally important. The people in the highlands of Mexico and Central America and the Andean countries of Colombia, Ecuador, Peru, and Bolivia have cattle everywhere, but never a surplus to export, save some lean cattle that move across the Mexican boundary into the United States. Cattle in large numbers are produced in small herds and consumed in all of these countries. Their hides, however, constitute a general and important export, since they keep indefinitely and can stand nearly all conceivable abuses in transportation.

During the period of the war the cattle of the tropics have entered the world's trade, and doubtless have entered it to stay: for the tropics have important cattle resources. Paraguay, with cattle as its chief industry, has for several years sent 30,000 to 40,000 live cattle each year by steamer down the river to Argentina, and has had hides for one of its leading exports. This country has 350 cattle per 100 people—a very high figure. Because of the meat scarcity during the Great War, one of the American companies erected a great modern plant for the manufacture of canned beef in Paraguay, 2,000 miles up the Paraná River from Buenos Ayres. In October, 1918, it was importing tin plate from the United States and sending beef to the Allied armies. Brazil, in the same latitude as Paraguay, has large areas of almost uninhabited unforested interior between 10° and 30° south latitude. In 1917 Chicago men, using American equipment, were erecting a slaughter house a few miles from Rio Janeiro, with a capacity for handling 700 head of cattle a day. At the same time Armour & Company of Chicago were supervising the construction of a much larger plant four miles from the Brazilian city of São Paulo, with 3,000 employees, and a daily capacity of 2,000 cattle, 3,000 hogs, 2,000 sheep. This company had the advantage of the experience of already operating a plant in southern Brazil near the Uruguayan frontier.

At the same time new freezing plants were going up at Corrientes (latitude 28°) on the Paraná, in Argentina, and British capitalists were building a meat-freezing plant at Odzi in Rhodesia (latitude 20°), inside the coast ranges at the edge of the great veldt over which the Dutch Boers, after the fashion of the American cowboy on the similarly dry plains of New Mexico, are following flocks and herds.

CATTLE IN SOUTHEASTERN ASIA

In number of cattle India leads the world, her supply

nearly equaling the combined numbers of the United States and the Russian Empire. The cattle are utilized very little for food, as the Hindus, who make up nearly 70 per cent. of India's population, do not eat beef under any conditions, and the Mohammedans, who form over 20 per cent., forego it largely out of sympathy, except on feast days. The cattle are of the humped type, though many breeds exist. The bullocks are used universally for labor. In most parts of India cattle are objects of religious esteem and the cows and bullocks beyond their years of usefulness are not killed, but subsist in a meager way until they die natural deaths. The carcasses are then skinned by a special caste and become carrion, or are sometimes buried. The utilization of cattle instead of the buffalo for labor in the delta region of Bengal is due in part to prejudice against the latter and especially against its milk. The cattle of this region are small and of poor quality and might well be supplanted by the buffaloes, which are suited to this region, as is shown by their number in the delta of the Kistna, north of Madras.*

In the Philippines, a somewhat similar dependence upon cattle was disturbed by rinderpest (cattle plague), which resulted in the loss of cattle "to such an extent that the entire economic situation of the islands was endangered" (United States Con-

* Finch, V. C., and Baker, O. E.: *Geography of the World's Agriculture*, p. 118.

sular Report, January 23, 1911). The same diseases ravaged Siam, while in 1912 and 1913 southern China carried on a lively trade in restocking the Philippines with live cattle. For several years there have been small imports of Australian fresh beef into both the Philippines and Siam.

THE FUTURE SUPPLY AND PRICE OF MEAT

The nineteenth century was a period of industrial discovery and commercial expansion by means of railways, steamboats, refrigerator cars and ships. This condition permitted the Western World to have for a few decades the cheapest meat supply it is ever likely to have. There are no more great plains to discover, and the population is increasing much faster than the number of meat animals; as a result meat is today rising in price, in practically all parts of the world. For this situation there is no remedy in sight, and it may not be an entirely fanciful prediction that fifty years hence a juicy beefsteak will be the center-piece at the banquet table.

Paris complained that between 1902 and 1910 the wholesale price of meat increased forty-five per cent. at her abattoirs. Similar conditions in Germany had, before the war, caused an absolute decline in the number of animals slaughtered, and that empire was importing $120,000,000 worth of forage per year. This situation must continue after the war. Supplies brought from new producing regions may be expected to afford some relief, but all the great areas on the agricultural frontier are already producing. The recently established exportation of pork from Hankow, six hundred miles inland in China, to Liverpool is interesting, but it shows no important new source of supply. It is chiefly promoted by the very low prices now prevailing in China and the fact that most of her people are too poor to eat meat.

Examination of world resources shows us that the chances for increase of beef cannot be compared with our chances for increase of potatoes, rice, or wheat. The prospects in Europe are well shown by the pre-war conditions in Germany: namely, decline because the land is needed for milch cows, and fields of wheat, barley, rye, potatoes, and sugar beets. While Europe may produce a little more beef than she now raises, her desire for it will grow more rapidly than her production. Asia will afford little relief, for she has long since passed the meat-producing stage, and save for some production in Siberia, is more likely to join Europe in the desire to import meat. Australasia may increase her output, two or three fold perhaps, but the great handicap of drought prevents her from ever having numbers of cattle nearly approaching those of Germany or the United States.

In Africa the chances are better. There are large areas in the highlands of east Africa, perhaps in the Soudan, where the example of the Rhodesian meat plant previously mentioned may be followed, and perhaps energetic men might make large alfalfa areas. At the present time, however, the African cattle are relatively unimportant: the number reported from the whole continent is about the same as that from Uruguay and Paraguay combined (about twelve million in 1910) and the most important part of the continent, British South Africa, has about as many (four million) as Iowa. African climate upon the whole is ill adapted to cattle. Aridity makes both north and south Africa resemble the less favorable parts of our arid West. It is too wet and hot in much of central Africa for cattle to live at all, and the interior plateaus have not yet been settled, though they seem to be lands of promise, cattle promise at least. South Africa was reduced to the brink of financial ruin a few years ago because the rinderpest swept from the Zambezi River almost to Cape Town, killing nearly all the cattle as it went. The stopping of this onrushing wave of death is an interesting example of large-scale government work, one of the hopes of the future. The disease went by contact from district to district, across river, vale, and plain, until in the highlands of Cape Colony the British prepared for it by removing all cattle from a wide zone. The cattle died down to the edge of this empty zone, where there was no means of transmitting the disease, which therefore stopped.

The Boer who was dependent on his ox cart was deprived by this plague of the means of transportation, and the farmer who had been keeping cattle had to turn to some other resource. Science has now conquered the disease and the industry is being restored. In Matabeleland, Rhodesia, north of the Transvaal border, a large grant of land was recently made to a London company, which built dipping tanks (for disinfecting live animals and removing disease-carrying vermin), dug wells, and stocked its ranch with cattle. It planned to build a meat-extract plant. The location, as far from the Southern Sea as is Chicago from the Atlantic, and with no home market and no lake boats, suggests the manufacture of a concentrated product. The building of the freezing plant previously mentioned nearer the sea indicates the success of the restoration of the cattle industry in these plague-swept lands.

Tropic America has important unused resources for cattle production. The new packing plants building last year in Paraguay and Brazil are suggestive of increased output from the large unused semi-arid interior region of Brazil and Paraguay, as large as that of the United States lying west of the one hundredth meridian, which, because of its aridity, is also largely limited to meat production. The grassy plains of the Orinoco with their alternating periods of rainfall and unbroken sunshine have large unused possibilities. Other lands, such as Colombia and Central America, produce grass the year round and are well suited to cattle. Diseases that have been fatal in the past need not be so in a more scientific future. Transportation difficulties hinder the project. It costs more to get a bullock from Guatemala City to Puerto Barrios, one hundred and ninety-six miles, than it does to take him from western Kansas to Chicago. If he continues his journey to New Orleans, the total cost is double the freight from western Kansas to New York or Boston. But if the cattle existed in great numbers, they could doubtless be moved more cheaply. The recent shipment of dressed beef to England from Puerto Cabello, Venezuela, suggests on a much smaller scale the revolution already wrought in Argentina and Uruguay.

The best prospects for the prompt increase of the world's beef supply may be expected to result from the extension of alfalfa growing in Argentina and the more careful utilization of the great meat-producing possibilities of the cotton-belt of the United States. This latter region has been surprisingly neglected, but the chief factor in its neglect—namely, the cattle tick—is now in full retreat before the disinfecting army led by the veteri-

FIG. 80.—The territory under quarantine for Texas fever of cattle December 1, 1917. The shaded line to the north of this area and in California is the boundary of the territory under quarantine when the work was begun in 1906. (U. S. Dept. Agr.)

narians of the United States Department of Agriculture. For years cattle from the Southern States brought mysterious death as they traveled northward. The disease was called Texas fever. It would kill whole herds that had come in contact with cattle from the South. That was about all we knew—mysterious death. We conquered it by establishing a quarantine line across which cattle could come only in the winter time, when, for some unknown reason, the cattle from the South did not spread infection. We now know the life cycle and the career of this disease. It is much like that of malaria; though far less mobile. The carrying agent is a crawling tick that sucks blood from the semi-immune southern cattle, gets the deadly disease germ, then bites the unimmune northern thoroughbred and gives the disease to him with fatal results. By plunging the cattle, ears, horns, and all, into disinfecting liquid in specially prepared vats, the ticks are killed and the cattle cleaned. By millions of these uncomfortable but beneficial dippings, the quarantine line has been steadily advanced to the southward until in 1917 the state of Mississippi held a great jollification over having driven a great wedge into the quarantine line by becoming entirely clear.

Between July 1, 1906, and December 1, 1917, the area of tick-infested land in the United States decreased fifty-two per cent., from 728,000 square miles to 349,000 square miles. It should be made one hundred per cent. free by absolute compulsion in twelve months' time. The people of the Southern States could then utilize their great cattle advantages. The Minnesota farmer must build large barns to protect his animals and their food from the cold and storms of winter. He must feed his animals throughout half the year from the results of his summer's toil. In Alabama, South Carolina, or Louisiana, there is so little winter that a barn is scarcely necessary, and the growing season is so much longer that more forage can be produced on a given piece of land than on similar land in the Northern States. The cattle can also pasture nearly all the year; therefore the industry requires less capital and labor than in the North.* The great advantages of the South for stock raising

* Pasture grasses of the South are not so succulent as those of the North, but in the warm Southland with its good rainfall, tractor plowed lands sown to peas, beans, vetches, clover, cane, and small grains produce great food supply for pasturing beasts.

have not up to the present time been used, because of the great and almost exclusive dependence of the farmers on cotton, a money crop of unusual excellence, and because of the deadly tick. The conquest of the tick is very suggestive in connection with the utilization of the tropics. Equally suggestive are the experiments with the tropically acclimated Indian breeds of humped cattle.

The number of meat animals in North and South America, Africa, and Australia, can be increased several fold if we will follow the practice of those parts of western Europe where the animals are kept in barns and supplied with food cultivated with great care and intensity of labor. Such a prospect is, however, decades or generations in the future, and it involves a price of meat several times as high as that to which the Western World was accustomed before the Great War.

No discussion of unused meat resources should cause us for a moment to forget the fact that there is no prospect of permanent relief in sight. After the war prices will fall somewhat from their high level, but there is little prospect of meat being as cheap relatively as it was before the war. There will be increases of supply, but also increases of demand. Indeed, we may scarcely expect it to hold its own, but instead to become relatively scarcer, and, as the population of the world doubles and triples, that small minority in the Western World who have so nearly monopolized the world's meat will have to reduce their consumption. It is fortunate that science as well as the Oriental practice shows that meat is not after all so important a food as we had thought. More and more of the human race will do well to approach the philosophy of the old colored man who had just taken a rabbit out of his trap and was gloating over the prospect of fried rabbit and corn pone, when, with a bound, away scampered the rabbit. "Oh, well," said the old man, "it's dry old eatin' anyhow."

CHAPTER XI

DAIRY PRODUCTS

MILK is the greatest of foods. It is the only indispensable article on the human bill of fare. It is also the only one that is made especially to support animal life. We can dispense with meat or bread, but we cannot dispense with milk; indeed we should use more of it than we do. One of the facts upon which nearly all the authorities in the nearly new science of human nutrition are agreed is that milk in some form should, with few and rare exceptions, be part of the food of every one.* Lusk and others agree in the recommendation that nó family of five should ever buy meat until they have bought three quarts of milk daily.

Whole milk contains everything necessary for the growth and maintenance of the human body: protein, fat, milk sugar, salts, water, and more—certain unknown substances, sometimes called vitamines, vitalizers we might call them. On account of their unknown nature some writers prefer to refer to them without name as "water soluble A" and "fat soluble B," because they find two classes of these mysterious substances without which

* Milk is the greatest source of calcium (lime). Lime is one of the components of food that serves two purposes: it is both building material for bones and regulating material for the body as a whole, helping in several important ways to maintain good health. It is essential that every one have a supply of lime and particularly important that all growing infants, children, and young people have plenty for construction of bones and teeth. There is almost none in meat and bread, none in common fats and sugars, and comparatively few common foods can be taken alone and digested in large enough quantities to insure an adequate supply; whereas a pint of milk (whole, skim, or buttermilk) will guarantee to a grown person a sufficient amount, and a quart a day will provide for the greater needs of growing children. Whatever other foods we have, we cannot afford to leave milk out of the diet because of its lime. Under the most favorable dietary conditions, when the diet is liberal and varied, an adult should have *at least* half a pint of milk a day and no child should be expected to thrive with less than a pint."—Rose, Dr. Mary Swartz: *Everyday Foods in War Time*, pp. 5-6.

The United States Food Administration urges the nation as follows: "If you cut down your war-time order, don't cut down the children's milk; cut somewhere else."

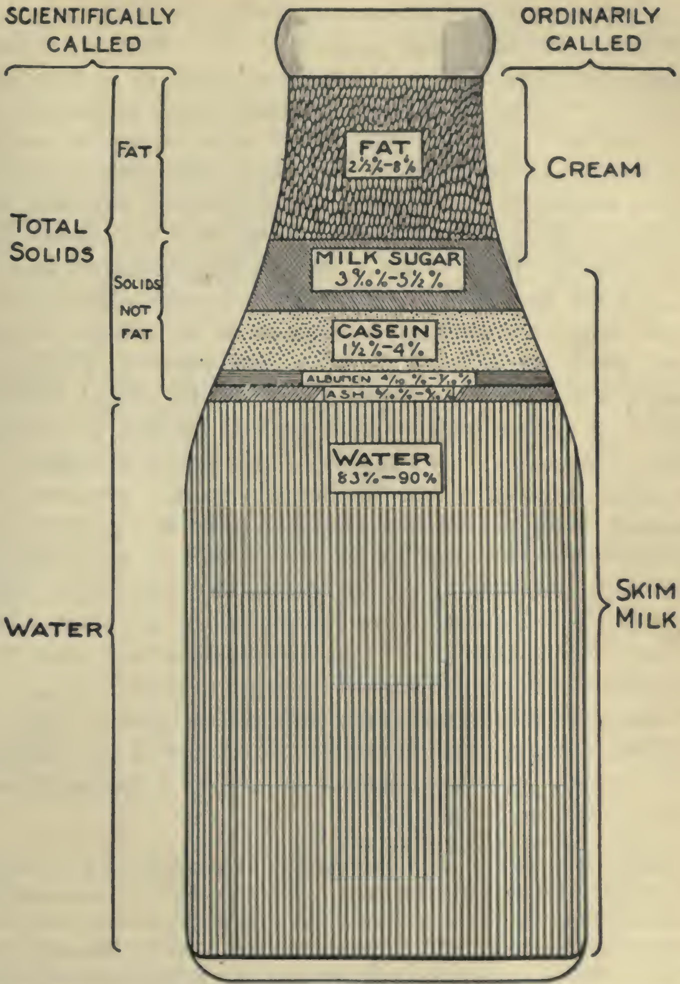

FIG. 81.—The contents of a bottle of milk. (Boston Chamber of Commerce.)

men and other animals die. We may liken them to electricity, a force which man may use, but whose nature remains absolutely unknown; we know how to produce it and use it, but do not know what it is. The same thing is true of the vitamines.

The students of nutrition have really greatly misled themselves and others by talking of foods only in terms of calories—protein, carbohydrate, starch, fat, etc., omitting vitamines. Certain food experiments are good examples of the old errors and troubles of the food expert. Animals have been given experimental diet with plenty of protein, plenty of carbohydrates, plenty of calories furnished by a good variety of grains, seeds, and vegetable fats. In from five to seven weeks the animals' eyes became inflamed, they lost weight, went blind, and died. But if, before the trouble had gone too far, the wretched beasts were given a tiny piece of butter, all was well with them. Their eyes recovered, their weight increased, and they grew sleek and fat. What had happened? Calories—carbohydrate, protein, starch, fat—do not tell the tale. Most of the cells in grains are dead; the living cells of the stalks and leaves of plants are a necessary element of nutrition, along with the seeds. The vitalizers or vitamines come to most animals through the eating of leaves. The sore-eyed experimental rat recovers as quickly when he is fed alfalfa leaves as when he is given milk product. On a combination of rolled oats sixty per cent. and ground alfalfa forty per cent. a young rat thrives, though he was starving to death on a collection of the best grains in the granary. Following this clue experiments are being made by the United States Department of Agriculture in co-operation with Dr. E. V. McCollum, of Johns Hopkins University, to produce bread made of a mixture of ground alfalfa and ground grain. The chief difficulty appears to be the unpalatable flavor of the alfalfa; we may, however, reasonably expect to produce a pleasant-flavored alfalfa. Dr. McCollum says:

> If it shall some day be found feasible to incorporate with wheat in the making of bread a sufficient amount of a leaf to insure safety, a strictly vegetarian diet may be found which would meet all the requirements of man. At present there is probably no diet employed by man which is strictly vegetarian in character, which induces perfectly normal well-being. I say this with the knowledge that there are in India, Japan, China, and other parts of the far East, people who are practically strict vegetarians in their dietary habits. In no case, however, are these peoples so vigorous and progressive as they should be.* These vegetarians, however, eat several times as much of the leafy vegetables as do the people of the United States. This fact, I feel confident, explains their continued existence.†

* Before accepting this as a purely dietary result, see Huntington, *Climate and Civilization*, mentioned in a later chapter.

† McCollum, Dr. E. V.: *Hoard's Dairyman*, December 21, 1917, p. 770.

Dr. McCollum is confident that the people of Russia, India, and other parts of the Orient not only suffer from beri-beri because of lack of greens and milk, but also have eye troubles almost exactly like those of the rats mentioned above:

Since it is not feasible at the present time to attempt to plan a diet for man which will contain both the seed and leaf of the plant in such proportion as will make the diet complete, there is but a single method of procedure by means of which we can be certain that the nutrition of our people will be safeguarded. That is to maintain the dairy industry at its present extent of development. Actually it should be considerably increased, but it must not be permitted to decline. If it does, the United States will not long maintain its position of supremacy in the fields of human endeavor requiring both physical and intellectual vigor. Such vigor can be maintained only when the diet is highly satisfactory in its chemical makeup, and neither the sense of taste nor the utmost refinement of the chemist's technique can discover when the food is satisfactory. This can be learned only by means of properly planned feeding experiments.* I have so perfected this type of feeding work as to make of it a systematic biological analysis of foodstuffs, and we are now rapidly acquiring the precise knowledge of the peculiar properties of our natural foodstuffs which will eventually enable us to so combine them as to obtain the very best possible results both in human nutrition and animal production.†

In connection with the oft-repeated statement that the people of England and America have been so efficient and energetic because of the meat they eat, Dr. McCollum says:

I have come to the conclusion, after carefully analyzing the probable effectiveness of the combinations of foods employed in human nutrition, that the efficiency of a people can be predicted with a fair degree of accuracy from a knowledge of the degree to which they consume dairy products. Probably the use of meat and of milk and its products will in nearly all cases run more or less nearly parallel, and I venture to assert that it is the milk and butter and cheese, and not the meat which

* As proof of this, Dr. McCollum records the placing of families of rats in the presence of abundance of wheat, corn, barley, other grains, and various foods prepared for them, and also alfalfa meal. According to a widely held notion about the guidance of the instinct of taste, the animals should pick out of this what they need and thrive. Instead they have repeatedly starved to death, although by the taking of two of the articles, namely, alfalfa meal and oats, and confining rats exclusively to a mixture of these, they throve, grew, and raised increasing generations of their pestiferous offspring.

† McCollum, Dr. E. V.: *Hoard's Dairyman*, December 21, 1917, p. 771.

has the good influence on the promotion of the virile qualities of the people.*

I only wish to point out the fact, which rests upon sound experimental evidence, that milk is an indispensable article of the diet of any people who wish to achieve; that milk production cannot rest upon a

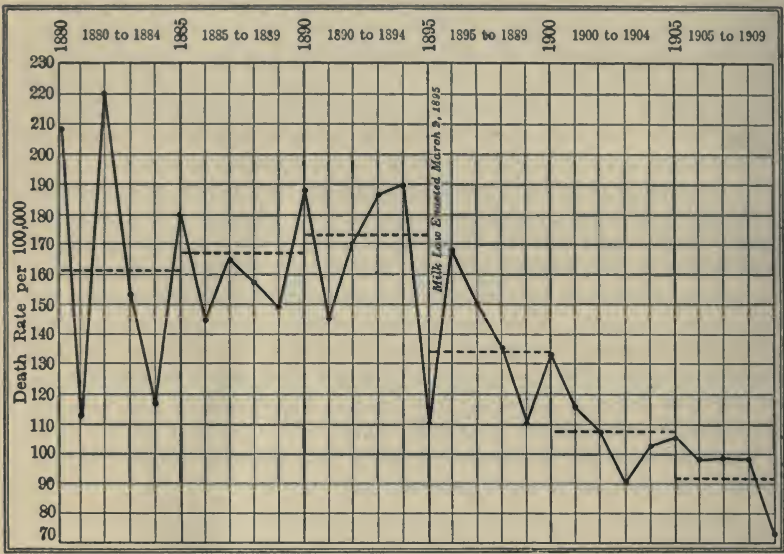

FIG. 82.—Our increasing knowledge of the cause of infant diseases and the importance of milk as food is causing rapid increase of governmental authority over the milk business. In a short time we will probably have one sanitary wagon exercising a controlled milk monopoly at a greatly reduced cost of service, instead of having ten unsanitary wagons rattling over each residence street each day. This districting has already been done in London under pressure of war shortage, and the same thing is already rapidly working itself out in several American cities, especially Philadelphia. Clean milk can be made much more cheaply than is supposed. If done in a large and sanitary way, certified milk can be produced for only two cents a quart more than any other (pre-war figures). This was proved by the experience of Germany and by figures from the United States Department of Agriculture.

philanthropic basis, but must be a paying industry. I want to emphasize that the public must allow the price of milk to advance so that the industry is profitable to the dairyman. Milk is worth much more than its energy value or than its protein content would indicate. It is the great factor of safety in making good the deficiencies of the grains

* This interesting statement is probably too strong. See Huntington (*op. cit.*) on climate influence and note the description of the almost milkless Chinese and Japanese diet in chapter on Vegetables.

which form and must continue to form the principal source of energy in our diet. Without the continued use of milk, not only for the feeding of our children, but in liberal amounts in cooking and as an adjuvant to our diet, we cannot as a nation maintain the position as a world power to which we have arisen. The keeping of dairy animals was the greatest factor in the history of the development of man from a state of barbarism. We are now in a critical time when the dairy industry is in jeopardy. I feel it my privilege to point out that we are still dependent upon the dairy industry for our continued prosperity. Let us appreciate the debt we owe to the milk producer, and reward him according to the service he renders.

Thus far milk has been chiefly praised for its mysterious vitalizing effect, which makes other foods available, but it is also a very valuable food in itself, in its content of protein, carbohydrate, fat, and mineral salts. The fact that it was meant to build the bodies of the young gives it peculiar ability to supplement the shortcomings of other foods, and explains its importance in the diet of every one. It is fortunate that ten or twenty times the present supply of a food so vital and so valuable can be produced.

The milk animals render us a great service in making food for us out of things that we ourselves cannot eat.* Bacteria at the

* The prodigious achievement of one record-breaking Holstein cow in converting vegetation into milk shows the following facts:
"Tilly's," record by years is as follows:

Age at Calving	*Butter*	*Milk*
2 years 6 months	556.20	14,837.2
3 years 5 months	841.22	21,421.3
5 years 1 month	1,189.03	30,451.4
6 years 5 months	1,190.46	29,826.6
7 years 7 months	1,042.20	26,814.8
9 years 2 months	1,323.00	33,424.8
Total for 6 years	6,142.11	156,776.1

The feed consumed during the test year totals as follows:
Pasture—4 hours daily for nine months.

	Pounds		*Pounds*
Ground barley	1,325	Beets	21,000
Ground oats	1,325	Dried beet pulp	2,550
Bran	1,325	Silage	3,000
Soy-bean meal	1,165	Alfalfa hay	5,000
Cotton-seed meal	532		
Linseed meal	200	Total	31,550
Total	5,872		

Tilly started with ten pounds of concentrates daily, and this was increased to twenty pounds three or four weeks after calving. . . . During roots of clover catch nitrogen. The clover gets it from the bacteria. The farmer makes the clover into hay. Months later the cow converts the hay into milk to make the baby grow. Dr. George F. Warren, averaging the figures for 8,000 cows averaging 6,198 pounds each of milk per year, finds that 100 pounds of milk required for their production 33 pounds of grain, 61 pounds of hay, 97 pounds of corn silage, and 2.8 hours of human labor.

Milk enters largely into commerce in the form of its derivatives, butter, buttermilk, cheese, condensed, evaporated,* and dehydrated milk. In these concentrated forms it can be kept for months. Butter retains the fat, and cheese retains both the fat and tissue-creating elements. During the food shortage of the war the United States Food Administration very wisely laid emphasis upon the fact that large quantities of skim milk were being fed to pigs or even in some cases being thrown away in the United States, when really it is a very valuable foodstuff in the form of soft or cottage cheese,† which has a protein supply

her heaviest production she consumed eighty pounds of beets daily and eight to fourteen pounds of dried beet pulp, with ten to twenty pounds of alfalfa hay. . . . Tilly averaged above twenty pounds of butterfat—more than twenty-five pounds of butter—a week for the year. Her milk sold wholesale for $920 at $2.75 a hundred pounds, which is below the average in the United States. . . . Charging her feed at prevailing prices I find that for each dollar in feed consumed Tilly has returned $3.17 in milk, or, if sold for churning purposes, she would have returned $2.90 for each dollar in feed."—Robert E. Jones in *The Country Gentleman*, February 8, 1919.

This cow seems to have been a veritable factory.

* Condensed milk is made by boiling off part of the water of milk and then canning the remainder, either with or without sugar. By more recent processes all the water is driven off and the milk is left as a powder.

† For supplying protein, the Food Administration says one pound of cottage cheese equals—

1.27 pounds sirloin steak	1.46 pounds fresh ham
1.09 pounds round steak	1.44 pounds smoked ham
1.37 pounds chuck rib beef	1.58 pounds loin pork chops
1.52 pounds fowl	1.31 pounds hind leg of lamb

1.37 pounds breast of veal.

In addition to protein, energy for performing body work must be furnished by food. As a source of energy also, cottage cheese is cheaper than most meats at present prices. The following table shows the comparison when energy is considered.

On the basis of energy supplied, one pound of cottage cheese equals—

8⅓ ounces sirloin steak	10¾ ounces fowl
11¼ ounces round steak	5½ ounces fresh ham
11¼ ounces chuck rib beef	5 ounces smoked ham

6 ounces loin pork chop.

of tissue-making materials as good as those of lean beef, at a much lower price. Buttermilk also has the same quality.

Although a perfect food, in that it completely sustains life, milk is very dangerous because of the ease of contamination in its collection, and the further fact that it is a perfect germ culture. The relationship between the condition of the milk supply and the infant death rate is often astonishing. Our increasing knowledge of the causes of disease and health has promoted rapid increase in the extent of governmental control and supervision of the milk supply.

Cheese, a condensed form of milk, is a substitute for meat (see table of food analyses); and butter is a fat, supplying well that deficiency in the albuminous and starchy foods. For this reason it is eaten with bread. All three of these major dairy products, especially milk and butter, are valuable in the preparation of many other articles of food. A good rice pudding, for example, is a very easy way for an adult to get a fine supply of lime and other salts along with some easily digestible proteins.

THE DAIRY INDUSTRY

The dairy industry is widely scattered because of many forces, agricultural, climatic, commercial, personal, and social. Among these is the fact that its products are for immediate or nearby use, as well as distant and later use.

Milk, intended only for the offspring of the particular species producing it, has been taken by man at various times and places from camels, mares, sheep, goats, cows, and even the Indian water buffalo. As a result of long selection and improvement, the goat and the cow have become especially adapted to this service and give quantities of milk which would have astonished our primeval ancestors who first domesticated the animals. Breeds of cattle are of two classes—the beef animals that get fat if well fed, and the dairy or milk breeds that give much milk if well fed.

To what extent the qualities of these different breeds of dairy cattle as regards bodily form, temperament, yield, and quality of milk are due to the natural conditions in the regions of their origin is not well known. Doubtless the breeders' ideals have been very important factors in their formations. The force of environment, however, may be seen in certain well-recognized characteristics. Such are the heavy, well-muscled bodies of the Brown Swiss, required in climbing mountain pastures, and the thriftiness and ability to thrive on scant pastures of the Ayrshire breed, which originated on the uplands of Ayr in Scotland, where disagreeable climate and poor, thin soils produce coarse and scanty forage. The striking contrast in characteristics between the Dutch or Holstein-Friesian cattle and the Jersey is doubtless due also in part to the difference in geographic environment. The native home of the Holstein-Friesian cattle is that portion of the Netherlands lying contiguous to the North Sea, where the climate is cool and moist and the soil is a heavy clay, which induces a luxuriant growth of grass carrying a high percentage of water and a corresponding low content of nutrient substance. The cows calve during the spring months, and during their heaviest milking period are obliged to obtain the needed sustenance from luxuriant but watery grass. As a result of this necessity there has been developed a cow having a large abdomen with a corresponding large digestive capacity. The cows also are large in size and their bony structure somewhat coarse and angular. Perhaps as a result of these large quantities of watery food, the flow of milk is larger in quantity and lower in percentage of butter fat and other solids than the milk of other improved dairy breeds.

Quite opposite are those conditions under which the Jersey cattle have developed. Their native isle possesses a mild climate much drier than that of Holland. The soil is a light loam and carries an herbage not abundant, but comparatively high in nutritive substance and low in water content. At no time is the Jersey obliged to consume large quantities of succulent food. The character of the food-supply has doubtless been one factor in developing a body of moderate size and rather fine bony structure. Environment, food, and selection by the breeder have resulted in making the Jersey cow a moderate producer of milk that is richer in fat and in other solids than the milk of any other breed of cattle.*

The nomads, such as the Kirghiz, who follow their flocks across the steppes and mountains of the southern part of Asiatic Russia, probably depend more upon milk and its products than any other people. Aside from these roving herds, milk production is at a low ebb in lands of little rainfall, or of summer drought, such as we find in California and the Mediterranean countries, because of the scarcity of grass. During the months of summer drought, the cost of supplying milk animals with green and succulent food is so great as to make milk relatively expensive and something of a luxury.

* Finch and Baker: *Geography of the World's Agriculture*, p. 119.

The small quantity of milk that is used, chiefly by children, in the dry summer countries of Europe is largely supplied by goats, which can live on a poorer and drier diet than is possible for the cow. In all Greece there are but four thousand cows, most of them near Athens. Goat's milk is more important, and cheese of sheep's milk, common throughout the Mediterranean, is here an important commodity. The Valchian breed of Greek sheep will give twelve ounces of milk per head per day for six months. Italy produces one hundred and twenty million gallons of sheep milk per year, mostly for cheese. Some varieties of milk goats in Mediterranean countries give a greater amount of milk in proportion to their weight and food consumed than does any other milk producer. Furthermore, goat's milk is richer than cow's milk in both fat and solids. One of the characteristic street scenes in these countries is the milkman driving herds of goats through the street and milking them at the door of the customer, being able thus to guarantee the absolute freshness and purity of the milk. He also avoids the difficulties of keeping his bottles clean, and the even greater difficulty of cooling milk in a country without the cool springs or ice that are so indispensable to the commercial dairy.

CHARACTERISTICS AND LOCATION OF THE DAIRY PRODUCT

Dairying as an important industry depends chiefly upon cow's milk, although the goat and sheep are minor helpers. It has arisen in lands of moderate coolness where the rainfall is sufficient to produce the succulent grass and other forage required by cows if they are to give profitable quantities of milk. Owing to the bulk, weight, and perishable nature of milk, it must be produced near the market if it is to be consumed while fresh. The great demand for fresh milk in the vicinity of New York City has caused milk to be brought nearly four hundred miles in special express trains, such as those running from Wayne County, Pennsylvania, and from the banks of the St. Lawrence to New York City. The supply for the city of Philadelphia comes from points as far away as the shores of Lake Erie, Lake Ontario, and the Chesapeake Bay. This condition, however, is exceptional, and it may be said that the number of cows increases with the density of population in the United States and northwestern Europe. Thus New York, our Empire State, long led all other states in its number of milch cows; and Pennsyl-

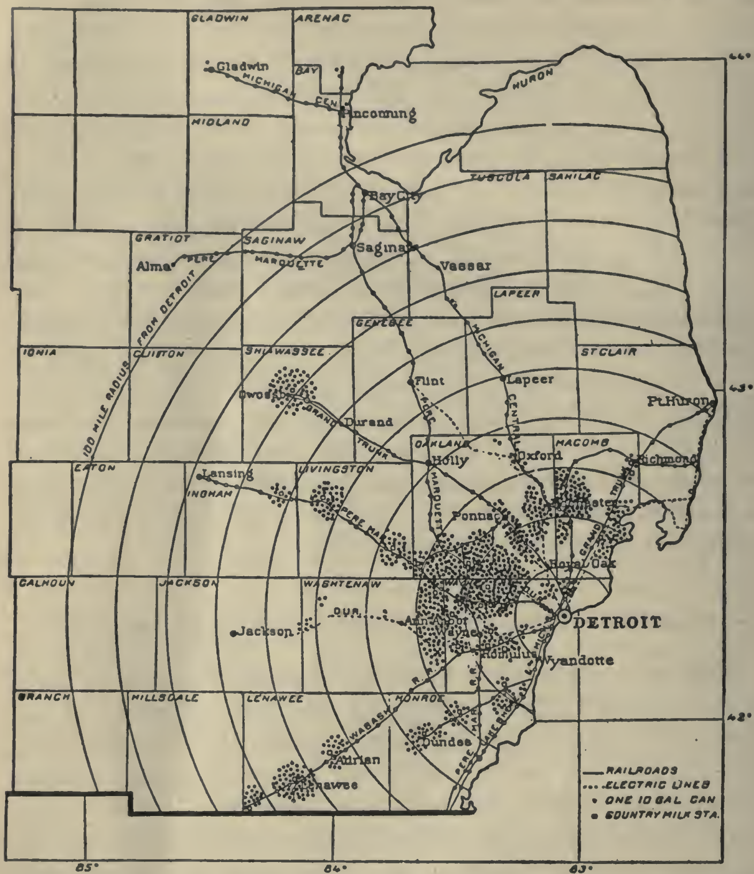

FIG. 83.—Sources of milk and cream supply of Detroit, and the steam and electric railways over which most of it is transported to the city.

vania, second in population, ranks high in the number of milch cows.

In both states the dairy industry has been seriously disturbed by the Great War, and the number of cows has declined. The farm laborer has been drawn to the munition plants, shipyards, or mines, so that the farmer has sometimes had to send his cows to the butcher. Pennsylvania had lost fifteen per cent. of her cows between 1910 and 1918, New York fourteen per cent., but there were increases in more distant states, especially Minnesota, Wisconsin, and North Dakota, where there was less opportunity to work in munitions plants.

Fortunately for the supplying of distant localities there are now good methods of condensing and preserving dairy products. That part of the milk which separates as cream can be condensed into butter and kept for weeks, or, in cold storage, for months; the milk can be converted into fleecy curds and the curds into cheese which keeps for months; and, by the processes called condensation and evaporation, along with hermetic sealing, milk can be reduced in bulk and canned so that it will keep for years. Last and perhaps best of all was the discovery (1900) of the method of evaporating milk completely and reducing it to a powder; while condensed milk takes up from one-half to one-fifth the bulk of the natural article, and requires tin for its preservation, dried whole milk takes but one-eighth of its original space, and dried skim milk but one-twelfth. In 1911 ten plants were manufacturing dried milk in the United States, producing eight million pounds. Doubtless its importance will greatly increase; for dietitians report that it is soluble in water and as digestible as fresh milk. Man is now no longer dependent upon his neighborhood for his milk supply. Many parts of the world hitherto unaccustomed to dairy products have, since the development of world

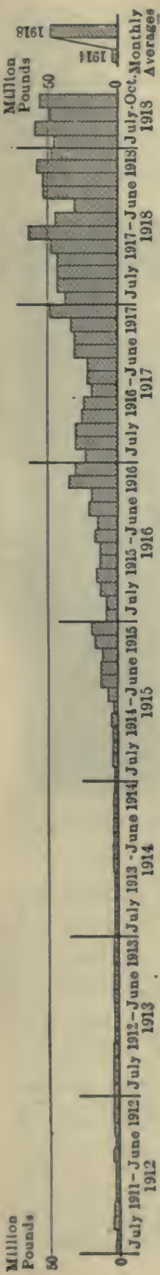

FIG. 84.—Exports of dairy products by months in the United States before and during the Great War. The increase was phenomenal and probably temporary.

commerce, adopted them. The West Indian planter opens tins of Danish butter in Jamaica or Porto Rico, while condensed milk is to be found in the uttermost ends of the world where it is too hot to produce and keep milk, as in Guiana and equatorial Africa; or too dry, as in parts of Cape Colony; or too cold, as in Alaska; or too mountainous, as in

FIG. 85.—Ammonia pipes cooling a car for the shipment of milk to market. (U. S. Dept. Agr.)

Rocky Mountain mining towns; or wherever camper, prospector, or lumberman pitches his tent or builds his shack. During the Great War condensed milk has sprung into a prominence hitherto undreamed. It has saved millions of lives. In Belgium three months of German occupancy reduced the number of cows from 1,800,000 to 700,000. At that point the protests of the Relief Commission checked the reduction, but in northern France absolutely all the cattle were taken before the Relief Commission arrived.

We have therefore, for nearly four years been sending them American condensed milk, not in single cans, but by scores of thousands of tons. There has been scarcely a child born in the north of France, and this is true of many in Belgium, whose continued life has not been dependent during all this period upon American condensed milk. Every American would be thrilled could he but see the gratitude which French mothers daily express over the pitiable ration which enables their children to survive.*

It is easy to see how condensed milk in cans is about the only form in which this product could reach the American soldiers, in the French camps and villages.

The war has taught us many things about food, among them is increased appreciation of milk.†

RECENT IMPROVEMENTS IN MANUFACTURE

Within a few decades great improvements have been made in the manufacture of dairy products. The cooling of milk formerly required much labor and care. The milk had to be set away in shallow pans for a day or two before the cream could be skimmed off. Now a little machine called a centrifugal separator, often operated by hand, takes the fresh milk as it comes from the cow, and by centrifugal force separates the cream into one vessel and the milk into another. The little hand churn of the kitchen is being used less and less as big, steam-driven churns in the butter factory (creamery) make more and more of the butter of the world. Most of the cheese is now also made in factories rather than upon the farms of the people who keep the cows—another victory in the long series of conquests of the factory over home industry—conquests of machinery over drudgery.

* From address of Herbert Hoover, National Milk and Dairy Farm Exposition, New York, May 23, 1918.

† "Another impressive observation brought out by food difficulties is that of our intimate dependence on our domestic animals. We are likely to think first of the supply of cereals, and, indeed, it must be admitted that bread is the very basis of the food supply of a people. But we do not sufficiently realize the equally critical importance of maintenance of our domestic animals in a period of food shortage. We cannot even raise our own young without them. Nor if a nation is robbed of its animals can you keep the death rate of that nation down to normal by simple importation of animal products. Hence one of the greatest problems in a beleaguered nation is that of the preservation of its herds."—Kellogg and Taylor: *The Food Problem*, p. vii.

DAIRYING AND INTENSIFICATION OF AGRICULTURE

Dairying marks an important stage in the intensification of agriculture, or the increase of the income from a given piece of land. There are two ways by which a farmer may increase production. One is to take more land, which often cannot be had; the other, to put more care and labor on the land he has. Where the population is sparse, little land is needed to produce the food, the price of land is low, and the farmer can pay interest on its small value by cultivating a small part of it, with a minimum amount of labor, and pasturing the rest. New countries are therefore rarely dairy countries. The Great Plains of the United States are an excellent illustration. There are millions of cows, but not enough butter, milk, and cheese for the use of the people. The cow, with little care from her owner, runs on the great range, and the calf which drinks all of her milk may never be seen by the owner until the day the animal is branded or sold. The plains of central Kansas afford another example of extensive agriculture; in this instance wheat is the product. Wheat lands of low price make good returns with small labor, small expense, and low yield. In New York and other Eastern States, on the other hand, the land is hilly, the farms are small, and the farmer cannot grow grain so cheaply as does his brother upon the flat lands of Canada. His farm is so small and high-priced that he cannot raise enough cattle to support him if he uses the method of the beef producer of the plains. (See table of Beef Cattle and Cows in 1912-18.) But a few cows eating his pasture grass, his hay, his corn fodder, and much of his grain will day by day produce enough milk to yield him a comfortable income. Therefore New York, having a market within reach, produces vast quantities of market milk and also ranks high in the manufacture of butter and condensed milk. As these latter products, concentrated and easy to transport, tend to come from locations somewhat remote from the large cities, their production is moving westward and replacing the less intensive meat industry. (See table, p. 255.) The table on page 256, which shows that the milk farmers produce four times as much food per acre as do the beef farmers, illustrates in another way the intensity of the dairy industry.

BEEF CATTLE AND COWS

(January 1, 1912–January 1, 1918)

	Milch cows, thousands		Other cattle, thousands		Per cent of cows to other cattle	
	1912	1918	1912	1918	1912	1918
Populous East:						
New Jersey	150	152	68	74	221	205
New York	1,495	1,524	894	1,005	167	152
Pennsylvania	943	960	627	717	150	134
North Central Dairy Belt:						
Michigan	806	874	701	752	115	117
Wisconsin	1,504	1,785	1,146	1,394	131	130
Minnesota	1,107	1,328	1,151	1,540	96.1	86.2
North Dakota	272	434	446	650	60.9	66.7
Iowa	1,393	1,405	2,773	2,919	50	48
Cattle Fattening States:						
Kansas	698	945	1,872	2,354	37	40
Missouri	822	910	2,773	1,782	30	51
Texas	1,034	1,128	5,177	4,660	20	24
Range States:						
Arizona	32	87	741	1,037	4	8
Wyoming	35	64	568	891	6	7

Wisconsin is now the leading dairy state; it displaced New York in 1912 and gained rapidly because of the war. Minnesota, showing nineteen per cent. increase in the number of cows in 1918 over the number in 1912, and North Dakota, with sixty per cent. increase, show the most conspicuous recent dairy gains in the United States. Before the war, dairying was steadily increasing in the northern section of the corn-belt, though both Iowa and Illinois show a recent decline in comparison to beef cattle, almost certainly temporary and due to the enormous prices being paid for meat. The dairy industry has been steadily gaining over the meat industry in this region, on account of the high value of land. The values of farm lands in the North-Central States have in many districts doubled in the first ten years of this century, on account of the high prices of corn and meat, due to the limited amount of good land and the steadily increasing demand, which has greatly enhanced farm values and has given a certain speculative value to farms in that region.

The farmer there now buys an expensive farm. If he keeps cattle and sells beef, he has difficulty in earning the interest on his investment. If he sends milk to the creamery or cheese factory, the cow each year gives a value in milk equal to or greater than the value of the bullock in meat at the end of his two or three years of life—and the meat-producing steer eats as much as the milk-producing cow. Thus, the greater intensity of milk production causes it to displace meat production. The table of cattle in 1912 and 1918 shows an interesting and suggestive

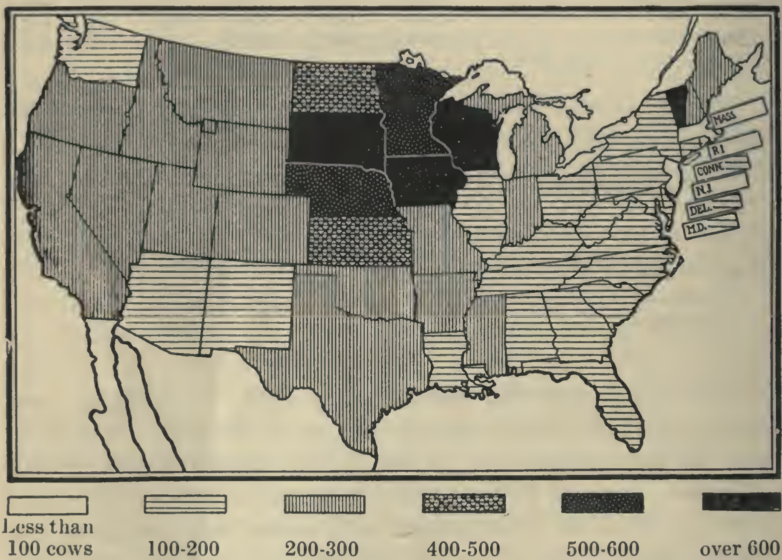

FIG. 86.—Milch cows in United States per 1,000 inhabitants, by states, January 1, 1912. (U. S. Dept. Agr.) Pop., 1910.

difference in ratio of dairy to other cattle as we go west and away from markets.

In dairying the farm becomes a kind of factory, using its own raw materials. A certain amount of hay, corn, and bran may with little labor be turned into beef worth more than its cash value. Twenty typical steers in 300 days will gain 13,500 pounds of weight, of which sixty per cent. is edible; the same food in twenty cows of similar quality may produce 120,000 pounds of milk, but much greater labor is required in the care and daily milking of the herd of twenty cows. Dairying often doubles or trebles the number of families living on the same farm and enables dairy districts to produce more food and support a larger population than meat- or grain-selling districts. Farmers in some parts of North Dakota have been driven into the dairy business because the Canada thistle choked out the wheat crop and broke up bonanza wheat growing or one-crop farming. This apparent disaster proved to be an economic blessing in disguise. The farmers were compelled to rotate crops (which killed out the thistle) and, instead of wheat, to raise forage crops and then keep cows to dispose of the product. This intensification of production increased the farm income and in a few years raised value of land from $15 per acre for wheat farms to $25 per acre for dairy farms.

Wisconsin and the lower peninsula of Michigan developed a greater and earlier dependence on dairy products than the states of the corn-belt proper because their cooler climate and rougher land are not so well adapted to corn, and therefore the people have been compelled to turn earlier from grain growing and make their land profitable by other means, such as potato growing and dairying. In Wisconsin, the State University has, through its school of agriculture, given conspicuous aid to the dairy industry by investigations, lectures, bulletins, and class-room work. It has thus spread among farmers a working knowledge of the most scientific and profitable methods of dairying, and it has been an important factor in bringing the state to leadership in this industry. In 1909 there were 2,969 creameries and cheese factories in Wisconsin, and since that date the business has steadily grown.

CANADIAN DAIRYING

That part of Canada bounded by Lake Huron, the city of Quebec, and the American boundary, comprising the populous parts of Ontario and Quebec, is like Wisconsin and New York in its inability to compete with the warm and level West as a grower of either corn or small grain. Consequently the people have long since turned to dairying with great success, and are the leaders in that great industry. Canada had 3,446 factories (1916) where butter and cheese, especially cheese, are manufactured from the milk supply of 221,000 farmers. Great care is taken to maintain the high quality of the product, and it is consequently much esteemed in Great Britain, whither four-fifths of the cheese goes, making up half of the British import of that article. Canadian competition, together with the inferior quality and bad repute of American cheese, had greatly lessened the export of the American product before the Great War.

The Canadian experience is an excellent example of the modern way of acquiring an industry. The Canadian Government sent experts to Britain to find what kind of cheese was wanted in the old country. Then they came back and established dairy schools to teach the people of Canada how to give the cheese the composition, color, flavor, and age required in the British markets. The government controls export by having inspectors pass upon and stamp all exported cheese, so that its quality is unquestioned. Meanwhile the term "Yankee cheese" has become a term of opprobrium, because sometimes the outside was good and the inside not so good. There is no American inspection and each man can do as he pleases. This is not the way to develop export trade in dairy products, as is shown by the experience of Denmark, Australia, and New Zealand, as well as Canada.

INTERNATIONAL TRADE IN DAIRY PRODUCTS (1913)

Exports			Imports		
Country	Butter million pounds	Cheese million pounds	Country	Butter million pounds	Cheese million pounds
Argentina	8	—	Argentina	—	11
Australia	76	—	Belgium	14	35
New Zealand	41	68	Austria-Hungary	14	13
Canada	1	148	Brazil	4	4
Denmark	200	—	British South Africa	3	5
Finland	27	—	France	13	51
Russia	172	8	Germany	119	57
France	38	31	Italy	—	12
Holland	81	145	Switzerland	11	7
Italy	6	72	United Kingdom	451	249
Sweden	43	—	United States	—	55
Switzerland	—	78			
United States	3	2			

That dairying is an industry of intensive agriculture which America has not largely developed is shown by the insignificance of our exports (see table above) before the war in comparison with those of such countries as Sweden, Holland, and Denmark. The increase in our dairy exports, due to the war, has been very rapid, but is probably only temporary.

DAIRYING IN NORTHWESTERN EUROPE

Northwestern Europe, with its fertile soil, cool climate, pasture-producing summer rains, and dense population, has every requirement of a great dairy region, and the scarcity of meat causes cheese to be used far more than in meat-eating America. Two hundred and forty-two kinds of cheese, most of them European, are recorded in a United States Department of Agriculture Bulletin. The European demand for cheese and butter is so great that Canada and other parts of the world supplement the enormous home production. England and Wales—an area smaller than Missouri, but with a population about a third that of the United States—consume in fresh form a large part of the milk that is produced at home. Ireland, on the other hand, with a sparser population and a better grass supply, because of the damper climate, is too far away to send milk to England, but sends large quantities of butter to help supply the huge demands of the English people, with whom bread and butter is an important article of diet. Consequently the British import more butter and cheese than any other half-dozen nations. (See table of international trade in dairy products.) Only twenty-seven per cent. of the Canadian milk is used as milk, while in the United Kingdom this figure rises to seventy per cent. An important source of British supply was the great continental dairy-belt which stretches along the northern plain of Europe from western France to Denmark, Sweden, and Russia. Throughout this whole belt the farms are small, the rural population is dense, and, while grain is raised on most of the farms, the keeping of dairy cows is also exceedingly common.

The north of France makes much excellent butter that goes in normal times to the great capitals, London and Paris. The Channel Islands between England and France, with daily steamers to London, have so long been important dairy centers that each of them, Alderney, Jersey, and Guernsey, has given its name to a breed of dairy cattle now widely scattered over the world. The town of Camembert in Normandy has given its name to a well-known brand of cheese and in the south of France is the town of Roquefort, where for generations the peasants have handed down from father to son the art of making from sheep's milk their famous cheese, which is ripened in stone caverns deep under the ground. Goat's milk from the herds that browse beneath the chestnut trees on the steep mountain sides of Corsica is regularly taken to the south of France for manufacture into famous cheeses.

Holland has been noted for its cattle since the days of Julius Caesar. Meadows, which the Dutchman has won from the sea by pumping out the water, are formed from the rich mud that the Rhine has brought down from the highlands of central Europe. These moist, rich lands, too wet for tillage, close to the sea with its grass-producing air, make very rich pastures. Here drainage ditches separate the little green fields, dotted with feed boxes from which the black and white cows eat bran and grains imported from America. By this means farmers increase the number of cows they can keep. When embargoes cut off the supply of imported cow food, as in 1917, the farmers had to send their cows to the butchers by the thousands. In damp and cloudy weather the cows are blanketed in the pastures (United States Consular Report, January 16, 1911). These richly fed and carefully tended herds of the well-known Frisian or Holstein breed give vast quantities of milk which makes dairy products the chief of all the farm products of well-tilled little Holland. The Dutch make twenty-four pounds of butter per capita per year. This is several pounds more than we make in the United States, but the Dutch being poorer eat less of it per capita than we do. Their cheese output exceeds that of butter. The town of Edam, west of the Zuyder Zee, has given its name to a kind of cheese produced largely in that part of Holland; this cheese, along with other Dutch brands, goes in normal times to England, to the United States, and even to South Africa and many other countries where the fame of Dutch cheeses has spread. Germany secured most of this food during the war because she could give Holland coal and iron. England could not. Sweet butter also goes in large quantities from Holland to England, but in the production of this commodity Denmark is the teacher of the world.

That little country, about half the size of Maine, is visited by the agricultural scientists of all the world who would learn in its best form the art of dairying. Forty years ago she was a meat exporter to Great Britain, but the demand for more products has turned this democratic kingdom into a vast dairy farm. The Danish peasant owns a farm of from five to twenty-five acres. The land is usually sandy and was originally poor, but has become rich by good care and imported fertility in the form of cow foods. More than half the land tilled is in oats, hay, grass, and root crops to feed the cows. The land used to produce forage has encroached upon the grain fields until there is not wheat land enough to supply bread. The harvest of 1910 was valued at 147 million dollars; of this 44 million was root crops (largely cattle food) and 62 million grain (largely oats and barley for cattle). In addition quantities of grain and grain products are imported from America and Argentina to feed the cows.* As a result of her great dairy industry, Denmark with a poorer soil rivals Holland in having more farm animals for its area than any other country of the world; there are more than a thousand factories for making butter; the cows are inspected once a month to insure healthy stock; and the dread disease of tuberculosis, so common among housed cattle of the entire world, has been entirely stamped out of the kingdom of Denmark. Over $50,000,000 worth of butter was sent each year to Great Britain alone before the war, but now Germany for a time gets much of the reduced export. The price received for his product by the Danish dairy farmer in peace times is less than that received by the British farmer, who sends milk to the city populations near at hand. This difference in price of milk for the two purposes is common in most dairy districts. Through careful catering to the demands of the market, Danish butter preserved in tin cans has become the standard article for

* The Allies greatly reduced the supplies of stock-food to Denmark, Norway, and Sweden, as well as Holland, in 1917, because of their exportation of meat and dairy products to Germany, with the result that herds were greatly diminished; but this condition will naturally be temporary, disappearing with the disturbances in trade brought about by the war.

consumption in the tropics and in all the remote corners of the globe where there is no local supply.

The southern parts of Sweden, which are not far from Denmark, have also recently learned the art of making good butter; and the country, which in 1870 was a butter importer, is rapidly increasing its butter exports to Great Britain, over $6,000,000 worth being shipped there annually before the war.

THE INTENSITY OF EUROPEAN DAIRY FARMING

Dairying is also carried on to a very large extent in northern and western Germany, but the large population consumes the entire product despite the fact that dairying there, as in France and other northern European countries, is carried on in its most intensive form with the cows kept in barns and food brought to them. In such a dairy district near Cologne, farm lands were worth $400 to $680 per acre before the war.

Switzerland has an interesting and unique dairy industry. Relatively large areas of land upon the high mountains, habitable only in summer, produce an abundance of rich grass as the melting snow recedes and lets sunshine reach the saturated earth. The villagers of the valleys take their herds of cows and goats to the higher pastures in summer and, because of the distance, stay with them through the whole season, spending the nights in little huts built for the purpose. At intervals members of their families bring up the necessary supplies and take away the accumulations of cheese and butter which the herders have produced. For the more rugged parts of these pastures, the Swiss have developed several breeds of very productive milch goats, whose rich milk is sometimes mixed with skimmed cow's milk to make cheese. On the lower slopes of the Alps the water from snow field and glacier is often led out over the fields to fertilize and irrigate the grass for winter hay. As a result of this careful industry, Switzerland is an exporter of good cheese, Neufchâtel being one of the best-known brands. She also sold nearly $2 per capita per year of condensed milk before the war, some of it going to England, to India, and even to Canada. Milk is also an important factor in the manufacture of milk-chocolate, in which Switzerland (like Holland) excels, sending abroad annually about three-fourths of the total product, valued at $10,000,000, a larger figure per capita than the normal grain export of the United States.

Italy is a land of summer drought where commercial dairying is in the main limited to the irrigated lands of the Po Valley. The Alpine streams furnish water for the succulent pastures and hay crops which are responsible for the few brands of Italian cheeses that are well known in many countries of the world. One of these, the Parmesan cheese, is made of goat's milk. Cheaper cheeses are imported into Italy to feed her own people just as the Dutch and Danes import oleomargarine from Chicago for their own use and sell the butter they make.

Oleomargarine, a butter substitute, has virtually the same chemical analyses and calorie value as butter. Being made chiefly from suet (body fat of beef) the probabilities of cleanliness of manufacture are better than in butter making. The opposition to its sale arose from the fact that it was sold at a fictitious value under a false name. The dairyman will doubtless soon be starting another campaign based on the fact that oleomargarine does not contain the vitamines (fat soluble A) to be found in butter.

The comparison of dairy exports (see table) from the United States—vast, rich, and agricultural—and from mountainous and populous little Switzerland, with half her used land in hay, is striking even in absolute quantities. On the per capita basis, Swiss cheese and milk exports exceed the entire exports of the United States in grain and grain products, animals and animal products. Thus the Switzer, like the Dane, makes the most of his limited opportunities and the American, with more resources, lets many opportunities go to waste. It is evident that commercial dairying depends more on the distribution of laborers (density of agricultural population) than on resources, so that production may be large in a place not necessarily best fitted for it. In dairy possibilities America greatly exceeds Europe. One basis of American superiority over Europe as a place for the dairy industry is the priceless boon of corn, the king of forage crops (especially as silage), for which the people of all European dairy regions must substitute the laboriously produced beets and other root crops and the less productive barley. The American cotton-belt has even better dairy possibilities than the corn-belt, though it imports from glaciated Wisconsin.

AUSTRALASIA AND REFRIGERATION

The refrigerator ship which has revolutionized the meat supply has also made possible the importation of butter and cheese from the most remote countries. Thus New Zealand, on the opposite side of the world from Great Britain, has become an important source of supply. That country, nearly as large as Italy, has a heavy rainfall owing to the prevalence of the constant west winds from the great southern seas. The government has taken great pains to inspect and guarantee the quality of exports, with the result that New Zealand butter and cheese stand well in European markets. Between 1910 and 1916, the number of cows in New Zealand increased more rapidly than the number of people, and produced one million tons of milk, chiefly used in the making of butter and cheese, two-thirds of the former and nine-tenths of the latter being exported. For the year ending March 31, 1918, these exports were valued at thirty-three million dollars. At that rate per capita the United States would have exported over three billion dollars' worth. The dairy industry of Australia, which is farther north and out of the latitude of steady rains, is sadly interfered with by the droughts. Consequently it is less important there than in New Zealand, being almost limited to Victoria, the most southerly, the coolest, and the rainiest part of

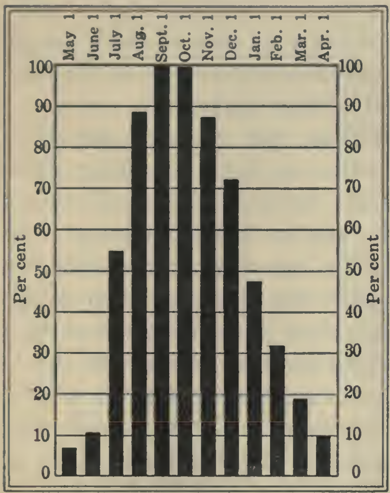

FIG. 87.—Percentage of our supply of cold storage butter on hand at the beginning of the various months, 1907–16 inclusive, 105,000,000 pounds on hand September 1, 1916. (U. S. Dept. Agr.)

a warm dry continent. Nevertheless, dairy farming is increasing there too, and, as in New Zealand, was seriously interfered with during 1917 and 1918 by the ship shortage.

THE ARGENTINE REPUBLIC

Argentina shows by its enormous exports of cattle and beef that it might also furnish milk and other dairy products in vast quantity; but thus far the industry has made but a small beginning. There are several reasons for this condition: it takes great care to make good butter and cheese in a warm climate; moreover, the sparse population of this new country does not furnish enough laborers for such intensive agriculture as dairying demands; and, furthermore, the laborers of Argentina have not yet developed skill in that class of work.

Dairying, of all the great agricultural industries, is the most exacting in its labor requirements. The cows must be milked morning and evening the year round or at least for many months; they must be treated gently; the utensils and product must be kept clean. The ability to do all this has been developed chiefly by the Teutonic peoples of northern Europe. The Spanish and Italians who make up the bulk of the population of Argentina have not for generations been trained to keep cows; but doubtless they can create a new source of dairy products in the Southern Hemisphere, because the steadily rising price indicates that new sources of supply are needed and Argentina is one of several countries having the resources.

POSSIBLE EXTENSION OF DAIRY AREAS AND DAIRY INDUSTRY

The keeping of milk products without ice or cold spring water is so difficult that people in most warm climates were virtually unable to make good butter or cheese before the recent improvements in dairy machinery and artificial cooling. Now that an engine, windmill, or waterwheel can make ice and a cold room anywhere, the tropics or the cotton-belt of the United States can, so far as climate is concerned, compete on an equal footing with Wisconsin or Switzerland in this respect. It requires a large number of cows, two to five hundred, to support a creamery with cold-storage attachment; this number is, however, merely the normal number for a modern creamery. The way is now open for the geographic extension of dairying. At the present time it is an industry unnecessarily restricted to the cooler parts of the world. It may become common rather than exceptional in the warm lands, as is the present export of goat butter from the green island of Sokotra across the straits from the arid mainland of Arabia.

The world may have ten or twenty times as much milk as it now has, without any serious reduction of any other food supply. This apparent contradiction comes from the fact that the keeping of cattle is almost the necessary accompaniment of the intensification of agriculture. Their manure enriches the ground so that greater quantities of other commodities, such as grain, potatoes, and cotton, can be grown. There would be little difficulty in doubling the wheat, corn, potato, and cotton yield of most farms in the United States if the farms growing these crops should also become dairy farms, as is easily possible. The silo, the engine driven separator, and churn, and the refrigerator in creamery, car, and ship, throw open to the dairy industry any part of the world which can support cattle in any numbers. The fact that the United States had not before the war begun to export dairy products, while Denmark, Holland, and Switzerland had, indicates that this great country has not begun to develop the dairy business, except as a local industry. Now that nearly all of the cattle-raising world is open to the dairy industry, cheap power and artificial refrigeration can do for cheese, butter, and condensed milk what the reaper and thrasher have done for wheat.

The milking machine is a factor of importance in the milk resources of the world. The same engine that runs the separator can run the air pumps that operate these machines, which from careful tests are found to be as good for the cow as the hand process, and much faster, though requiring a higher degree of intelligence and care.

In our corn-belt instead of keeping large quantities of meat animals, we might keep as large or larger numbers of milk animals and treble the food production. The cotton-belt of the United States may, without much exaggeration, be said to lie idle to briars, rabbits, opossums, and *shockingly* poor crops of cotton and corn because it needs an animal industry.* It is to be expected that the first stages of animal industry should be concerned with meat rather than milk; but the milk resources are there.

The wheat-belt, from Kansas to Alberta, would yield more wheat if it also produced butter and cheese. The productivity of even the dry lands beyond the wheat-belt would be improved, for butter and cheese are admirable products for a far frontier because of their great value in small bulk, which makes it worth while to pay the freight on them. Already distant lands are beginning to ship concentrated dairy products. In Minnesota the dairy industry has grown most rapidly in the last six years, and Alberta, still largely unsettled, already has nearly as many cows per capita as has Ontario. The Imperial Valley, the delta at the mouth of the canyon of the Colorado River, has wonderful alfalfa fields, and began to develop the dairy industry before the region was fully settled. It contained sixteen creameries producing six million pounds of butter in 1916. As this region has the climate of Egypt, its experience is exceedingly suggestive.

Central Siberia, a thousand miles beyond the Urals, was one of the world's great shippers of butter until the year 1918. Under the Danish leadership, the Russian settlers along the trans-Siberian railroad had developed a great butter industry in latitude 55° to 56°, farther north than the upper end of Lake Winnipeg, and far above Lake Superior. In 1916 there were 3,100 factories in the Siberian provinces of Tobolsk and Omsk. There were experimental stations for the development of technical knowledge of the subject. Cheese-makers had been sent from Canada, and the cheese industry was making good headway before the Great War.

If the world desired, the Southern Hemisphere, now devoted (save New Zealand) so exclusively to meat and wool, might also produce large quantities of dairy products for export. Since

* "Fifteen southern states imported $600,000,000 worth of food in 1916," says Andrew M. Soule, President of the Georgia State Agricultural College, in a hearing before a committee on Agriculture and Forestry, Part V., Sixty-first Congress, first session. "Eighty-five million dollars of it went to Georgia, thirty dollars' worth of human and animal food per capita."

the cutting off of the European supply because of the war, dairy products in South Africa * have greatly increased.

Before the war South Africa imported much butter. In 1916 she exported 1,600,000 pounds; in 1917, 3,000,000 pounds, the product of co-operative creameries.

Improvements of the breeds of dairy cattle † and the quality of the average cow may be expected easily to double, treble, and possibly even quadruple the output of a given number of cattle such as exist today on many dairy farms. A few years ago the average cow in Pennsylvania was giving 3,900 pounds of milk per year, while the average cow in Ayrshire, Scotland, was giving 6,600 pounds. Yet Ayrshire is by nature a poorer place for the dairy industry than is Pennsylvania. The only difference was that the farmers of Ayrshire had cow-testing associations; they

* "Not so long ago the cheese exhibits at the agricultural show were accommodated on a small table, and a certain large Transvaal firm scrapped a stock of cheese-making apparatus, imported ten years ago, as unsalable. Today the South African cheese is candidly admitted by experts to be as good as the imported article. Its consumption is increasing daily, and the local manufacture of cheese is expanding every month. For a while the government expert has been touring the country districts with his pail and his press, demonstrating the simplicity of the method of manufacture, and pointing out that whereas one gallon of milk yields one pound of cheese, two and one-half gallons of milk are required to yield one pound of butter fat. Now, so far from the old story of the consumer of South African cheese being regarded as eccentric, there is talk of a big export trade.

"The position may be put in figures roughly as follows: In 1913 we imported 5,586,244 pounds. In 1916 we imported only 2,028,508 pounds. In February, 1913, we imported 432,289 pounds, valued at £13,273; in February, 1916, 123,790 pounds, valued at £5,886; and in February, 1917, 8,310 pounds, valued at £668. These figures show how rapid has been the decrease in imports during the past year, and the rise of the local manufacture has been equally rapid. . . .

"It is told of the wife of a prominent farmer in the Free State that on the outbreak of war she drew her husband's attention to the fact that so much milk was going to waste. 'Buy me a small cheese plant,' she said, 'and I will show you what can be done with it!' Today she has increased the revenue from the farm by £1,000 per year" (*Commerce Report*, July 26, 1917.)

† The problems and possibilities of cattle-breeding are well shown by the work of William Hohenzollern in one of his many attempts to make Germany independent. I have seen hybrid cattle from his estates produced by crossing the Indian zebu or hump cattle with Holstein Frisian. The Holstein Frisian, the common cow of Germany, as well as Holland, is a huge beast, very susceptible to tuberculosis, and giving large quantities of milk, low in butter fat, three to four per cent. On the other hand, the Indian zebu is proof against tuberculosis, and gives milk with ten to twelve per cent. butter fat. W. Hohenzollern and others have worked for years to mingle the strains of these two breeds in such a way as to get Holstein size and quantity of milk, and Indian vigor and richness of milk.

sent the poor cows to the shambles and kept the better cows. By this same process the cows of New Zealand improved fourteen per cent. in their average output between 1910 and 1916. There is no reason why, a few decades hence, the cows of all intelligent peoples should average less than 3,500 to 5,000 quarts of good milk per year. See the record of the Holstein cow given on p. 245.

On the whole, the prospective supply of dairy products, outside of the Orient, is like that of potatoes—capable of indefinite increase, according to demand. China and Japan have, however, reached a stage of intensity of agriculture in which there is little room for the cow. Their development of milk substitute is one of the most interesting, suggestive, and stupendous things in the world's food situation.

Dried milk is a substance of great promise for the world's milk supply. Its perfect fitness for transportation enables the ends of the world to meet.* In 1918 New Zealand became enthusiastic about the business; several new plants were built with more in prospect.

* "Milk is about 87.5 per cent. water. It is produced most cheaply at such distances from the best markets that it cannot be transported to them. It is difficult to keep and its production throughout the year is not uniform. By proper drying we have a concentrated food that can be kept without ice, is bacteriologically safe, and is cheaper than the corresponding grade of fresh milk. For many reasons dry milk is actually superior to fresh milk in the kitchen."

"Regarding dry eggs it is interesting to note that American apparatus is being put into operation in China, where eggs are six cents a dozen and not six cents each as with us, to help supply our needs. It takes 51 yolks to make a pound and one plant has a capacity of 2,000 pounds in 10 hours. Fresh eggs dried in China and sent here will make a far safer and better omelet than many of our cold storage eggs. Years ago experiments with eggs dried in the same way by the American originator of the plan were very successful and the value of the properly prepared egg powder established."—*Scientific American*, July 20, 1918, p. 52.

CHAPTER XII

THE MUTTON SUPPLY

Sheep and goats are an important factor in the local meat supply of many countries, and also in the meat supply of the world. Now that the refrigerator ship pours forth its truck-loads of frozen carcasses at far ports, according to local demand, sheep are an important factor in commerce, whether they are chilled by the mists and snow of Terra del Fuego, panting with the heat of Australian droughts, or dodging the coyote on the ranges of Wyoming.

Flocks of sheep and goats are scattered over all the continents, wherever is found a certain peculiar combination of geographic environment, industrial environment, and social environment.

It is generally thought that our ancestors found the sheep on the mountains of central Asia, a mottled animal of black, white, and brown, whose pelt has made us the best of all protections against the cold and has aided our advance into the lands of frost and snow, and whose savory flesh had been prized long before it was prescribed in Hebrew Law as an offering to Deity. Men speak of the "golden hoof" or the "woolly idiot," in accordance with their recent experiences of profit in commerce, or the exasperation of handling a difficult, delicate, and stupid animal, very properly called an idiot. In his native home the sheep was probably like his wild cousins, who inhabit the most inaccessible mountains and seek their safety in speedy flight up the almost impassable rock surfaces. But fenced in, where escape is impossible, a hundred sheep are utterly defenseless against the attack of even one small dog, which can kill them by the dozens without their making any attack or even lifting up their voices in complaint while he rends them one by one. One deer would stamp the life out of three such dogs and the sheep could do so if he tried.

Fig. 88.—The world's sheep and regions of light rainfall (Adapted from Finch and Baker.)

In agriculture the sheep occupies two positions: (1) he is very important on the far frontier or the desert's edge, where he can crop grass and yield wool, skins, tallow, bones, or meat, one or all, according to market conditions. In regions of diversified agriculture, sheep raising occupies a position midway between the extensive cattle raising and the intensive dairy farming. The yield is greater than that of beef, because of the rapid growth of the lamb and the rich by-product of wool, and the industry requires much more care because the animal is subject to disease, is an easy prey to accident and dogs, and on account of his small size and climbing qualities is more difficult to inclose with a fence. On the other hand, sheep raising is less exacting than dairy farming.

The Old Testament shows that sheep were of great importance to the peoples at the eastern end of the Mediterranean Sea; they were little less important to the early Greeks, the Romans, and the barbarians who overwhelmed the Roman Empire.

It is to Britain, however, that we owe most of our breeds of sheep. English pastures are among the best in the world. The country has been less disturbed by war than any other in Europe, and the people, being lovers of good mutton and manufacturers of good wool, have had reason to grow sheep, of which there are about thirty breeds, falling into three groups: the large, heavy sheep of the succulent, lowland pastures; medium-sized sheep of the rolling hills; small, horned, goat-like sheep of the mountains of Scotland and Wales. Other parts of the world show even more strikingly the influence of environment on sheep. Many desert countries have sheep that are really the superiors of the camel in their ability to store food against the time of shortage. Instead of having humps on their backs, as does the well-known camel, they have stores of fat in their tails, which member sometimes weighs as much as eighty pounds. The different breeds of desert sheep have different shapes and even different places for this fat accumulation. In some cases the tail is big and broad like a sack, and in others it is long and narrow, like a great sausage. Other breeds, especially some of the Asiatic, store the fat in various places and shapes on their rumps. It is said that in some parts of the Kalahari Desert of South Africa the sheep tails sometimes get so large that the owners relieve the sheep's burden by putting a pair of wheels under his tail. I have not seen this, as I have never visited that country. In some parts of the dry plains of central Asia the native herdsman host honors an arriving guest by sticking into his mouth a morsel of the pure fat from a lamb's tail, which

FIG. 89.—Desert edge vegetation, Tunis. Rainfall 5 to 10 inches per year. Bare ground with scattered bushes edible for sheep, goats, donkeys, and camels. This flock contains goats and fat-tailed desert sheep. Photograph at end of rainy season; tails show great accumulations of fat.

etiquette decrees the host must hold in his own fingers and the guest must take, a rather high price for travel.

The names of the common commercial breeds show their British origin—as Lincoln, Dorset, Southdowns, Hampshiredowns, Oxforddowns, Leicestershire, and Highland sheep. The judges of the highest English courts have for centuries sat upon a cushion of wool called the woolsack—a symbol of the early commercial importance of wool. The best breed of sheep for wool production, however, is the merino, a breed developed on the high plateau of Spain from sheep whose ancestors originally came from Africa. The necessity of making annual migrations from the dried-up pastures of the Spanish plains to the greener pastures of the mountains has made the merino a good traveler, a bony little beast inferior for mutton, but very superior for fine wool.

FACTORS AFFECTING THE DISTRIBUTION OF SHEEP INDUSTRY

Before the beginning of the railway epoch, sheep were distributed upon the farms of Europe and America, and most

FIG. 90.—By artificial selection for one quality some strains of merino sheep have become racks for wrinkly skins, and every wrinkle covered with fine wool until the sheep is almost blinded by it.

countries were much more nearly self-supporting with regard to supplies of wool and mutton than at present. Sheep were more numerous in the United States in proportion to people and to the land cultivated in 1840 than they have ever been since. This condition is typical of many countries. The period of world settlement and world commerce following introduction of the railway and the steamship about 1850 led to a revolution in the sheep and wool situation of the world. A sheep industry on the largest scale that has ever been or is ever likely to be seen resulted from the throwing open of large areas of land, which

FIG 91.—Fine specimens of British-bred wool sheep with fine fat carcass, and smooth, round water-melon form. (H. A. MacDonald, Director Colonization, Toronto.)

could be best used as sheep ranges, in North and South America, Africa, Australia, and central Asia.

Probably because of his mountain and desert origin, the sheep is a good climber for rough pastures, and a good traveler. He can go far for his food and water or to market. His sharp nose enables him to reach into the crannies of rocks for scanty herbage. Altogether he is well fitted for the utilization of land not fit for the plow, and regions most dependent on sheep are those parts of the earth's surface which for some reason are not available for cultivation. It may be that the land is too rough or too wet, as in the Scotch Highlands with their heavy rains. These hills would naturally be covered with luxuriant forests, but are entirely barren of trees because for centuries sheep ranged the forests and ate every young tree that came up, until finally when the old trees died, the land was left for grass and heather on which the sheep flocks have in some cases subsisted for several centuries. Similarly, certain hills in the south of England bear to this day the names of forests, although for many generations they have been treeless pasture lands devoted to flocks of sheep. Thus, Cotswold (meaning wood) Hills gave their name to a breed of sheep which long ago killed the trees of this wood.

Semi-aridity, however, is the greatest reason why land is devoted to the pasturage of sheep rather than to cultivation in grain and other crops.

For instance, the plateaus of dry Spain have been famous for their sheep since the times of Hannibal and of Caesar. The greatest flocks in the world are on the semi-arid plains of Australia, Argentina, and western United States; the fact that some of these lands are hot, and not naturally suited to sheep, furnishes another example of an industry which flourishes in an unsuitable place. The sheep with his warm coat is equipped for cold climates; the fleece degenerates in hot lands, and the wool entirely disappears in Cuba, Brazil, and central Africa, leaving only the hair coat of which all sheep possess a little. In Australia, the tendency to degeneration because of heat has been overcome by the constant importation of fresh breeding stock from England, Vermont, and other localities where the sheep is at his best.

NUMBERS OF SHEEP (1913).

(From *Year Book of Agriculture*, 1913).

Semi-arid countries:	Millions
Australia	83.2
British South Africa	30.6
Algeria	8.5
Spain	15.8
Italy	11.1
Greece	4.0
Turkey	21.1
Asiatic Turkey	45.
Asiatic Russia	32.3
Chile	4.1
Mexico	3.4

Countries partly semi-arid:	
United States	50.1
Argentina	80.4
Russia	48.1
Countries of scanty population, good rainfall and remote from markets:	
Uruguay	26.2
New Zealand	23.9
Countries with highly developed agriculture:	
France	16.4
Germany	5.8
United Kingdom	27.8
Belgium	.2
Denmark	.7
Switzerland	.2
Total of the world	538.9

VALUE OF SHEEP TO REGIONS REMOTE FROM MARKETS

A third reason why land may be devoted only to sheep is its inaccessibility to markets for the heavy and less valuable products of agriculture, whose cost of transportation must be relatively high. Grain requires a railroad close at hand. Cattle, unless their meat can be marketed, have nothing to yield but the hide and tallow, which is of less value than the fleeces, skins, and tallow of sheep. Consequently, sheep give the people of remote plains the greatest possible cash income, and the opening of new lands between 1850 and 1890 caused an enormous increase in the number of sheep throughout the whole world.

The Falkland Islands afford an excellent illustration of the commercial service of sheep to the people of a remote land. This group of islands, more than half as large as Maryland, is located in the South Atlantic Ocean opposite Cape Horn, in a latitude corresponding to southern Alaska and Scotland. The rainfall of the islands is heavy; but the climate is cool, and there is no tillage, because the prevailing westerly winds of that latitude blow so hard that even trees are blown out of the ground. Yet these windy plains and hills produce good grass, and each of the 2,200 inhabitants who give Falkland a population of one-third of a person per square mile, owns, on the average, one horse, two cattle, and 300 sheep. The non-perishable wool, skins, and tallow of the sheep, comprising practically the entire export of the islands, enable the people to command the goods of all the world, to become well educated, and to receive more mail per capita than the people of any other land. It requires a very small population to utilize the land in this way, and as a result

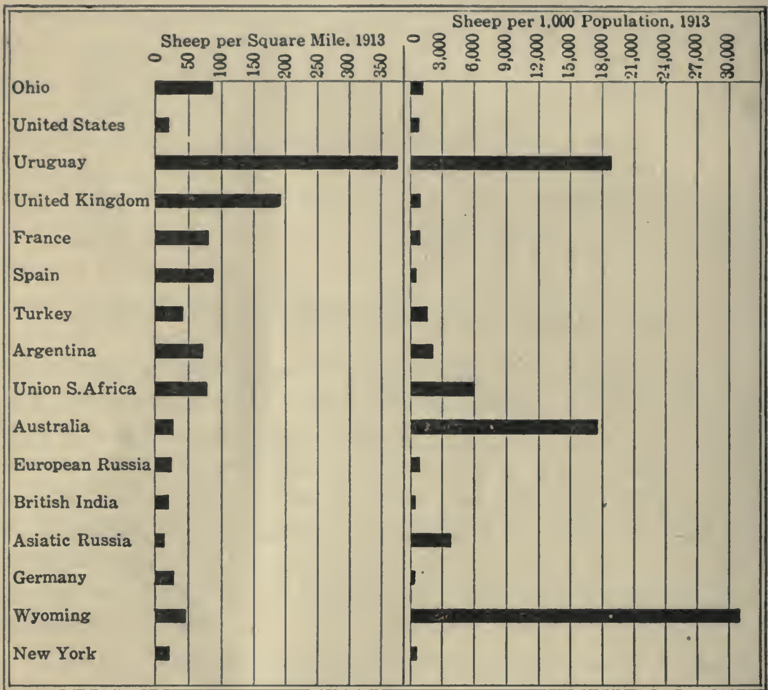

FIG. 92—Sheep per square mile and per one thousand inhabitants before the Great War. Interesting comparisons on the relative importance of sheep.

the people are so scattered upon their large sheep ranches that the public schoolmasters must travel from ranch to ranch to teach the children in their homes. The surplus population from this region is migrating to the nearby coasts of Patagonia and there spreading the sheep industry. The Islands of Faroe and Iceland, in northern latitudes corresponding to that of Falkland, also depend greatly on the export of sheep products.

IMPORTANCE OF SHEEP IN SOUTH TEMPERATE ZONE

The south temperate zone, with its large plains in South America, South Africa, Australia, and New Zealand, is the part of the world most dependent on sheep. This zone, with less than one and one-half per cent. of the world's population, owns about forty per cent. of the world's sheep. For the whole world, there is about one sheep to two and two-thirds persons, but in the south temperate zone, which combines the qualities of remoteness, semi-aridity, and sparse population, there are ten sheep per person.

On the plains of these countries, as on other great sheep ranches, there is a special method of caring for the sheep. These stupid and defenseless animals require constant care, and cannot be allowed to shift for themselves like cattle. In all regions of large sheep production the method of care is much the same. The herder with a couple of dogs takes a flock of two or three thousand sheep and follows them for days and weeks, being met at appointed places by supply wagons sent out by his employer. The speedy sheep dogs,* with the qualities inherited for many generations, are much more skilful helpers than men in driving the animals, and the herder's rifle protects from wolves, foxes, and wild dogs, while the flocks are commonly put into corrals or fenced inclosures at night.

Australia has long been known as the greatest of sheep countries, the leader of wool exporters, and is now a great mutton exporter. That continent, which is about as large as the United States, has a mountain barrier parallel to the eastern coast which shuts off from the interior most of the rain brought by the southeast trade-winds. The narrow plain along the coast is good for corn and other agricultural crops requiring moisture, and there are almost no sheep (see Fig. 88 on page 271 and Fig. 93 on page 280), but west of the mountains the wide expanses of plain that slope gently away from the sea have too little rainfall for the cultivation of crops, though enough to produce good grass. Some of the finest sheep ranges in the world lie between these

* Nearly every sheep country has its own breed of sheep dogs, each of which is "the best in the world." In this respect they resemble everybody's dog.

mountains and the grassless desert which occupies the central and western part of the continent. The desert may be said to begin at the line of ten inches of rainfall—a climatic barrier beyond which the pasture is scarce worth the walking. The railroads that connect the ranches with the eastern ports reach almost to the desert and all the land that has any value has for some decades been oc-

FIG. 93.—The enormous numbers of sheep in a small area of good rainfall show what Australia missed by her aridity. (Finch and Baker.) See Fig. 88.

cupied by the sheep flocks. Australia is unfortunate in the arid nature of much of her territory and also in the irregularity of such rainfall as she does get. Droughts sometimes last for long periods, cutting off both grass and water so that the poor sheep perish by millions, as in the period from 1894 to 1898, when continued drought reduced the sheep flocks from 110 million to eighty-four million. During the next four years 25,000,000 more sheep perished, bringing the flock of 1902 down to nearly one-half that of 1894. During the same period, 1898-1902, the number of cattle was reduced one-third. The great dependence of the flocks upon rainfall is shown by the observations of a scientist who says that with ten inches of rainfall per year an Australian plain will support ten sheep per square mile; with thirteen inches of rain, twenty sheep, and with twenty inches of rain, seventy sheep.

New South Wales contains more than half the sheep of Australia, while Queensland, farther north (nearer the torrid zone), has more rain and heat and better forage, and, therefore, a predominance of cattle over sheep, since they can stand heat with moisture better than sheep, and also require better pasture. South of New South Wales is Victoria, which lies far enough from the equator to be in the region of prevailing westerly winds and gets more rain that New South Wales; it has better pastures, but only one-quarter as many sheep. Because of the superiority of the Victorian pasture in a *cool* climate the farmers have enough grass to keep cows and make butter, of which much more is exported than is exported from the United States. (See Table of Dairy Products.) The market for the butter, as for the frozen beef of Queensland and frozen mutton of New South Wales, and New Zealand, and the wool of all lies almost entirely in the mother country, Great Britain.

New Zealand, farther south than Australia, with the good rainfall from the prevailing westerly winds, is an excellent sheep country, and is largely given over to that industry.

Some of the mountain pastures on the western coast of New Zealand, very wet from exposure to the sea winds, have such plentiful grass that they will support five sheep per acre throughout the year. Owing to the sparse population—less than a million people in a good grazing territory as large as New York, New Jersey, and Pennsylvania combined—agriculture cannot be very much developed and the twenty-three million sheep and two million cattle are the chief wealth of the country. There are 5,000 ranches of over 1,000 acres each; the newness of the country is shown by the fact that between the years 1891 and 1901 the occupied land increased from twenty to twenty-seven million acres, and the latter figure is less than half the total area. The good pasture and regular food supply of New Zealand causes the frozen mutton of that country to be considered the best imported into England. The sheep are often fattened by being turned into large fields of turnips, from which they first eat the tops and then the entire root. It is said that mutton could be produced at a cost of three cents a pound before the war.

The sheep district that most closely resembles Australia in character and rivals it in importance is the Paraná (the English call it Plate) Valley of South America, comprising the most of Argentina and the little, but good, country of Uruguay. Here, as in interior Australia and in central North America, is a level plain of vast extent. For hundreds of miles it seems as level as the sea. One railroad runs westward toward the Andes on a perfectly straight line for 278 miles, a distance greater than that from New York to Washington, or from London to Edinburgh. Near the Paraná River, the rainfall is sufficient for the growth of corn, wheat, flax, and alfalfa, but as the distance from the river increases, the rainfall decreases, and as in the region beyond the Missouri River, a corn-belt is followed by a wheat-belt, and the zone of farm lands is succeeded by a zone of ranch lands in which the industrial future must, like the present and the past, be devoted to roving flocks. Forty or fifty years ago, when there was a great demand for haircloth, herds of horses valued at $2.50 each were driven into pens twice a year by their owners to have their manes and tails clipped to furnish horse-

FIG. 94.—Southern South America with some fine grass land and much that is too dry, shares, to a less extent, the handicap of Australia. (Finch and Baker.) See Fig. 93.

hair for the crinoline looms in England and France. Then came the merino sheep, whose wool and tallow, skin and bone also, went to Europe, while his meat was thrown away because there was no possible market for it. Sometimes the sheep were even killed because it was easier to pluck the dead than shear the living. Then came the refrigerator ship and the export of mutton. The pastures of the Paraná Valley are so fine that the sheep fatten entirely on grass, which is uncommon. The moister eastern section, with its corn and alfalfa lands, is devoted to cattle raising, pushing the sheep westward.

It is interesting that the present vast sheep flocks of Argentina are very largely owned and cared for by English and Scotch people, who for many generations in their own countries have been thoroughly acquainted with sheep and know their ills, their wants and their ways, and are reliable enough to care for them. The cattle, requiring less care, are usually owned by the people of Spanish descent and cared for by the rough and boisterous *guacho* or half-breed Indian-Spanish cowboy of that country.

In northern Argentina, the greater heat and rainfall make cattle more important than sheep, and toward the cold south the plains of Patagonia, a little known region, are being rapidly taken up as sheep ranges by the Falkland Islanders. Sheep farms have been established in most of Patagonia as well as on the faraway island of Terra del Fuego, at the extreme end of South America, the sheep being better able than cattle to live in this country, since their wool protects them from the severity of the winter; they will also scratch away the snow to get at the grass that lies beneath it, and, if necessary, they can fast for several days when the snow lies deep.

The island of Terra del Fuego, with its heavy grass, cool climate, plenty of rain and freedom from disease, is one of the best sheep-raising regions in the world.

Uruguay, across the Paraná River from the best part of Argentina, is from end to end an undulating grassy plain. There are a few grain growers near Montevideo, the capital, but in times of peace twenty-five times as much land is devoted to sheep and cattle pastures. The number of sheep doubled between 1880 and 1900 and their products make up the great bulk of the exports of the country.

SOUTH AFRICA

South Africa is a dry land of flocks and herds. Like Australia, this region has mountains near the ocean which shut off the southeast trade winds from the interior, leaving a moist plain near the sea for agriculture and cattle raising. Back of the mountains is a wide expanse of interior, too dry for the plow, where the climate and the pasture conditions are suited to sheep and goats, save where they are too dry for pasturage, as in the Kalahari Desert, which corresponds to the central desert of Australia.

WESTERN UNITED STATES

The plains of the United States have not been at any time so exclusively devoted to sheep raising as have similar parts of

FIG. 95.—The United States, with corn, hogs, cattle, dairying and nearby markets, has no such concentrations of sheep as have Australia and Argentina. The nearest approach is on the hills of the upper Ohio Valley. (Finch and Baker.)

Australia and Argentina, because the vigorous and hostile Indians held the American plains against the advance of the white man until the railroads came. Then cattle could be sent to market, and the sheep growing and wool exporting so common in the Southern Hemisphere became less necessary. The first industry of our West was the rounding up of cattle on the plains by the cowboy. Sheep herding, which came later, has had large development, especially in Montana, Wyoming, New Mexico, Utah, and Oregon. Most of the American sheep are in regions with rainfall of from ten to fifteen inches, where much of the land still belongs to the government, an open, unfenced range, whose grass belongs to any beast that eats it. The sheep eat it more closely than do cattle, leaving nothing behind them for the cattle, and often destroying the grass itself by pulling it up by the roots. A bitter animosity between the sheep-owners and cattle-owners has resulted, sometimes leading to fights involving loss of human life and the destruction of hundreds of sheep and cattle by shooting or driving over cliffs.

Half the sheep of the United States are in the Rocky Mountain states, where they graze the mountain pastures in the summer, and winter in the lower valleys, or on the desert plains that can be pastured at no other season. Large numbers of sheep get summer pasture in the national forests under careful supervision of the Forest Service.

WOOL SHEEP, MUTTON SHEEP, AND REFRIGERATION

In the newer quarters of the world, the earliest object of keeping sheep was the production and sale of fine wool, a purpose for which the merino is the best breed of sheep. By careful breeding and selection through many centuries, it has been developed into a little bony animal, with a wrinkly skin, thereby furnishing for a minimum of food a maximum of surface covered with a long, fine fleece which has at times been known to comprise, with the grease, thirty-six per cent. of the weight of the entire animal and to have 48,000 strands per square inch of skin.

In the decade between 1880 and 1890, the perfection of cold storage and refrigeration suddenly caused a demand for mutton at Buenos Ayres, at Wellington, New Zealand, at Melbourne and Sydney, Australia, as well as at Chicago, Kansas City, and Omaha. The rising price of meat since 1900 has emphasized that demand and made the carcass more valuable by far than the fleece. The merino sheep, with his excellent fleece, long master of the far-found pasture, has a lean carcass, while the mutton-loving English had carefully bred and selected the Lincolnshire and the Southdown and other breeds for the ability to grow large and fat and make fine mutton, regardless of their coarse and meager wool. In Argentina, Montana, and Australia the refrigerator ship suddenly made the big, fat sheep more valuable than the little merino with its fine fleece. As a result, many sheep breeders at once began cross-breeding their flocks for mutton rather than wool, and in a little while the sheep were half-Lincolnshire, then three-quarters, and often seven-eighths. As a result, the people of Europe can now eat antipodean mutton; but the wool market has been disturbed by the increased abundance of coarse wool and the scarcity of fine wool. In New Zealand and Argentina the sheep have changed more rapidly than in Australia, because in the latter country the droughts often make it impossible to fatten sheep for market, so that breeders have continued to raise sheep for wool, and have kept more merino blood in their flocks.

SHEEP UPON THE FARMS OF EASTERN UNITED STATES

On the farms of the eastern United States and Europe, which were the sole sheep regions before 1850, sheep are still kept; but they are in small flocks grazing in fenced fields, and are declining in number. When the remote regions began to produce fine wool there was an added reason for the farmers to devote their attention to the mutton breeds. In the United States these sheep are, like the cattle, usually migrants. The full-grown ewe is brought from some place in the range country to Kansas City, Omaha, or Chicago, and then sent to the farms of Wisconsin, Michigan, and Eastern States, where the farmers keep them for several years. Each year a crop of lambs is sold and finally the fat old ewes are sent to market and another supply purchased from the distant regions, where the young sheep, like the young cattle, can be raised to maturity more cheaply than upon the small farms. These small flocks that can receive the personal care of their owners fare much better and produce a larger proportion of lambs than can be raised in the large flocks upon the range, where less attention can be given them. Many of the Eastern sheep-owners make a specialty of rearing their lambs in the winter season and sending them to market early in the year when they command a very high price.

There is a rather large area in the southern Appalachian highlands of Tennessee, Virginia, and West Virginia where ewes are

FIG. 96.—Forage beets in a New England field. Much stock food and much labor per acre. The silage substitute of East Canada and Europe. Characteristic New England upland landscape in the background. (U. S. Dept. Agr.)

grown and sold to the farmers of the Great Valley and the Piedmont sections of Virginia, Maryland, and also lower Pennsylvania.

New England, with its rocky and little-used farms, offers one of the best, but not extensive, places in the United States for the increase of sheep growing. The rocky lands produce grass; and there might be worked out a combination of hill pasture and valley-grown winter forage such as exists in the arid West, with its irrigated valleys.

At the present time rather more than a third of the sheep in the United States are east of the Mississippi River. It is a common practice of some corn-belt farmers from southern Michigan to central Nebraska to buy carloads of lean lambs from the western range in the autumn, and fatten them on corn and hay for the winter market.

The farms of the United States might easily produce many million more sheep without any material reduction in any other output, because much of the country is admirably suited to the sheep. The reason why they are not grown is man's affection for the sheep's deadly enemy, the dog. Go down the road anywhere in the grass country, from Maine to Tennessee, and ask the farmers if they ever kept sheep. Most of them will tell you they have, and when asked if they keep sheep now, most of them will answer, "No." When asked why, they say, "Dogs." Nearly all farmers try sheep once; and in a year or two, sometimes in a day or two, their flocks are attacked by dogs, several sheep killed, others maimed, and the whole flock put into a condition of nervous excitement in which they will not thrive. The Food Administration of the United States says:

> There is, however, the general fact to consider that through the Middle, Southern, and Eastern States anywhere from 3 to 20 sheep could be added to almost every 160-acre farm. They would feed upon material that would otherwise go to waste, and in the aggregate would furnish the United States with the greatest flock of sheep in the world.*

We shall have to choose either (1) mutton and wool, or (2) cur dogs, who are probably reducing our sheep flock by twenty million and making the nation several hundred million dollars a year poorer than it otherwise would be. At present we choose the cur.

SHEEP IN WESTERN EUROPE

The great increase of sheep in the Southern Hemisphere, together with local causes, has produced a general decline of sheep raising in Europe, especially in the densely peopled regions where the climate is good for agriculture. Throughout western Europe the sheep industry resembles that of the eastern United States, and lambs and mutton are of more value than wool. The Ger-

* *Grain and Live Stock*, Bulletin No. 10, p. 14.

man flocks declined from twenty-five million in 1873 to six million in 1912, as population and the demand for grain and

FIG. 97.—The value of sheep in humid Britain, semi-arid North Africa, and the rough and semi-arid Balkans, is apparent. (Finch and Baker.)

milk increased. The field in grain will produce more food than in sheep pasture, so that the grain field, the garden, the dairy farm, and the sugar field have taken the place of the sheep pasture in Germany, as the valuable wool and meat can be

FIG. 98.—Comparisons of sheep industry in some European countries. (Finch and Baker.)

imported more easily than the cheaper and bulkier food products. In France also the grain fields have replaced some of the sheep pastures. Some fine mutton sheep, however, continue to be produced in the most intensely cultivated parts of Europe, as in Belgium, Holland, and Germany, usually in the poorer, more scantily populated parts of these countries. The European sheep are fed much on barley and rape, a succulent cabbage-like plant that grows in sandy soil.

Down to the outbreak of the war there had been less change in the sheep industry of Great Britain than in any other country of western Europe. The English began early to keep sheep; they prize mutton, and especially British mutton; their moist climate gives abundant grass, and their policy of free trade makes easy the importation of grain, so that it was cultivated much less than in France or Germany; its place was taken by sheep and cattle. The war has reduced the flocks of England, as of all other European countries, and the pastures have been converted into fields of grain. The chief British sheep districts are the highlands of north England and of Scotland, the hills of the south, and the eastern plain, where the Lincolnshire and Romney Marsh sheep have developed an unusual ability to survive on moist level land. Great Britain, with one-half as many sheep as people (1913), had slightly fewer sheep per thousand people than the United States, and in actual number about one-third as many as Australia, one and a half times as many as France, four times as many as Germany, one and a half times as many as Spain, but only two-thirds as many as Russia, which, on account of its great size and somewhat arid eastern part, is the leading sheep and cattle country of Europe. But sheep have declined in Russia as in all western Europe, although a recent report to the Russian Department of Agriculture states that the country is capable of maintaining 300 million. If so, it would be at the expense of other production, or the result of a great improvement in agriculture.

SHEEP IN THE MEDITERRANEAN BASIN AND CENTRAL EURASIA

The California climate, with its winter rain and dry summer, is very wholesome for sheep, especially if they can have mountain pastures, which stay green all summer. The similar climate of the Mediterranean countries of Europe, Africa, and west Asia produces another region where sheep do well if the food be present. In this belt is Spain, with as many sheep as Germany, and Bulgaria, mountainous and dry like Spain, also equals Germany in the number of sheep (see previous figures), Turkey in Europe, mountainous, and with dry summers, has more sheep per square mile than any other country of Europe. In Italy the sheep have the central and southern pastures, while the cattle and milch cows feed on the succulent forage of irrigated Lombardy.

In the dry region of southeastern Russia the conditions of the American and Argentine ranch country are nearly duplicated. Much of Siberia and central Asia, with its thousands of miles of plains or steppes, is too dry for anything but pasturages. Some estimates credit Asiatic Russia with a much higher number of sheep than that given in the table (page 289).

Sheep are very common and very important in semi-arid Asia Minor, Persia, Afghanistan, the mountainous parts of India, Thibet, Manchuria, and the interior dependencies of China. From all these countries there is an export to the Western World of the coarse wool yielded by the hardy native sheep belonging to those careless Asiatic peoples who have never possessed themselves of the better breeds of western Europe, and who contribute little to the food supply of the outside world. Throughout this whole region, from the Bosphorus to the Amur Valley, the sheep live almost entirely by pasture, which is subject to the cruel uncertainties of climate; and despite the shifting of flocks from place to place, as described in the Book of Genesis, disasters occasionally occur. "Unlooked-for heavy snowstorms occurred in January, 1911, in Asia Minor. In the autumn months of 1910 almost 300,000 head of sheep, one and two years old, had started overland from Suleimania, Kerkook, and Mosul toward Aleppo and Alexandria to be shipped to Alexandria, Egypt, for mutton; ninety per cent. perished en route."

SHEEP IN TROPIC HIGHLANDS

There is some sheep husbandry for local use throughout the mountainous regions of Mexico, Central America, and the Andean regions of South America. In Ecuador, Peru, and Bolivia, the Andean plateaus spread out in greater expanse and, with their rough surface and cool and semi-arid climate, are a good place for sheep; there is an export of wool but not of meat.

Since sheep flocks are declining in the old countries and the conditions in the important new countries remain stationary, it is interesting to note the appearance of a possible new region in the highlands of east Africa. Five million sheep are now reported in British East Africa, but most of them of the native woolless variety, of which there are eight million in all Africa. Experiments in breeding from these hardy sheep are succeeding.

	(Pre-war)
The sheep of the first cross shears $1\frac{1}{2}$ lb. wool worth...	$5\frac{1}{2}$c per lb.
The sheep of the second cross shears 3 lb. wool worth...	15c per lb.
The sheep of the third cross shears 4-5 lb. wool worth...	16c per lb.

THE GOAT

The goat, sometimes a producer of wool, zoologically a cousin of the sheep, is associated with him throughout the world; the chief difference between the two is the goat's ability to survive a less hospitable environment and food supply. The goat, who will cheerfully steal your handkerchief and eat it, has an ability to eat almost anything, at which we sometimes make merry, but the catholic taste indicates that it is one of the hardiest of animals, capable of living under the most severe conditions. Accordingly, where land is good and pastures are fat, goats are few; but where sheep can scarcely subsist, the goat thrives on the leaves and twigs of desert and mountain shrubbery. He often but not always fights enemies that kill the sheep, or else scrambles to some distant height for safety. The semi-arid countries, therefore, have most of the world's 100 million goats (pre-war). Thus Mexico is credited with four million, more than the United States or any country of Europe; Algeria has four million; Asiatic Turkey, nine million; British South Africa, twelve million, and British India, where the goat is both a meat and milk animal, is far in the lead, with thirty-four million. The result is that goat skins, which with sheep skins are very important to the leather supply of the world, come from the poorest and driest countries of the world. Many are exported from China, whence they are brought by caravan from Mongolia and the central deserts of Asia. They come from the arid parts of India, from Persia, from Italy, and from the edge of the Sahara. Most goats are of commercial value only on account of their skins; but in the district of Angora, Asia Minor, near Anatolia, has been developed the Angora goat, whose long, silken fleece, called mohair, competes with wool as material for the finer fabrics.

THE FUTURE SUPPLY OF WOOL AND MUTTON

Unless we change our habits with regard to wool and mutton, the future supplies of these articles must increase in order to keep up with increasing demand. Yet during the last quarter of the nineteenth century the number of the world's sheep reached its maximum under present conditions of production and since that time has actually declined. As most of the new great plains are fully occupied, the quantity of mutton can be increased only by improvements in the quality of the sheep themselves and intensification of agriculture, which must cause a greater and greater portion of the world's sheep to be kept on farms in small flocks as they are in western Europe and eastern United States. As this method, with costly land, barns, and the storing of winter food, is more expensive than that by which a single herder drives 2,000 or 3,000 sheep over a fenceless, barnless plain, costing little or nothing, the price of mutton and wool seems certain to rise.

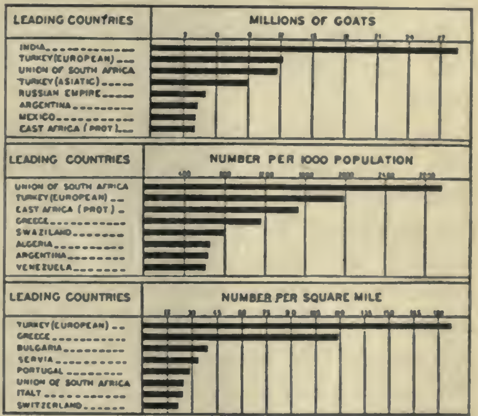

FIG. 99.—Goats in leading countries. (Finch and Baker.)

The prospect for any very extensive enlargement is not bright. As the pressure of population upon the animal industries becomes greater, we may expect the keeping of steers to give place almost entirely to the keeping of dairy cows and sheep. The sheep is about the equal of the steer as a meat producer, with the added advantage of a fleece which is at present indispensable to wool-wearing peoples. A certain proportion of the earth's surface belongs by natural right to sheep and goats, because they can utilize rough land and dry land; but when sheep and cows compete for the time and lands of the farmer with well-tilled fields, the incentive of high prices of meat, butter, and cheese on the one hand is matched by those of meat and wool on the other. Between these two pressures the steer is doomed to disappear.

At present the American dog restricts this competition, but the Americans may some day conclude that the cur dog is not worth the one or two hundred million dollars a year that he now costs them, and through them the whole meat-eating, wool-wearing world.

As land becomes more and more valuable, the daily yield of milk in comparison to the annual yield of wool gives the great advantage to the cow, and the sheep gives way as in Germany and Belgium. We have in Japan and China examples of population of such great density that they have for generations had to get along without sheep, clothing themselves in silk and cotton almost exclusively, and living on a diet of little meat, or milk, but eating fish, cereals, and vegetables, especially vegetables. The present dearth of wool and mutton is indicative of future higher prices, relatively smaller supply, and better use of land in the countries of small population.

CHAPTER XIII

SWINE, POULTRY, AND SMALL ANIMALS SUPPLY

QUALITIES AND DISTRIBUTION OF THE HOG

THE nursery jingle about the lion is a mistake. He is not the king of beasts. The hog has been crowned in his stead. The British did it during the fat famine of the Great War.

In three respects the pig is the greatest of meat animals: (a) grant him food, and no other of our important animals can equal him in the amount of meat that he will produce; (b) no other animal equals him in the speed of growth, and (c) no other animal equals him in the rapidity with which he will increase. These qualities are of special value in an emergency when sudden increase of animals is needed. If we desire more horses, we can have one ready to work in four years. If we desire more cows, we can have one ready to milk in three years. If we desire more sheep, we can have a lamb ready to eat in a year, or one ready for shearing in a year and a half. But in the case of all three of these animals the rate of increase is slow. There is no reason to hope for 100 per cent. increase of horses and cattle in a year, although, like the sheep, they give birth to young once a year. Among the sheep, twins, and occasionally triplets, are born often enough for a good flock with care sometimes to exceed 100 per cent. increase.

In comparison with these animals the fecundity of the hog is amazing. We resolve in the autumn to increase the pork supply. In the spring the sow brings forth a brood of eight or ten, and another in late summer, so that she may with care have from twelve to twenty offspring ready to be eaten within twelve or thirteen months. The spring litter, seven to eight months old, will be at their maximum efficiency and weigh 200 pounds apiece. The August litter, 100 hundred days old, by December may weigh 100 pounds apiece, so that one mother may produce in twelve months eight offspring weighing 1,600 pounds, and eight others weighing 800 pounds—an amount of meat equal to that of a whole flock of sheep or three two-year-old cattle—provided, of course, food supplies are sufficient.* We here see one of the reasons why the hog is the most common of all domestic animals save the dog. Another reason for wide distribution is his catholicity of taste in diet. He can eat anything and digest anything.

Swine are the meat animals of grain-growing lands, as is the sheep of grass-growing lands and the goat of bush and shrub-producing lands. Thus pastoral Australia has 100 sheep to one hog, and Iowa, a great corn state, has seven hogs to one sheep. Just across one state from Iowa is Wyoming—another land of grass, where there are more than sixty sheep to one hog. The hog was originally an animal of forest countries, living on concentrated foods, such as acorns, nuts, grubs, and rich roots, which his strong snout admirably excavates. Consequently he must have somewhat similar foods when domesticated, since his small stomach is not adapted to a diet of bulky grasses.† His appetite and digestion are amazing and enable him to lay up nutritive treasure for his own future. In his original forest home he converted the abundance of autumn nuts into a thick layer of fat which covered his body and carried him through the hungry time of winter while he slept in a bed of leaves. Therefore, the rich grains of the farm exactly suit him, and he encases himself in fat at every opportunity.

He is still fond of the nuts and acorns of his original forest home, but is able to eat anything, from a piece of beefsteak from the garbage can to the weeds which his owner pulls from the garden. This makes him a fine saver of edible odds and ends. Tame, harmless, hardy, and fecund, the hog is an admirable door-yard scavenger and meat-producer for the cottagers of many lands, and has attained an almost world-wide distribution, being of great local importance as a food supply in many coun-

* In 1918 the winning pig in the Bucks County, Pennsylvania, boy's pig club weighed 279 pounds at 140 days old. It cost 10½ cents a pound to produce him and he sold for 26 cents per pound. The second in the contest weighed 253 pounds.

† The dressed weight of a hog is about eighty per cent of his live weight, while the pasturing cattle and sheep have such large stomachs that they yield only about fifty per cent. of meat.

tries where he is of no commercial value. He is the friend of the new settler in British Columbia, and also of the new settlers in Siberia—the peasants in the old home lands of Russia, or of Ireland, where he is sometimes affectionately called the "gint who pays the rint." He lives near the shack of the half-breed Indian of Mexico and South America, and is as friendly to the Spanish and Italian immigrant in Argentina as he is to the inhabitants of the stone houses in the old countries in Europe. He is as much at home beneath the shack of the negro in the West Indies as by the palm-leaf hut on the banks of the Congo or the coast of Guinea. In the eastern world he is common in China, Malaysia, Australasia, and the mid-Pacific, where, in at least one group of coral islands, the price of a dusky bride is from ten to twenty pigs.

HOGS THAT RANGE IN FORESTS

He has been long domesticated and developed into many breeds, but many of his kind still fatten on his original diet of mast, the natural product of the forest. In many parts of the United States the hogs run in the farm wood lot or the open forest, where the fallen mast provides a large part of their food. This method is customary in the Appalachian highlands, in the Ozarks of Missouri and Arkansas, and in many parts of the South Atlantic and Gulf States. An oft-told tale narrates the discomfiture of a Northern swine grower who took some fine plump porkers with bodies like watermelons to an agricultural fair in the cotton-belt. Despite the great superiority of his pigs, the prizes went to long-legged, slab-sided, sharp-backed natives commonly known as razor-backs. "No, siree," he was told, upon inquiry, "them hawgs of yourn won't do down heah. They haven't got no speed. A hawg that can't beat a niggah to a swamp's got no show in this country, and ain't worth havin'. Youah hawgs may be all right fer up Nawth."

Great injury to the Southern pine forests often results from the uprooting of the young pine tree, which the hog kills by eating the succulent taproot. In the Southern States, salt pork, easily kept in a warm climate, is the staple meat food of the working man, white and black alike. Its use is a good example of the value of meat as a stimulant and flavorer. Salt pork is savory, and a little of it is the life of a meal made up largely of corn bread and potatoes, sweet or white. The fat of the pork, mostly fried, replaces butter in hundreds of thousands of families in warm regions where dairy products are but little known. (See chapter on Dairy Products.)

Hogs fatten in many European forests. An important hog-raising district is located in southwestern Germany, where the animals can roam the beech forests and live on the beech nuts. In Servia, hogs, largely mast fed, hold the important position of chief export. The fertile valleys of this mountainous country were, before the desolation of the three wars, carefully farmed chiefly for wheat and corn, but in the oak and beech forests of the mountains there is excellent feeding ground for hogs, which were sent to Budapest, Vienna, and Germany.

This method of producing pork is of some importance in all the Mediterranean countries, but is most highly developed in Spain and Portugal, where cork forests cover large areas and yield an occasional harvest of cork and a biennial harvest of acorns, gathered by the pasturing pigs. Another oak (ilex or evergreen) is an important timber tree and also yields an abundance of acorns. These two species of oaks together produce from one-half to two-thirds of all the pork grown in Spain and Portugal. But upon the whole the mast-fed hog is of relatively small importance in comparison with the grain-fed hog and the potato-fed hog.

RELATION OF THE HOG INDUSTRY TO GRAIN GROWING

Since the hog must have some kind of concentrated food, such as acorns, nuts, or grain, he is naturally raised in the regions producing cheap grains. The chief regions with hogs for export, therefore, are those with much corn or barley, the great forage grains of the Western World. Since corn has long been the cheapest and also the most fattening of the grains, the corn-belt of the United States is the leading hog-exporting region of the whole world. Twice as many hogs are found in the United States, chiefly in this corn-belt, as in any other two countries of the world. Half the hogs of America are found in the seven corn-belt states: Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, and Nebraska. The farmer in Iowa, Kansas, or Nebraska nearly always grows one or two fields of corn, and often keeps from twenty to one hundred hogs, which he feeds almost entirely on the corn. Fully one-third of the American crop goes to the market in the form of pork. The distribution of hogs within the corn-belt reflects an interesting phase of agri-

FIG. 100.—Compare this with the corn production map, Fig. 43, to see cause and effect. (Finch and Baker.)

cultural economics. Maps of hog distribution (see page 299) and of corn distribution (see Fig. 43) show that while the center of corn growing is in east-central Illinois, a region from 100 to 150 miles around Chicago, has far fewer hogs than have the districts beyond. Because of the lower freight rate to the Chicago market, the corn of eastern Illinois is worth five cents more on the farm than is the corn of Iowa. As it takes several pounds of corn to make a pound of pork, pork is better able to pay transportation, so that distant places produce pork and nearby places produce market corn, which is made into glucose or shipped to eastern cities, and to Europe.

Hog production extends to the northward of the American corn-belt as a by-product of the dairy industry. A large amount of skim milk is left over from the manufacture of butter. (See map of milch cows, Fig. 86). There is no better food for growing pigs than skim milk, combined with corn and barley or any other grain product, and a little alfalfa and clover hay. Hence hogs are grown in the dairy districts of the United States and Canada, even where corn is of minor importance. In the western half of the United States, beyond the one-hundredth meridian in Kansas, and beyond the region of extensive corn growing, the number of hogs is so small that they do not meet the needs of the scanty population. There are more hogs in Iowa than in all the Rocky Mountain and Pacific States, and all the Atlantic States north of Georgia. Owing to his small digestive tract, the hog cannot pick his forage and thrive on the dry range like sheep, goats, and cattle. He is, therefore, limited in the dry country to the irrigated localities, where he can get alfalfa and grain, chiefly barley. The great bulk of the American pork crop depends on corn.

Owing to the great ability of this grain to produce fat, the American hog is often called the "lard hog," because of the large amount of lard (melted fat) he makes. He is quite different from the so-called "bacon hog" of the barley-growing districts of Canada and Europe. Owing to the fact that barley yields less grain and therefore costs more to produce than does corn in the corn-belt, the pork-raisers of Canada and Europe feed their pigs as much as possible on grass, especially clover. This food, rich in protein, produces more lean meat in the pig's body than does the corn diet; for this reason the famed Irish, Danish, and English breakfast bacon has the streaks of lean with the fat. Because of this desired leanness, some English bacon is in times of peace imported into the United States, although we have many millions more hogs than any other country, and send vast quantities of cheaper pork to England and Ireland. At the same time that Ireland imports American pork, it produces bacon of high quality, which is exported to the English market.

Despite the importance of the United States in the pork trade of the world, Europe with its intensive agriculture had, before the outbreak of the Great War, more hogs than the United States. At the present moment she has far fewer; but they will return with returning forage supply. The great European pork region is in the lands touching the North and Baltic Seas: Belgium, Holland, Germany, and Denmark. In this region swine are fed chiefly on barley and potatoes, with some imported corn, but in Germany alone 600,000,000 bushels of potatoes in normal times, forty per cent. of the crop, are fed to pigs. It is only in Hungary that the European pigs gets much home-grown

Fig. 101.—Compare this with the potato, Fig. 51, and oat, Fig. 30, maps of Europe. (Finch and Baker.)

corn. In Denmark, with its enormous butter trade, we find skim milk used for pork production, as in the American dairy-belt. It is probable that no people prosecute the pork industry so systematically as do the Danes. The experts of the Farmers' Cooperative Pork Packing Societies have found that the English market prefers a certain kind of bacon from a hog of a certain size, with a certain amount of lean and fat. They have found that this bacon can be best produced by a cross-bred pig of certain breeds; therefore, some farmers make a business of raising pure-bred females of the recommended mother breed and others raise pure-bred males of the recommended sire breed, for sale to the average farmer, who raises the cross-bred market pig. Experiments have shown that certain food combinations bring this cross-bred pig to the good ham and bacon stage with a minimum of food per pound of pork in seven months; he then weighs 200 to 225 pounds, and goes to one of the thirty-four Farmers' Co-operative Pork Packing plants of Denmark.

The Danish Co-operative Pork Packing Society sells its product to the English co-operative wholesale stores, which in turn pass

FIG. 102.—Hogging down corn—the cheapest method of harvesting. (Courtesy *Country Gentleman*.)

it on to the retail co-operative stores scattered throughout Britain. Profits are thus divided between producer and consumer. In America the government issues a report every so often telling us that we have a meat trust. In Denmark everybody fits into one, and doesn't complain.

Germany is second only to the United States in its number of hogs. Perhaps it was jealousy that made a fellow-student in a German university assure me twenty years ago that all Americans were "Schweinhändler." There is no good reason why the industry should not be as important in parts of Russia and

Poland near Germany, except for the lesser aid and attention from the government.

Some pigs are kept in the Orient, for even on the almost vegetarian farm of the Chinese garden farmer there is some material which the pig can convert into edible and more valuable form.

THE FUTURE SUPPLY OF PORK

The Food Administration of the United States has pointed out, to the disadvantage of the pig, particularly in America, that, next to poultry, he most nearly resembles man in the grains he eats, whereas sheep and cattle eat coarse herbage that is by us inedible. The county farm agents in nearly all states, however, are with great emphasis urging the farmers to adopt a practice which reduces the pig's grain consumption and at the same time increases his productivity: namely, the growth of concentrated forage crops which the pig himself can eat where they grow, with consequent reduction in the labor and cost of production. Thus in April the pig may be eating the green herbage of a field of barley. He may spend May and June in a clover field. In July he may go back to the barley field and eat the grain as it stands. In August and September fields of beans, called cowpeas, and soy beans, are ready for him. So are sweet potatoes or peanuts, which he dearly loves. In October he goes into the corn field and harvests it himself, "hogging-down" as it is called. In late November, with this succession of harvests upon his ribs, he is ready for the packer.

This system is being followed by increasing numbers of farmers in many localities, and is especially useful in the South, where the long growing season permits many crops. It will greatly help to extend the world's pork production, as will also the extermination of the swine plague, which has yearly killed its millions of hogs in America, but which can largely be controlled by the use of serums.

There is, on the whole, however, no reason to expect that pork will ever be any more plentiful than it was before the war. The really significant thing about the pork supply is shown by the relative numbers of pigs and people. In 1840 there were in the

United States 154 pigs per 100 people. In 1910 there were sixty-three. In Europe there were about fifteen, and in China there were much fewer. Since we cannot have both bread and meat in indefinite quantities, the increased use of grain must lead us to class all the meat animals among the things we cannot eat. In time the pig will be reduced to a scavenger for the

FIG. 103.—Inoculating the pig to prevent hog cholera. (U. S. Dept Agr.)

humid lands, as the sheep and goats are scavengers for the arid lands. Where land is precious, the good forage goes to the dairy cow, who, after her service to the dairy is rendered, will constitute an ever-increasing proportion of the meat supply of a large and increasing population.

POULTRY

A few years ago Mr. H. Rider Haggard, the English novelist, who is also a land-owner, and much interested in rural betterment, went to Denmark to investigate the rural co-operation which has replaced poverty and despair with comfort and contentment in that cool and sandy little country. On his first morning in Copenhagen he called for boiled eggs. They came with printing on their shells. When he was examining the eggs, the printing, after the fashion of a rubber stamp, was transferred to his hand, and there was not enough soap in all Denmark to wash it off in the space of two days, during which time he went about numbered No. 174 and initialed D. A. A. G., N. P. Upon investigation he found that this lettering signified literally that he was a good egg from the Danish Co-operative Association, Branch 174. He further found that this branch was located on the Island of Falster in the Baltic Sea, and that N. P. was Nils Poulsen, the Danish peasant who had turned in that particular egg. If the egg had been bad, the thrifty Nils would have been fined something like $1.40. If he had turned in another bad egg, the fine would have been increased. If he had turned in a third, he would have been expelled from membership in the egg society—three terrible calamities for a thrifty Danish farmer. That is the kind of individual responsibility that has made Denmark great in the egg market as in the realm of butter and bacon.

In the main, however, in the poultry and egg business men in both Europe and America have continued to demonstrate the inefficiency of individual and unorganized effort. The hen has also been intellectually neglected. Despite her almost universal service as food-producer and the enormous total value of her product, the hen has been strangely let alone as a subject of discussion by economists and publicists. Wheat, cotton, iron, and gold seem constantly in the scientific, industrial, and financial mind, if we may judge from the number of books, treatises, articles, and statistical analyses pertaining to them. If you say "iron," men look wise and serious. If you say hens, they grin. The intellectual neglect of the lowly hen is not due to her lack of value, for the poultry and eggs of the United States (worth about 800 million dollars a year before the war) are normally of more value than the wheat crop, the cotton crop, or the hay crop, and are exceeded in value only by the corn crop. The value of the peace-time output of all our pig-iron furnaces is far exceeded by the value of our poultry and eggs. This lack of interest may be partly explained by the universality of production, the non-capitalistic character of production, the difficulty of securing statistics, the absence of large financial or speculative operations in connection with poultry and eggs, the small influence of legislation upon them, and the small part they play in international trade. Poultry-farming is none the less important and is undoubtedly the most universal form of animal industry in the United States and also in Europe, eastern Asia, and other foreign countries. The names of breeds attest their world-wide distribution—Peking and Muscovy ducks; Cochin, Brahma, Leghorn, Hamburg, Minorca, Indian Game, Wyandotte, and Plymouth Rock chickens; Brabant geese.

Fowls are found to some extent in great cities and are kept in villages as well as on farms throughout the United States. They are usually a by-product, often a perquisite of the farmer's wife. The very large majority of the fowls in the United States are found in comparatively small groups (forty to fifty per farm) on a very large number of farms, where they gather their own subsistence and receive practically no care. Consequently the eggs are produced at little cost. This industry may easily be much further developed.

The commercial production of poultry and eggs will undoubtedly result in increased cost. Emphasis should be laid upon the service rendered by these birds in the United States as scavengers in getting material that would otherwise go to waste, and converting it into good food. The dooryard hen catches flies, cleans up the table-scraps to the last crumb, eats grass, digs through the barnyard manure for stray grains of corn, scratches up the ground for worms, hunts along the roadway, and cleans the fields. She pecks fallen fruit, and also diggeth up the garden and produceth vexation in the flower bed. She will even establish her nest secretly, hatch a brood of ten or fifteen chickens, and bring them up to the eating stage without the knowledge of the farmer or his wife.

The turkey, yet nearer to nature, spreads her growing brood of ten or twenty in a broad phalanx from three to six feet apart, and thus they range the grain fields after harvest, picking the green grass, rescuing shattered grain, and spearing the springing grasshopper with unerring aim, quite unmindful of the last

Thursday in November, or any other of man's feasts. In the table of food values per acre (see page 182) poultry make a very bad showing in comparison to the grains, dairying, and even the other meat animals, but they render an irreplaceable service by converting grass, insects, grain, and waste material into the easily digestible egg, and into the delicious meat of their bodies. The egg is unusual in having ninety-seven per cent. of its edible portion digestible. Like milk and unlike meat, it cannot be changed in our bodies into uric acid, and in addition to protein (the chief product of the white) it also furnishes fat, the chief product of the yolk, and a number of valuable mineral elements, including sulphur, phosphorus, iron, calcium, and magnesium, in an easily utilizable form. It also contains the indispensable vitamines discussed in the chapter on Dairy Products.

There has been a marked increase in the number of specialized poultry farms since 1900. One of the causes of this change is the work done by the mechanical incubator, which works on a very large scale as successfully as the hen, who is thus free to devote her whole time to the production of eggs.

Poultry farming can equally well be a by-product in extensive agriculture or a main product in intensive agriculture, with a strong tendency to become important as agriculture becomes intensive. Egg production predominates over the less intensive poultry selling (meat production) in all parts of the United States except the region south of the Potomac and Ohio rivers, which have no local markets of importance, and parts of the corn-belt, which have unusual opportunities to fatten poultry. In Maine and New Hampshire the value of the eggs is about double that of the poultry. The relation of poultry raising to intensification is well shown in Canada. In 1902 the value of Canada's egg export amounted to nearly $2,000,000. It rapidly decreased until, in 1910, eggs were imported from China and Russia. The great development of railroads and wheat in western Canada had enlarged the Canadian market and afforded a new business opportunity for the people of the Eastern Provinces who had before exported eggs. Moreover, the egg producers of Denmark and Russia studied their business and excelled the Canadians just as the Canadians excelled the Americans at cheese production. When the war shut off the British supply of eggs from the Continent and the price rose, Canada again began to export them to Britain, her shipments increasing from 3,000,000 dozen in 1913 to 14,000,000 in 1916.

During the period of development in the western United States, the poultry industry in that country went through the same fluctuation as in Canada. In 1870 the construction of railroads and the development of the West began, and in 1872 the egg imports suddenly rose to five million dozen. From 1882 to 1890 fifteen million dozen per year were imported, then suddenly the number decreased during the next four years and the number exported rose steadily from 1897 to 1911, when it reached eight million dozen.

China affords the best evidence of the suitability of the poultry industry to intensive agriculture. It is the general testimony of travelers that enormous numbers of poultry are grown, and eggs are exported. Before the war, factories in Tsingtau, German China, converted millions of dozens yearly into dried eggs, dried yolks and albumen (dried white of egg). By this means, 1,000 eggs can be reduced to twenty-two pounds' weight, can be easily transported, and are said to keep indefinitely.

The price of eggs in China helps to explain how the Chinese have been able to live at all on the very low wages of which we hear. China is so isolated, such a world to itself, that it has had a set of prices all its own—low prices, so that the low-wage man bought low-priced commodities. A dozen years ago eggs cost four to five cash (two cents per dozen, U. S. gold), at Yangtse ports. Then the government abolished the old currency. The ten-cash piece (cent) is the smallest coin, and eggs were five to six and two-third cents per dozen at Shanghai in 1911 and 1912. F. H. King (*Farmers of Forty Centuries*, p. 180), found eggs in early April, 1910, selling near Shanghai, at forty-eight cents (American gold) per hundred; little chicks at $1.29 per hundred. At the same place the wage of a man per ten-hour day was twenty-four cents, the price of four and one-sixth dozen eggs—a fact which suggests interesting comparisons with Western conditions.

The greatest commerce in eggs and, with the possible exception of China, the greatest production, is in Europe. Great Britain imports far more eggs than all the rest of the world combined, over 215 million dozen in 1913. Russia sent the half of them, and France, Belgium, Germany, and Denmark were important contributors. Even Morocco and Egypt sent more than the United States. The war greatly reduced this import. British imports were but 102 million dozen in 1915, sixty-six million in 1916. In that year Russia succeeded in sending only seven million dozen in place of the 114 million of 1913. As a result of this shortage and the accompanying high prices, British poultry keeping has received a new impetus. In March, 1917, a poultry demonstration train with a yard of six pullets, and lecturers, was creating much interest in the textile cities and towns where intensive poultry keeping was being advocated and explained to large audiences. The train was furnished, equipped, and manned jointly by the Northeastern Railway, the University of Leeds, and the Yorkshire Council for Agricultural Education.

In normal times the European peasant farmer finds it more important to sell eggs than does the American with more land, but America is tending rapidly toward the same conditions as those in Europe, as is shown by the great increase in the poultry business. The conspicuous thing about the poultry industry of the United States up to the present time is the almost entire absence of export. In this respect it is much like the dairy industry, and for the same reason. As yet we do not have to export eggs. We are too rich. We leave that diligent task to the poorer Irish, Danes, Russians, and Chinese.

In the marketing, especially of eggs, great improvement is possible, as is proved by recent Irish experience. France and Denmark sent the best eggs to the British market a few years ago, but recently the Irish Agricultural Organization Society began to give lectures and instruct classes in poultry production, and organized co-operative societies for the marketing of the eggs. The resultant improvement in the freshness, cleanliness, and careful packing of the eggs has so greatly improved their standing in the markets that Irish export of eggs increased one-third in six years, 1904 to 1910, and the Irish export of poultry products was greater at the outbreak of the war than the butter export, and was exceeded in value only by the export of linen and cattle.

Because of the high value of output in proportion to weight, it should be emphasized that the distribution of the poultry industry depends more on man and markets and less on the immediate environment than any other of the animal industries thus far discussed. It should also be noted that in poultry farming on a large scale the failures far outnumber the successes, because of the unusual amount of detail involved, and the great difficulty of inspection.

Turkeys, ducks, and geese comprise about six per cent. of the poultry of America, but despite the feathers of the ducks and geese, these birds, because of their small number of eggs, do not contribute the double source of income furnished by the chicken. In Germany the tractable goose is esteemed as is the untractable turkey in America, and it is common to see boys herding large flocks of geese at pasture.

The supply of eggs and poultry, particularly eggs, may be multiplied almost as many times as we may desire. It is possible to let poultry replace to a very great extent a large proportion of the other animal industries outside of dairying, as has been the case in China, where it has also partly replaced dairying. At the present time the egg industry of the United States is in a chaotic, unorganized, inefficient, wasteful condition in comparison with that of Ireland, Denmark, or even Russia in 1913. The United States Department of Agriculture estimates that we were losing $50,000,000 a year through needless breakage, "unnecessary addling, spoiling, and deterioration of good eggs from bad handling on the farm, on the way from the farm to town, in town, in transit from town to city, in all stages in the progress from the car to the breakfast table." We have neglected our eggs because they were an unimportant by-product not worthy the attention devoted to a larger crop. If necessity arises, we shall, of course, organize our markets so that the eggs will reach the consumer promptly and in good condition rather than slowly and in bad condition. In the American egg case, for example, there is much breakage; but Russian eggs come to the British market with almost no breakage in wooden cases, 6 feet long, 2 feet wide, and 15 inches thick, in which 1,440 eggs are packed solidly in wooden wool; that is, fine shavings.

Another way of increasing the future egg supply is the keeping of better fowls. In the matter of breeding, chickens are almost like clay in the hands of the potter. They have been bred so long that their form has become pliable. Chicken fanciers can vary breeds almost at will. We have in this country 104 standard breeds and a large number of non-standard. Some are large, some smaller than your fist. They are of all colors. Some will scratch up the yard, fly over the house and hunt their living like wild animals, others sit around like statues, waiting to be fed with a spoon. Some are good mothers, others have become so perverted by selection that they will not rear their own young, but will lay eggs furiously at most unnatural speed.

Poultry raising, and especially egg production, responds readily to the fostering care of governmental or other outside aid. The application of the laws of animal breeding cause large increase in the average egg output, as various agricultural experiment stations have shown. It is estimated that the average American hen lays seventy eggs per year; but in the *Philadelphia North American* annual egg-laying contest the winning hen of 1912 laid 256 eggs, and in the next three years the number rose to 282, 286, and 314. Flocks of hens laying over 200 eggs per year are not uncommon at the present time. Here is a substantial possibility of increasing the supply of this very good and very important article of food.

In speed of reproduction, the hen is almost as far ahead of the pig as the pig is ahead of the sheep or the cow. The hen (a good one) may lay seventy-five to eighty-five eggs in March, April, and May, of which nine-tenths will be hatched by the heat of an oil lamp and reared wholesale in artificially heated boxes called brooders, while the hen continues her egg-laying business. An appeal was printed on June 2, 1917, for more food production, including the setting of an extra hen. At Christmas time the author of the appeal had roast chicken from one of these surplus broods, started after the appeal was printed. It was one of eleven raised by one hen after the main laying season was over.

RABBITS, HARES, OTHER SMALL ANIMALS, AND OSTRICHES

The rearing of rabbits and hares is, in its economic aspects, like the poultry industry. In 1917 the French peasants got a cock and two hens and a pair of rabbits as part of the equipment given by the American and English Quakers working with the Red Cross in the reconstruction service in areas devastated by the Germans. Hares have the advantage of being able to thrive in closer confinement than poultry. The mother hare will raise several fine families a year in a box a few feet square. And they will feed on a very wide range of vegetable food—weeds as well as hay and grains. They are quite generally kept by the small farmers of northern France and Belgium, whence they have for years been exported to England by the hundreds of tons. The total British import of rabbits amounted to over $5,000,000 per year before the outbreak of the war.

The high price of meat has caused the rabbit of Australia, which has long been a great pest, suddenly to become of great value. In that land there are no wild dogs or foxes, and rabbits, which produce three or four litters of young per year, multiplied in the genial and almost winterless climate until in places the pasture would no longer support any other animals. Thus the sheep industry has had to fight for its life against this nimble-burrowing, fur-bearing grass-eater. The people of Australia have built wire fences, hundreds of miles long: they have poisoned and shot and hunted rabbits by all means in their power, and still bunny has thriven, devastating large areas of good grass. But a new enemy has appeared, one of the great forces on this earth—an economic force. The high price of meat has changed the aspect of the rabbit situation. Suddenly rabbits became worth catching to sell. In 1917 a special commissioner in New South Wales said they were worth $5,000,000 a year. Frozen rabbit is now regularly exported to Europe whenever the shipping permits. In August, 1918, the British Board of Trade ordered 600,000 crates of skinned rabbits, 21,000,000 rabbits, 36,000,000 pounds, with felt from their fur for hat-making as a by-product.

In ostrich farming we have an example of a new domestic animal and a new industry, which, like the sheep industry, may yield a double product, including meat. This bird is a native of semi-arid Africa, being found over most of the Sudan and large areas in South Africa. The Hamar Arabs in West Kordofan, Sudan, keep a few birds in pens, but the feathers are inferior to those from wild birds, which were until recently the sole supply in all lands. The British in South Africa are the real founders of the ostrich industry, having found that when inclosed by a strong fence and supplied with suitable food of grain and good grass the ostrich will thrive about as well in domestication as the sheep. In forty years the Afrikanders have reduced ostrich farming to a science, established systems of registry for pure-bred birds and improved them to the point where \$5,000 has been paid for a single bird for breeding purposes. The number of tame birds in the fields of Cape Colony farmers was estimated at 500,000 in 1912, the best feathers sold at over \$200 per pound, and the feather export of \$9,000,000 rivaled that of wool even though the colony had eighteen million sheep. In one irrigated district on the Grobbelaars River, two miles by seventy, 80,000 ostriches were kept at pasture on alfalfa. They yielded over \$20 apiece per year, and the land sold for \$750 to \$1,000 per acre. A change in styles might permanently change all this, as the war has already temporarily done. There is little reason other than custom why the feather-yielding ostrich should not eventually become in some form an article of our food supply, like the milk-giving cow, the wool-yielding sheep, or the laboring ox.*

* We may add other animals to our domesticated and edible list, as meat scarcity increases and prejudice decreases Fur farming offers some interesting possibilities here. The Canadian fur hunter eats on occasion every animal that he skins.

"Do not forget to include musquash (muskrat) among your foods, sold as 'marsh rabbit' in the markets of Washington, Philadelphia, and Baltimore. Thousands of tons of this delicious meat are thrown away by the trappers every year because somebody called it 'rat' and then people refused to eat anything which anybody had given the name of rat."—Robert T. Morris—letter of 3/27/19.

CHAPTER XIV

EDIBLE FATS

The war has taught us that we cannot get along without some fat in our food. We knew less about fat before the war, because every one had a chance to get it, and physiologists thought that starch like that of the potato, which is easily converted into fat, would meet all our needs. We have found, however, that we need some little round globules of fat taken directly into our systems. Without it, man's food digests so quickly that his stomach becomes empty and he has a continual sense of hunger and loses weight. Fat was the food element of which Germany had the greatest shortage, and it is generally reported that the average adult had lost fifteen pounds of weight before the war had been going on for three years.

Fat is a kind of safety bank for our bodies. If our stomach gets a little surplus food, it makes a few globules of fat which our blood tucks away into some part of our framework, to be used later in some time of need, as is the case with the camel and other fat-storing animals.

Besides its great value as food, fat is very necessary in cooking. Without it we could not fry at all. Baking bread would be difficult and many other embarrassments would beset the greaseless cook. Boiling is the chief refuge, and boiled food is very tasteless and monotonous. Furthermore, fat is one of the important elements of seasoning, as the butter on potatoes or beans, or the savory flavor of lard or fat pork in fried potatoes, demonstrates.

Man gets his food fat from a great variety of sources, depending on the climate and therefore the natural products of his country as well as upon his wealth, or what he can afford to buy. In some places it is butter, in others lard, fat pork, goose grease, olive oil, cottonseed oil, coconut oil, oleomargarine, ghee, or beef tallow, which is carried in shiploads from the semi-arid regions of Africa opposite Arabia, over into India to add flavoring and fat to the rice and other cereal food of the peoples of Hindustan.

Edible fats may be divided into three grades, according to cost: 1, butter; 2, animal body fats; 3, vegetable fats. It was shown in the last chapter how fat pork is in many parts of the United States the substitute for butter, but even this is too costly for the people of many parts of the world, and we have a great increase in the use of beef suet (body fat) as a substitute for butter, lard, and pork.*

There has been a long legislative fight (for profits) between the dairymen and the people who wish to make oleomargarine look like butter, sell as butter, and replace it. Properly colored and slightly mixed with butter, oleomargarine is so much like butter that it will pass undetected in nearly all cases. As tallow costs much less than butter, there is plainly an unfair profit in selling the margarine as butter, but its use has nevertheless been steadily increasing for many years, and will surely continue.

Dr. Graham Lusk in *Food in War Time*, p. 15, says:

> The legal restrictions placed upon the sale of oleomargarine and the taxes enhancing its cost, now in operation in many of our states, are without warrant in morals or common sense and should be entirely abolished in times like these. A well-made brand of oleomargarine is much more palatable than butter of the second grade, and certainly for cooking purposes is just as valuable.

The war has made us drop many of our food prejudices, so that margarine is now in a position of much greater importance than ever before. In Canada, a land where cities are few, and the dairy interests are strong in politics, the manufacture of oleomargarine had been absolutely prohibited until, late in the war, the need of it in Britain caused it to be manufactured for export to the mother country. In Great Britain 75,000 tons were imported in 1913, 130,000 in 1917. By the end of that year

* "West Point Academy has been buying 840 pounds of lard and 450 pounds of butterine per month. Both were discontinued and their place taken by drippings from the fatty portions of meat carcasses, which yield about 2,500 pounds of fine grease used in the making of pie crust, French fried potatoes, etc. After this grease has served its purpose, it is shipped to New York, where the clear grease brought thirteen and a half cents per pound, and by-products in the way of scrap, four and a half cents. During January, 1918, the Academy realized $616 from the sale of once-used grease."—United States Official Bulletin, February 28, 1918.

the British output was 5,000 tons a week. It is part of the established ration, four ounces per person per week being allowed. It has long been manufactured in Holland, and by 1917 the butter production of 70,000 tons, amounting to twenty-five pounds per capita, was exceeded by the margarine output of 180,000 tons, or sixty-six pounds per capita. This condition was probably temporary, due to the slaughter of cattle that could no longer get imported feed.

Despite her great export of butter, Denmark has also been an important producer, importer, and user of margarine, because it was cheaper.

In 1915 the Danes began to make margarine from hardened whale oil which is said to compare favorably with hog lard. Norway has also taken up this industry, which has doubtless come to stay.

Competition between different sources of supply has been going on for a long while, and is getting keener. Not only has there been competition between butter fat and body fat, but also between animal fat and vegetable fat.

VEGETABLE FATS

THE OLIVE

The Mediterranean climate with its dry summer is a poor place for dairy products of any sort. Its pasture is scanty and its animals tend to be few, but fortunately this climate furnishes a partial substitute for butter fat in the fat of olive oil, which is chemically almost exactly like the fat of butter and replaces it and lard in the diet of the people of southern France, Italy, Asia Minor, and north Africa. It is said that every Spaniard eats from twenty to twenty-five pounds of olive oil per year, although the olive tree grows on only half the area of the kingdom. The Portuguese produced about fourteen pounds per capita in 1910. In 1911, a year of unusual yield, the Greek oil output of twenty-five to thirty million gallons amounted to eighty or ninety pounds per capita. Many restaurants in American cities, run by people from the Mediterranean Basin, serve good meals, in which olive oil entirely replaces butter.

America has a territory where the olive tree and the cow compete. People from the eastern part of the United States, accustomed to an abundant supply of milk, have moved to southern California where the Mediterranean climate makes butter production more costly than in the old home with its moderate rainfall. The milk is expensive to produce and much butter was brought from the Mississippi Valley until a few years ago, when dairying in the damper sections of the Pacific States made them independent of Eastern butter. Readjustment of consumption to geographic conditions is coming through the discovery that the olive will grow in that dry region, and the manufacture and use of olive oil, the natural product of that climate, is increasing.

The olive-growing area in southwestern United States and Mexico, in North Africa, South Africa, and in other parts of the warm temperate zones can be greatly extended. The production of olive oil has, however, been held down by the appearance of yet cheaper rivals, just as the appearance of margarine has held down the production of butter.

COTTONSEED OIL

A few decades ago cotton seed was thrown out in piles to rot —a waste product. Sometimes it was burned, and was then put back on the fields for fertilizer; but now we are getting from it more than $100,000,000 worth of edible oil a year. In the eleven months ending June 30, 1918, the total product was 1,300,000,000 pounds, or nearly thirteen pounds for every person in the United States. At least a third of it was eaten as lard substitute. It is mixed with beef suet, which is margarine, and the joint product is called oleomargarine, a well-known butter substitute. Even before the war, the United States consul at Stavanger, Norway, said that nine-tenths of the population ate oleomargarine instead of butter. We can easily see why people not overrich should do this, for butter at that time cost thirty-five cents a pound, and the cottonseed oil for the margarine cost seven and one-half cents a pound. The import was rapidly increasing.

Cottonseed oil * is a substitute both for butter, lard, and

* Cotton almost merits a place by itself in a book on food, so important is the seed, of which the world uses annually about 11,000,000 tons, pro-

tallow, and for olive oil, with which it is often mixed. Very few people can detect by taste the difference between the pure and the mixed olive oil, unless it has been allowed to get old, when cottonseed oil, but not the olive oil, becomes rancid. Olive oil can stay in an open tub in a hot climate for two years and still be good, sweet oil, whereas the cottonseed oil becomes cloudy and rancid in a much shorter time, and butter is even more quickly spoiled.

It was pointed out in a previous chapter that the warm lands have not used their great possibilities for developing the dairy industry, but these lands, more than any others, have increased the supply of edible vegetable fats or oils in the last fifteen years. Cottonseed oil is but an example.

THE COCONUT

Even more promising rivals of dairy products are the oily coconut and the nutritious peanut. These two little-used plant products have recently made a late start on a career of usefulness very suggestive of great changes to come in food supply and production.

Nearly half of the meat of the coconut is fat or oil, and the nut has the quality, rather unusual among oily vegetables, of keeping for many months without becoming rancid. The recent rise in the price of animals, causing the price of lard to be nearly doubled in a few years before the war, made its substitute,

ducing 350,000,000 gallons of oil, most of which is eaten. The food service of this remarkable textile plant is not confined to the oil. From fifteen to thirty-five per cent. of the seed is oil, and the rest as it comes from the press is a hard cake easily ground into a brownish meal which still contains a considerable quantity of fat, and three times as much protein as white flour. It has for the last twenty-five years been the cheapest source of protein for dairy cattle. It has been widely exported, especially to northwestern Europe. Its price has been steadily rising until in 1918 it was more than sixty dollars a ton. It may become a very important part of our bread supply if we continue to rationalize our eating. In the spring of 1918 a bakery in Charlotte, North Carolina, was turning out 400 loaves of cottonseed bread weekly. It is rather dark in color, but has twice as much protein as lean beef. The value of adding such a meat substitute to bread itself can easily be appreciated. Up to the present we have made no serious attempt to produce cotton seed, except as a by-product of cotton. The time may come when we will deliberately try to produce strains of cotton that produce more and richer seeds, and as cotton grows on more than 700,000 square miles of the United States, it is a promising source of both fat and protein.

cottonseed oil, advance in price, and hence caused increased attention to be given to the coconut as a source of food fat. It has long been used as a soap fat, and for some other industrial purposes, but it has a rather strong taste not relished by many people. Then some chemist performed a miracle. By an easy process, he managed to work one atom of hydrogen into the oil molecule and it became a relatively hard white substance, without disagreeable flavor; and the world received another edible fat easily produced and with enormous possibilities of increased output. It was the lack of their usual supply of coconut fat more than any other one thing that caused the Germans to grow thin and to feel the continuous pangs of hunger from harvest season to harvest season. Before the war commerce in and the use of coconut oil was increasing with great rapidity in Europe.

FIG 104.—Coconut palm is one of the great automatic food machines. There is a saying in the tropics that when a man gets his coconut grove started he hangs up his hammock. (U. S. Dept. Agr.)

A firm in Mannheim, Germany, had put upon the market "Palmona," a hard snow-white vegetable cooking fat made from copra (dried coconut meats) and practically one hundred per cent. pure fat. None of the rival animal fats (margarine, butter, lard, goose grease, etc.) contains less than seven to ten per cent. of water. An American consul said in 1910: "The product has found such favor that the manufacture can scarcely keep up with the demand" and the output of the Mannheim factory increased in a few years from 700,000 to over 21,000,000 pounds per year. To make the substance spread like table butter, small quantities of egg-yolk and butter are introduced; the resultant product is called "Palmona."

In Austria, Holland, and England the same substitution has found favor. Coconuts were imported through Hamburg and taken in boatloads up the Elbe to Bohemia, where the oil was pressed out and mixed with a small proportion of egg-yolk and cream and sold for fourteen cents per pound in competition with butter at from thirty-one cents to forty-one cents per pound. It is difficult to estimate the importance of this food supply to a population whose adult laborers received from forty to seventy-

FIG. 105.—Opening coconuts for drying to make copra. Philippine Islands. (Bureau of Insular Affairs.)

five cents per day. The output of European margarine factories using coconut oil as a base was estimated at sixteen million pounds per week in 1912, an amount exceeding the total European import of butter. Consequently the market price of coconut oil had increased enormously and the world was being searched for additional supplies of coconuts. The world will have little difficulty in finding the coconuts if it will wait a few years for the trees to grow. The supply can be increased much more easily than the supply of butter, because large areas of unused land on nearly all tropic continents and islands are suited to the coconut palm. It is easy to acquire a product that falls from the tree, virtually a wild tree at that, and lies for weeks safe and sweet, embedded in its thick cushion of husk waiting to be picked up. The food possibilities of the production of the coconut sound almost too good to be true. Where there is even a moderate rainfall, the tree grows on a great variety of soils, upon the shores of almost all tropic seas. Perhaps it is most important in the South Sea Islands, many of which are only coral reefs, with a little limestone soil, bearing groves of coconut trees which nature long since planted on them by casting up floating nuts.

The cottonseed oil plants of Texas and other Southern States are now being used to some extent for the production of coconut oil. It is compressed from the dried meats of the nut, which is imported from the South Sea Islands. As a result, we are told by *The Manufacturers' Record* American capital will doubtless be invested in coconut plantations on these islands and closer trade relations with them will be established. Copra may then become one of our chief imports. This product is now to be found on our own markets. The raising of coconuts and their preparation for exportation are interestingly described as follows:

Of the many romantic flavors that enter into the life of the people of the different island groups lying adjacent to the equator in the Pacific Ocean, none is more pronounced than that which is attached to the coconut-growing industry. It is these stately palms that lend distinction and attractiveness to the islands. To the growing of coconuts is largely due the advancement of civilization in many of those remote islands. As an evidence of this fact it may be cited that one British concern owns a coconut plantation of 100,000 acres in the Solomon Islands and that the very borders of this plantation are inhabited by natives who still practise cannibalism.

It is the ambition of practically every man who has lived even for a brief time under the tropical skies of the South Seas to own a coconut plantation. When once established, the industry insures a lifetime of profit and ease for the grower of the product. The trees require practically no attention from the time their growth begins until the deadening commences, nearly one hundred years thereafter. The bearing period of the coconut tree is seventy to eighty years. The first coconuts may be expected in about six years after the original planting. The tree comes into full bearing about the twelfth year and from then on until its life is ended it gives an average annual yield of about fifty nuts. The average yield of copra per acre is about one-third of a ton. It was selling at the beginning of the war for about $150 a ton in the London market. The price has advanced considerably since then, it is stated. The cost of operating a plantation of coconuts is exceedingly small. All of the labor is performed by island natives, and the ordinary expenses of gathering, cutting, and drying the crop of nuts do not exceed $50 for each one hundred acres. This cost is much more than offset upon many of the plantations by the utilization of the land also for the grazing of cattle and sheep.

The preparation of the copra for market is very simple. The nuts are allowed to fall naturally, and at intervals of once a month, and sometimes not oftener than once every two months the nuts are collected into piles upon the ground. The laborers then split the nuts open lengthwise with a blow from an ax. The kernels are removed with two or three dexterous cuts of a small knife. This is the copra in its raw state. The ordinary daily task of each laborer is to split and clean six hundred coconuts. The empty shells are burned upon the ground, the ashes from them being regarded as good fertilizer for the trees. The meat of the nuts is placed in bags and conveyed to the platforms for drying. The drying frames vary in size and arrangement, but the principle of their construction is always the same. The kernels are exposed to the sun in shallow layers on trays, and protection is provided from the showers and from the heavy dews at night. On the larger estates the trays are arranged to run on rails from under a roof, two and sometimes three or more trays being arranged under one another, thus economizing roofing area. The bottoms of the trays are usually constructed of reeds, which allow some circulation of air through the kernels, which are occasionally stirred during the drying process. This occupies from three to six days, depending on the climatic conditions. When thoroughly dry the finished copra is packed into bags for export.

The establishment of a coconut plantation, we are told, is an interesting process. Nuts are carefully selected, placed in piles, and exposed to moisture; when the sprouts are three or four feet long, the nuts are placed in holes in the ground, generally about thirty feet apart. The cost of planting varies according to local conditions. Ordinarily, it will run close to $100 per acre, including clearing the land of underbrush and keeping it clear until the trees arrive at the producing stage. It also includes the cost price of the wild land, which ranges from $1 to $5 per acre.

To quote further from *The Manufacturers' Record:*

To the native of these islands it may be said to provide all the necessaries of life—food, shelter, and clothing. The full-grown tree attains a height of fully ninety feet, and the timber may be used as logs for bridging streams and for house-building. The trunk of a tree may be split into lengths which bend readily, and in this form the timbers serve useful purposes in house construction. The plaited leaves are used for thatching the roofs and for making the outer covering of the walls. They are made into beds to sleep on, into mats for the floor, and they serve for plates to eat from. Beautiful baskets and fans are made of the leaves. The flesh of the nut forms an excellent and nourishing food; it produces oil for cooking, for mixing native puddings, for lighting the house, and anointing the body. The milk, especially that from the young nut, forms a palatable and refreshing drink. An industry of no little importance among the natives of the different islands is the manufacture of twine, known as sennet, from the husk of the nuts. This material is used chiefly to tie the timbers together in construction of native houses, no nails being used in such work. Twine and rope of any size up to towing line are made from the fiber. The natives are adepts in weaving fishing-nets and door-mats of the fiber. The "cabbage," as the soft central part of the head of the coconut-palm is called, can be made into a delicious salad. It is not the privilege, however, of many to enjoy this delicacy, as few persons can afford to sacrifice so valuable a tree for such a purpose.

Some of the natives of the South Seas make what is called coconut "toddy" out of the nuts. The liquor is intoxicating to a high degree, and upon most plantations its manufacture is forbidden, owing to the trouble that it causes.

In Venezuela the people live very largely on coconuts and cassava—cassava, as stated in Chapter VII, being the substitute for bread, and coconuts the substitute for butter.

In Trinidad the people make a local coconut butter, four nuts with their seventy per cent. of fat producing a pound. The method is simple. The meat is grated, and the oil extracted with boiling water. The oil rises to the surface of the water, is skimmed off, and allowed to stand for a few hours; it is then churned, making a white fat sometimes almost the exact duplicate of our cow's product.

For years steamers have made regular rounds in the South Seas bartering for nuts and taking cargoes of them to Australian ports for the crushing of the oil. Copra is taken in great quantities to Marseilles, to Hull, England, and recently to the cotton-mills of the American cotton-belt for grinding. The amount of land available for the production of coconut is probably one hundred or perhaps even a thousand times the area at present so used. On the west coast of Costa Rica, for example, a few months ago coconuts were worth one and one-third cents each, a price so low that people did not think it worth while to raise them.

During the four years, 1906-09, the Philippine Islands produced eight hundred thousand tons of copra; the rapidly increasing output is an important element in the economic life of the islands, and the industry gives promise of becoming yet more important there and elsewhere. A single Liverpool firm recently invested $5,000,000 in west African coconut plantations.

THE PEANUT

The peanut may be considered as a partner of the coconut in this vegetable onslaught on the animal industries—this vegetable replacement of animal scarcities. While the coconut is a substitute for butter and other fats, the peanut (see its content in table of food values) is a substitute not only for butter and other fats, but also for cheese and meat. Taken together, these two nuts form an admirable example of the substitution of plants for animals as a source of food supply (a step towards the easy support of larger populations), and also illustrate the transfer of the source of supply from cool to warmer lands.

The peanut, so little appreciated in the past, is really one of the most valuable of foods. It is nearly as nutritious as cheese, contains per pound more protein than a pound of sirloin steak, plus more carbohydrate than a pound of potatoes, plus one-third as much fat as a pound of butter—an amazing total. Excluding shells it has more nourishment per pound than a pound of sirloin steak added to a pound of white bread. This unusual food cost five or six cents per pound by the sack before the war, and keeps without deterioration for years—in striking contrast to dairy products and meat.

Now that rising prices force us to look about for new supplies, the peanut enters into our diet in many forms. Since it furnishes both protein and fat, both of which have been made very scarce by the war, it is natural that it should spring rapidly into importance. Since it is a crop that we use directly rather than indirectly, through animals, the United States has been able to increase its yield more than that of any other crop. In 1910 the acreage in the United States was 800,000; in 1916 it was estimated at more than 1,000,000, and in 1917 more than 2,000,000 —an increase without a parallel in American agriculture, perhaps in the world's agriculture. The average yield per acre is about thirty-four bushels of peanuts in the shell; a good yield is sixty bushels, with a ton to a ton and a half of good hay. A mill can produce a gallon of oil from a bushel of peanuts in the shell. An acre of land that can produce 20 bushels of wheat or 40 bushels of oats, or 40 bushels of peanuts, will yield 154 pounds of digestible protein in the form of wheat, 149 in the form of oats, or 186 in the form of peanuts. It will yield 24 pounds of fat in the wheat, 61 pounds in the oats, and 300 pounds in the peanuts. Truly, the peanut is a food of promise. Despite the great increase in production, the United States has been steadily importing it from China and Japan during the war. In Europe its chief use is in the form of edible oil, which before the war sold at wholesale for eight cents per pound—a highly prized substitute for lard, butter, and olive oil. Marseilles, long the center of the European vegetable oil industry, crushed 240,000 tons of shelled peanuts in 1912, along with 120,000 tons of peanuts in the shell, which yielded altogether more than 15,000,000 gallons of edible oil. In 1916, 26,000,000 pounds of oil were produced in the United States. The nut also is coming into dietary use in various forms. The United States Department of Agriculture has recently issued a special leaflet urging us to use peanut meal, mixed with corn meal and wheat flour, for griddle cakes, biscuits, and muffins; to eat it as a cereal; to use it in cakes, cookies, puddings, and in soups; and to make of it a meat substitute. Its value as a meat substitute, shown in the table of analyses, may be proved by the eating of a few peanuts at the end of a meal which has left us hungry for meat. The fact that the peanut plant is at home from latitude 37° north to the south temperate zone shows its wide range of soil and climate and the great possibilities of increased production, as compared with any of the staples thus far discussed.

It has long been an important money crop in that part of the sandy Atlantic plain lying near the Virginia-North Carolina boundary. It is grown in Argentina, Brazil, and Costa Rica. It is the chief export of the French and English colonies of Senegal and Gambia in west Africa, and is also exported from Madagascar, east Africa, India, Japan, and China. It is one of the few articles produced and exported by the white, black, yellow, and brown races. It has recently been cultivated in the semi-arid districts west of the lower Mississippi Valley, because of its ability to wait long for rain and to grow whenever the rain comes.* The fact that it can be harvested by the pigs adds to its importance. The export of peanuts ($6,500,000) from Madras in 1910 was more valuable than the wheat exports during the same year from any port in the United States except New York.

As population, land values, and cost of living steadily rise in the cool temperate zone, the pressure bears most heavily on the animal products, because of the large areas of land required by the animals. It is decidedly comforting to find good substitutes in the palm and peanut, which very nearly furnish diet equivalents of the animal products. They are well suited to the vast areas of the fruitful tropics and to cultivation by the native populations already inhabiting those lands.

These two plants are merely members of a class. The soy bean, so promising in American agriculture, contains eighteen per cent. of oil, which has long been an important fat food for the Japanese. At $1.50 per bushel of beans (the American price in 1912), the ten pounds of oil was far cheaper than butter. In parts of North Carolina these beans were being regularly grown two or three years ago at a cost of seventy-five cents a bushel. Rows of corn were planted six feet apart, with rows of soy beans planted between them at the second cultivation. A harvester was then driven astride the row of ripened beans, which were gathered and thrashed at the same time, at a cost per bushel not exceeding three-fourths the daily wage for a negro laborer. This method of production can be practised over large areas, extending from the mouth of the Chesapeake to the

* Compare corn in this respect (see Chapter III) and note the great importance of the peanut in semi-arid lands.

mouth of the Rio Grande and from the Gulf far up into the corn-belt. The bean, being a legume, enriches the land and improves the corn that grows beside it. The oil is a satisfactory edible oil with a history perhaps as old as that of the olive. It has, however, only recently been consumed by Europeans. In 1907 important shipments of the beans were made from Manchuria to England with such success that in a few years the amount rose to a million tons. In Manchuria beans had been grown for ages, but no one could export them because of the rapacity of the Chinese governors, who in that region pursued the same policy as the Turks: namely, such imposition on the peasants that it was very unwise for any one to have more of a crop than merely enough to carry him through. If he had more the governor took it; therefore, why grow it? The Japanese have kept order, so that farmers could ship what they grew. In the period just preceding the Great War, soy beans were sent to the oil works of Marseilles, Antwerp, Amsterdam, Hull, and Liverpool.

THE PROSPECTIVE SUPPLY OF VEGETABLE OILS

The sunflower seed has thirty to fifty per cent. of edible oil, used to some extent in Hungary and Russia, and capable of growing over large areas of the southern part of the United States and elsewhere. Many other vegetable oils are already in use, and many more could be used if we set out to find them. From Nigeria come reports of vast numbers of oily nuts of the shea tree which may be exported by thousands of tons as soon as the railways open up new districts. A native working by the day gathers one hundred pounds of fruit, yielding fifty pounds of nuts, making with European machinery seven pounds of oil called shea butter. This is prized as a butter material by the people of the interior, and, like the palm nut, another oil producer, promises quickly to enter commerce. In Sierra Leone, palm-nut (not coconut) shipments doubled in five years before the war and furnished two-thirds of the total export of $5,000,000. Of palm kernels alone the United Kingdom succeeded in importing 250,000 tons in the year of ship shortage, 1917. At the beginning of the war the city of Hull alone was crushing

750,000 tons of oil seeds, chiefly cottonseed, linseed, rape seed, soy bean, sesame, and castor bean.*

The fact that we get all these products without the intervening beast necessary to butter and cheese is of great importance in considering the food possibilities. These substances are valuable both on account of ease of production and the amount of produce left for man. The beasts leave us a small residue. (See table on page 182.) The probable service of the vegetable oils to the food supply of the future is prophetically shown by our recourse to them in the emergency of the war. In 1914 we imported 58,000,000 pounds of coconut oil; in 1917, 163,000,000. The figures for copra rose from 60,000,000 to 367,000,000 pounds, more than six-fold increase; those for peanut oil rose from 7,000,000 to 27,000,000 pounds; the amount of soy-bean oil imported was increased more than twenty-fold, from 13,000,000 to 265,000,000 pounds. It is very suggestive that during this period a factory in Wisconsin, the greatest dairy state of America, started to manufacture and sell throughout the United States a nut butter composed of sixty-five to seventy per cent. of coconut oil, fifteen per cent. peanut oil, two and one-half per cent. salt, and eleven to twelve per cent. moisture. It is undoubtedly easier to double, triple, or quadruple our production of coconut and peanut oil than it is to make any great increase in the amount of butter.

In nearly every climate some vegetable fats are produced—in the wet tropics, the palm and the coconut; in the less wet tropics, the peanut and the coconut; in the warm temperate regions, the peanut and the bean; and in semi-arid localities, the olive. For a fuller discussion of the olive, see Chapter XXVII. Vegetable oils may remove the need of a warm-land dairy industry.

* Castor oil has suddenly become important as a lubricant because it will stay liquid in the great cold of high aeroplane flight. Strange to say, this oil is also a good cooking oil, the process of cooking removing from it all of its violent physiological effect.

CHAPTER XV

THE FISH SUPPLY

FISH AND PREJUDICE

THE Sea! We have not discovered it yet. If man insists on eating animal proteins and wants a twenty-fold or a hundred-fold increase in the supply, I call his attention to the sea as a place where he may drop his prejudice overboard, investigate, and probably find food in amounts that are beyond present computation.

Would you eat shark? Most likely not, according to your first impulse, yet the Chamber of Commerce of a Southern city dined sumptuously last spring, then voted unanimously that the fish course was good, after which they were told by a representative of the United States Fish Commission that it was creamed shark. "Although the meat of some sharks, prepared in various ways, has been eaten, a particular prejudice has been held against certain kinds of sharks, especially the sand shark, which has been claimed to be absolutely unfit to eat. During the summer of 1918 the director of the Woods Hole Laboratory of the United States Bureau of Fisheries tested six species of sharks, including the sand shark, by supplying the meats as food to about fifty persons. Served in different ways, they were pronounced not only good, but especially pleasing in flavor and texture. Several persons said they were equal to swordfish." *

Why not eat shark? Because he is carnivorous, perhaps, you object, and eats any kind of meat he can get, including at rare intervals, human flesh. But no one objects to the speckled trout or the gamy bass, both as carnivorous as the shark and quite as willing to eat people if the portions are made small enough. Nearly all of our food fish are carnivorous, although they all derive their ultimate support from the vegetable life of the

* Commerce Report, October 12, 1917.

waters. Even the clear water of the sea has countless millions of minute plant organisms which are eaten by many small animal organisms; they in turn are eaten by each other and by the smaller fish, which in their turn are eaten by the larger fish; but the support of the whole pyramid of marine animal life from shrimp to whale, like the life of land animals, whether lion or elephant, is based upon vegetation.

We have many foolish notions about what is good food, and this seems to be especially true about what fish is good food. There is a pitiful tale of woe in the state archives of Maryland, where it has rested since it was sent up to the royal governor about 1680 by the inhabitants of one of the islands in Chesapeake Bay. They petitioned that he should send them from the royal bounty some food, for they were about to starve. They went on to rehearse that their crops had failed and that they had been forced to such extremities by the approach of starvation that they had been compelled to go down to the bay, dig up oysters out of the muddy waters and *eat them.* For the last fifty years the descendants of these same islanders have made their living by selling these oysters and have eaten them whenever they could afford them. At the time of the founding of this nation no gentleman was willing to be seen in an Atlantic seaboard town eating shad, for by condescending to such cheap stuff he might indicate that he was short of bacon at home. Yet for several decades the shad has been perhaps the most highly prized of all fish upon the Atlantic seaboard of the United States. So great was the demand for shad that it has been nearly exterminated.

Would you eat dogfish? Instinctively you probably say no, even if you never saw one. The dogfish is a little shark and thousands of people cheerfully ate him in the last three months of 1918 after he was renamed, and, thus respectably camouflaged, went innocently and quickly into general use.

If we can abandon a host of foolish prejudices as to what kinds of fish are good to eat, we have great possibilities of increased supply of a kind of food that is greatly needed. It has been shown in other chapters that our supplies of bread and bread substitutes are almost unlimited. The same is true of milk, and of fish. Meat is sharply limited and must become scarcer as population increases. It is therefore a matter of great importance to the human race that the supply of fish may expand almost indefinitely and that "fish meat contains as much body-building food as beefsteak and is as readily digested as our other meat."*

Fish are the cattle of the deep and the deep is vast. Three-fourths of the surface of this globe is sea. Most of this 150,000,000 square miles (fifty times the area of the United States) is inhabited by some kind of fish. It has, however, been greatly neglected in the past. So little has it produced that the sea, despite all we hear of fish, has really been a desert, a mere separator of continents, a highway.

One must not get the impression that all of the sea is equally good for fish. Some parts, far from land, are relatively poor in fish, and the cold waters of the north have more fish than the tropics because they have greater amounts of microscopic plant-food. The northern fish are more easy to catch than the tropic fish, because they go in schools.

The fishing industry, through its connection with sea power and the romance and charm of the ocean, tends to be overestimated in its present importance. All the fish that are caught by American fishermen ($54,000,000, 1908, last fish census) were less valuable than the tobacco crop, not one-third as valuable as the pork, not one-fifth as valuable as the butter, not one-tenth as valuable as the poultry and eggs annually produced in the United States. The fish of all the world have thus far been only two-thirds as valuable as the poultry and eggs of the United States. The future, however, promises to increase the fish supply much faster than the egg supply, for the fish in the main take care of their own young and feed themselves. We merely catch them after nature has produced them.

While the industry has upon the whole been much less important than many land industries, it has been of very great importance in many parts of the world. It is probably true that the last half-century, the period of cheap meat, has been a period of temporary eclipse of the fish industry because during that time man, with the steamship and the railroad, has made quick conquest of the vast corn fields, grain fields, and pastures

* *Eat More Fish*, Division F, United States Bureau of Fisheries.

of the continental interiors—a movement which took him away from the sea and gave him other meat. Now that the era of greater intensity of use of resources is upon us, fisheries with their great possibilities of increase promise to rise more and more in the service of man. What fish may be to the human race is well shown by Japan, an island kingdom much like England in size, population, and location. (See page 175.) But England is rich in coal, iron, and trade, and can buy meat. Japan is poor in coal, iron, and trade, and cannot buy meat, so she goes fishing; 1,300,000 of her people and thousands of boats were engaged in fishing in 1914, whereas in England in the same year but 100,000 people were so engaged.

The food scarcity resulting from the war has given a great boom to the use of fish for food. Canning and refrigeration have helped extend the use of all kinds of fish. Canned crab from Kamchatka was a part of the ration of the armies on the Western Front. Refrigeration has permitted frozen fish, fresh and savory, to go from Canada to the armies in France without the use of the tin can or the sacrifice of fresh flavor. Refrigeration plants were built even under the stress of the war in many corners of the world, in Sweden, in Australia, and in Newfoundland, where a fishing corporation is building a series of plants one of which alone will hold ten million pounds of frozen fish. The government of New South Wales is building a series of government refrigeration plants, the first of which has been opened with ceremony and was expected to double the supply of fish produced by a given set of fishermen, because when they had a good catch they had often had to throw fish away. This is the case in nearly all fish markets. No market can consume the fish that are sometimes caught. Thus in 1917 in Philadelphia, in the height of Mr. Hoover's food conservation campaign, twenty-six barrels of fine drumfish were thrown overboard one warm day because there was not an immediate market for them when they arrived on Saturday.

The governments of many countries have been trying to educate their people to eat all the fish that are good to eat. The United States Bureau of Fisheries has been working diligently to call the attention of the people of this country to the fact that there is good eating in grayfish, sablefish, burbot, bow fin, carp, whiting, eulachon, rays, menhaden, sharks, skates, "which heretofore have been little used or not used at all for that purpose. The more extensive utilization of the large number of little-used fishes will greatly increase the food fish supply." *

The possibilities and the practice in connection with the little-known fishes is well indicated by the story of "the redoubtable Captain John Smith, who, while exploring Chesapeake Bay during the summer of 1608, after trying vainly to catch fish in a frying pan, resorted more successfully to the sword, an instrument in the use of which he was doubtless more expert. Included in his catch was a sting ray which he found to be no mean antagonist, for it drove its tail spine into his wrist, inflicting a wound an inch and a half deep, and of such severity and alarming consequences that the captain selected his burial place, and his companions busied themselves in digging his grave. Fortunately the use of a 'precious oyle' so alleviated the pain that the grave was not required and the sturdy soldier was able to eat his foe for supper.

"In the more than three centuries since this adventure, which so nearly cut short the career of one of the most interesting characters in American history, not much progress has been made in utilizing the abundant food supply offered by the skates and rays. A few of these fish are eaten in some parts of the country, but it is safe to say that on the day in which Captain Smith and his companions ate his late enemy the per capita consumption of rays by the white population of the United States probably reached its maximum. . . .

"The sting rays, of which there are a number of species on the coasts of the United States, reach a large size, being sometimes 6 or 7 feet in breadth, with a total length of 10 or 12 feet, but the giant of its kind is the so-called devil-fish, which reaches, and by some authorities is said to considerably exceed 20 feet in breadth." †

As part of this campaign for better use of fish, the Norwegians have succeeded in making bread with twenty per cent.

* United States Fish Commission, H. F. Moore, Deputy Commissioner's letter, 1918.

† *Skates and Rays*, by H. F. Moore, Deputy Commissioner, Bureau of Fisheries.

of fish, which is said to be very good, while the Dutch have erected new plants to take inedible fish and make of them oil and fish-meal for the feeding of swine, which will turn inedible fish into edible pork.

In recognition of the importance of fisheries to Dutch welfare there was each year for centuries a national celebration in which one of the most important ceremonies was the public eating of a salt herring by the Dutch ruler. The fleets of England had their origin on these same fishing banks of the North Sea, and later the New Englanders became the pioneer seamen of America because good fishing banks were near them. The schooner, the fastest of all sailing vessels, was invented and is yet used by the fishermen of Gloucester, Massachusetts, and in recognition of the importance of the sea industry to the state, a codfish has, since colonial days, hung over the desk occupied by the speaker of the Massachusetts Senate.

THE LOCATING FACTOR OF FISHERIES

Most of the world's fishing industry depends upon two habits of fish which enable us to catch near the land many of those that pass most of their lives hundreds of miles away at sea. The first is the spawning habit of many species which lay their eggs only in rivers or in the shallow waters near the shore. The second is the congregation of fish to feed upon the bottoms, in shallow waters, commonly called "banks." The occurrence of such banks near the shores of northeastern Asia, northeastern North America, and northwestern Europe is responsible for the three greatest fishing regions.

NORTH ATLANTIC FISHERIES OF AMERICA

The fisheries of northeastern North America are based on a great combination of rivers, bays, and shallow, off-shore banks. Especially important are the Grand Banks of Newfoundland and smaller banks off Labrador, New England, and New Jersey. The Newfoundland banks were known to the fishermen of the French province of Normandy and Brittany within a dozen years after Columbus had returned to Spain from his first voyage. Unquestionably the knowledge of these fishing banks made a greater sensation in Europe than the mere fact of the discovery of the new continent, because at that date Europe was poorer than now, and a new food supply was important. Also in that day the fishing industry was relatively more important than at the present time. Practically the whole of Europe was Catholic, and even to those who could afford meat, there were many fast days upon which fish must be eaten in place of it. Scores of vessels sailed back and forth from France to these Newfoundland banks each year for a century before the French made their first settlements in the St. Lawrence Valley.

The most important fish on these and other northern banks is the cod, a fish which feeds along the bottom and is commonly caught on a "trawl" which consists of baited hooks attached to short lines that are fastened at intervals of four feet to a longer line sometimes three thousand feet in length. These trawls are attended to by fishermen in rowboats called dories that put out from the schooners. The men in the dory take up one end of the trawl, which is anchored and marked by a float, pass the boat along under it, and let it down in the water again after the fish have been taken off and the bait replenished. Fishing on the Grand Banks is an exceedingly dangerous calling, as the banks are one of the foggiest places in the world and the schooners often collide with each other and with the icebergs, the men in the dories often lose their bearings and drift away to death, while a single fearful storm sometimes drowns scores or even hundreds of fishermen. To complete the chapter of dangers the fishing banks are in the path of trans-Atlantic vessels which sometimes run down the small fishing craft in the fogs.

These banks have enabled New Englanders to catch fish of as great value as all those caught by fishermen of the rest of the United States. Massachusetts and Maine are the leading states, and Gloucester, Massachusetts, was long the greatest fish port in America, nearly the whole population being engaged in the catching, curing, buying, and selling of fish, and the supplying of the tackle and equipment. Boston with its better marketing facilities has recently surpassed Gloucester as a fishing port.

The cod fisherman also catches halibut and hake. The American catch of these is actually greater in quantity, though less valuable, than the catch of cod. The cod is at its best in cold waters and is taken in greater quantity by the Canadians than by the New Englanders, the people of Newfoundland and Labrador catching more codfish than all the rest of the people of America. Dried cod makes nearly two-thirds of the exports of this northern dependency of Great Britain.

Newfoundland and Labrador offer one of the best modern examples of a people living from one resource—so great is their dependence upon fish. There is a little iron mining, a little lumbering, and paper making, but eight-ninths of the exports are fish products and nine-tenths of the workers are busy with fish. The climate is so cold and damp that there is practically no agriculture, even a garden being a rarity in Newfoundland. The people who are not at sea catching cod, or herring, are busy curing them. Some of the cod are sold fresh, but most of them are cleaned and salted as soon as they are brought to the schooner by the dories, and when the schooner reaches its port they are dried in the sun upon sheds which stretch conspicuously along the coasts. The herring is salted or cured by smoking over a slow fire after being salted.

The Nova Scotia fishing industry with a catch of $7,000,000 per year before the war, equaled that of Massachusetts, the leading state of the United States, and the total Canadian catch ($25,000,000, 1907) was slightly greater than that of New England at the time of the last fishing census, which was in 1908. Nova Scotia with her many good harbors partakes somewhat of the character of Newfoundland but, though she catches nearly one-third of the fish of Canada, the warmer climate of this province enables the people to engage, to a considerable extent, in agriculture, and they ship sheep, cattle, and horses across the straits to the people of Newfoundland, who cannot themselves produce these animals.

Fishing fleets from Europe still visit the Grand Banks, and although Newfoundland belongs to Great Britain, the French fishermen may by right of treaty fish along the shore of the greater part of the island. They may also land and dry their fish, although no permanent French settlements may be made.

France also owns two islands, Miquelon and St. Pierre, situated just south of Newfoundland, with a population of a few thousand dependent entirely upon the fishing industry. This single product serves to give these islanders a per capita trade many times as heavy as that of the United States.

NORTH EUROPEAN FISHERIES

The North Sea, so plagued with submarines these last years, is the greatest fishing ground in the world. It is very shallow and abounds in fishing banks. It is surrounded by populous lands, being within easy reach of the British, French, Belgian, Dutch, German, Danish, Swedish, and Norwegian fishermen, and belongs alike to all of them since by the custom of nations the sea three miles and more from shore is free to all mankind. These peoples having access to the North Sea caught about $80,000,000 worth of fish per year before the war, the greater part of which came from the North Sea. Britain with a catch of $50,000,000 per year is the second fishing nation of the Western World, and a close rival of the United States.

The fleets of vessels that figured so much in the submarine war news are mostly steam trawlers and have their headquarters at Aberdeen, Hull, Grimsby, Lowestoft, Yarmouth, and at London, which is the greatest fish market in the world. The Dutch, by their location more dependent upon the North Sea than are the British, catch nearly as much fish per capita as the British and have a fishing fleet with twenty thousand men. The French, having no important fishing banks along their coast, sail as far away as Newfoundland and Iceland.

In Iceland, in the Faroe Islands and in others west and north of Scotland fishing is an important industry, but Norway is of all Western nations the most dependent upon fish. With its cool climate, its mountainous rocky land, and its coast full of bays, it duplicates in many respects New England, Canada, and Labrador, and like them has great fisheries of cod and herring. The cod are caught near the Lofoten Islands and the herring in the bays about Bergen in southern Norway. The little town of Stavanger canned thirty-two million herring in 1917, two fish in each box. The catch of fish is about five times as great per capita as in Great Britain. Fish and fish products make up more than a third of Norway's export, and Norwegian codfish, codfish oil, and herring are known in many lands.

FISHERIES OF JAPAN

On the coasts of northeastern Asia is a fishing region of great importance. Here again we have a cool climate and irregular coasts similar to those in the same latitudes in eastern North America and western Europe. The Japanese are credited with eating more fish than any other people in the world. Two reasons account for this. In addition to the almost entire absence of the meat animals in Japan, there is the abundance of fish in the waters surrounding the islands and thus tempting the people to go to sea. Yezo, the northernmost of the four large islands of Japan, is too cold for rice growing, much of it is too rough for any other kind of agriculture, so its people, like those of Norway and Newfoundland, have depended almost entirely upon the catch of cod, herring, and other fish of cool temperate latitudes.

Japanese fishermen scour the coasts of Asia, especially those of Korea, the Kurile Islands to the north, desolate Kamchatka, and Sakhalien, a barren and almost uninhabitable island on the Siberian coast near the mouth of the Amur River. Half of this island the Japanese were careful to secure by treaty at the close of the Russo-Japanese War. Thus they guaranteed their fisheries, which furnished not only the chief animal food of fifty million people but also an important fertilizer, made of dried fish refuse and non-edible fish, and extensively used in the well-tilled garden-like farms of Japan. The thrifty and enterprising Japanese have of recent years begun to sell in the United States and in Europe attractively packed cans of crab meat, the flesh of a giant crustacean caught in the deep cold waters along the bleak shores of the faraway Kamchatka. During the war the exports of this commodity as well as canned salmon and other fish have increased greatly to help fill the meat shortage of the Allied countries.

THE FISHERIES OF THE OPEN SEA

Mackerel, unlike the cod, are surface swimmers, and are caught in nets swinging in the open sea. They are caught off the coasts of Europe and the United States, and immediately salted.

Another surface fish caught by nets as he swims near the surface is the menhaden, taken chiefly off the northeast coast of the United States within a hundred miles of New York. This fish has not been considered good for food until the recent educational campaign started by the United States Fish Commission. For many years a valuable oil has been extracted from its flesh and the dry remains brought high prices as a fertilizer rich in nitrogen and phosphorus. Floating fertilizer factories have for years steamed up and down the coast manufacturing this oil and fertilizer from the menhaden brought in by the fishing tugs that operate the nets.

The sardine, deriving its name from Sardinia, is a small pilchard, commonly dried, packed in oil, and sold in sealed cans. It is exported largely from France, the sardines of the Mediterranean being packed for shipment at Beauclaire on the Rhone, while Bordeaux and Lemans are two great centers of the industry on the Bay of Biscay. Sardines are also caught along the coasts of Spain, Portugal, and Italy, but a kind of sprat is often sold under the name of sardine. Sardine fisheries reach their greatest importance in Brittany, the northwest province of France, where the failure of the sardines to appear in the neighboring seas for a season has caused as many as eighty thousand persons to be in a starving condition, dependent for their lives upon the donations of the French Government. Along the coast of New England, especially in Maine, there has long been an important industry in the so-called "American sardines" which are really small herring, a fish closely allied to the pilchard. "Genuine sardines packed in olive oil" have for years been sold from certain thrifty towns along the eastern coast of North America, but since the passage of a pure food law the same plants now modestly sell cans whose labels state that they contain small herring packed in cottonseed oil. The nutritive value is about the same. Many kinds of fish can be packed in many kinds of oil, depending upon the price of the oil. Although the

Maine "sardine" canners have to dry their herring with artificial heat while the Frenchmen do it in the sun, the American product is much cheaper, and is shipped to all parts of the United States and South America.

Whaling is of all fishing enterprises the least connected with home ports of ships or with particular shores. It is an industry

FIG. 106.—A whale about to be rendered—our greatest meat animal. (Courtesy Canadian Bureau of Fisheries.)

that is just emerging from a half-century of eclipse. It was of very great importance in the first half of the nineteenth century, when whale oil supplied the family lamp. In those days New Bedford and Nantucket in Massachusetts, and New London, Connecticut, were the great outfitting centers of an industry that was prosecuted in all oceans of the world so persistently that the whale was nearly exterminated by 1860, when the discovery of petroleum lessened the demand for whale oil. Some whale fishing is still carried on, but the whalers of Nantucket have changed their base to San Francisco, so that they may be nearer the home of the whale, now chiefly caught in the Arctic Ocean near Bering Straits. There is still some fishing in tropic waters for the sperm whale, which has in his head a white mass called spermaceti, useful in the preparation of sperm candles and certain ointments. Dundee, Scotland, is, besides San Francisco, the only other important whaling port. The whaling industry is about to experience a revival. The future peace of the poor whale seems to be imperiled for all time. It was cloudy, indeed, in 1860 when petroleum took his place in the family lamp and gave him a respite. The discovery of the art of manufacturing steel substitutes for whale-bone still further emancipated him from the harpoon of man, but from now on he must lead a pursued life. Alas for the great leviathan! his peace while man survives is gone! we have discovered during the war that he is good to eat.

The issue of the *Pacific Fisherman* for September, 1917, contains the following paragraph, under the title "Whale Meat in San Francisco":

> The experimental placing of whale meat on the menu of the Palace Hotel one day in July served to bring it before the public sufficiently for some of the hotels, restaurants, and markets to take it up. Whale meat in August was selling in the California market, San Francisco, at 22½ cents a pound. This seems to be too high a price for popularity, although it is cheaper than beef, when the absence of waste is considered. The Palace and St. Francis hotels and the St. Germain restaurant in San Francisco now have whale meat daily on their menu.

The inspector of the Bureau of Animal Industries at Seattle, Washington, made a report telling of the successful use of whale meat and the experience of his own family with it.

> A steak prepared at home was partaken of by three members of my family, having no previous knowledge of the character of the meat, as beefsteak.*

It has already reached Boston and been sold and utilized acceptably. If we do not exterminate the whale with too persistent fishing, we have here an important source of meat. For several years past it has been estimated that fifteen to twenty thousand of these huge carcasses have been turned adrift in the Antarctic Ocean to feed the gulls and other scavengers of the sea. They might just as well come, canned or frozen, to augment our failing meat supply, and doubtless they will do so.

* Commerce Report, 1917.

SHORE AND RIVER FISHERIES

Many rivers and bays have a fishing value out of proportion to their area because of the sea fish that annually enter them for spawning and become the rich harvest of the fishermen.

The sturgeon, the largest of these visitors, is a fish that grows as much as ten feet long and is also found to some extent in the American Great Lakes * and the rivers of the Atlantic, especially the Delaware, but in greatest quantity in the Caspian Sea, whence years ago it ran up the Volga River in such quantities that at times they crowded each other out of the water in narrow places. The sturgeon is caught chiefly for its eggs, which are sold as Russian caviar, and the industry has been prosecuted so vigorously that this valuable fish is about to become extinct. The industry has practically disappeared from the Atlantic rivers of America and has greatly diminished throughout the world; but the rising price of caviar makes sturgeon containing eggs more and more valuable, and the quest more fierce—another example of the wanton waste perpetuated by men, and another example of the need of social control in industry.

The salmon, of which there are several species, is easily the (economic) king of all river running fish. It is said to ascend only streams having their sources in glacial lakes in which the females deposit their eggs. Salmon are found to some extent in northwestern Europe, New England, and Canada; but the rivers of the north Pacific, between San Francisco and Japan, are the chief sources of world supply. In Alaska they have for an unknown period been almost the only food supply of the natives, who at the time of the annual run put away the year's supply of smoked salmon in little houses on high poles, out of the reach of wolves and dogs.

For many years salmon canning has been an important industry on the Pacific Coast. It was first established in California, Oregon, and Washington, then in British Columbia, and finally in Alaska, where in almost every river, especially the great Yukon, salmon are, or were, exceedingly abundant. They run in great numbers, and a common method of catching them for

* This marine fish, like the seals of the Caspian Sea, seems to have survived from the time when these inland bodies of water were connected with the ocean.

the cannery is by the fish wheel, a large water wheel revolving in the swift current and having wire baskets which catch the salmon and throw them into a boat below the wheel. Large salmon canneries have been built at the mouths of various streams in Alaska along coasts so rocky and cold as to be undesirable for human habitation throughout most of the year. As the season for the salmon running approaches, sailing vessels loaded with empty cans and carrying many workmen, usually Chinese, leave San Francisco, Portland, or Seattle for the cannery. In a few weeks hundreds of thousands of pounds of salmon are canned, loaded into the sailing vessels, and brought back to the home port for distribution throughout the United States, the United Kingdom, Australasia, and to a lesser extent to many other countries. Salmon is the chief fish export of the United States (1911, forty million pounds, \$4,000,000; 1918, one hundred and ten million pounds, \$16,000,000). The Japanese also have a salmon canning industry in the colder part of their empire.

The shad, probably the most highly prized of American food fish, ascends each spring the rivers from Florida to the St. Lawrence. North of the Delaware this fish is unimportant and the estuaries of the Chesapeake furnish about one-half of the total catch. The herring also ascends these same rivers in such numbers that at times their scaly backs make the surface of the water shine almost like a mirror. These herring are easily caught, for they crowd the small streams in such numbers that they squeeze into the water wheels that lift water from an arm of the Chesapeake into the Chesapeake and Delaware Canal, where, unable to escape, they perish in the fresh water by the thousands, their decaying bodies becoming a nuisance. These fish help to show the great value of the sea as a part of man's support and also help to explain the great excellence of the region of the Chesapeake Bay in eastern North America as a place for the easy support of humanity. For a half-century past the herring has been sold in this region in the spring for less than one cent each, often \$4 or \$5 a thousand. Since one of these fish is quite as much as the average person needs for a meal, and since corn meal in that region has in most of this period cost not over two cents a pound, it is plain that the cost of living has been exceedingly low. For a pound of corn meal and a herring contain over two thousand calories, and a man only needs three thousand per day.

SHELLFISH

A number of marine animals, such as the oyster, the clam, the lobster, and the sponge live in shallow waters where they can easily be caught. The oyster, of which the United States supplies from five-sixths to nine-tenths of the world's catch, is the most valuable fish product in America, furnishing about one-third of the total value of all fisheries of the United States. This delicious shellfish lives on the sandy or gravelly bottoms of shallow bays and estuaries. It is found to some extent in the English Channel and the Bay of Biscay and on the Pacific Coast of the United States; but the numerous bays between Cape Cod and the coast of Mexico, with their large expanses of shallow water of suitable temperature, seem to be the best place in the world for oysters. The oysters of best repute are produced between Cape Cod and Cape Hatteras. The Chesapeake Bay, an old river valley into which the sea has flowed, is the most important district of all for oysters, while Long Island Sound is second. The Middle Atlantic States supply two-thirds of the total American product.

The oyster, after being hatched from the egg, swims around for a time and then attaches itself to some firm substance, such as gravel, an old oyster shell, or sunken wood. For one, two, or three years he eats whatever the tide brings him, and is then scooped up with long-handled tongs in the hands of an oysterman or by a steam-drawn dredge. During the seven or eight months of the season oysters are shipped in barrels and sacks to many parts of the United States and even to Europe, while at Baltimore there is a large canning industry, the product of which goes to small interior towns and to foreign countries. The natural supply having been found inadequate, oyster culture has been established. Beds of young oysters are sometimes planted, that is, put down to grow large; another method is to lay old oyster shells and the bushy tops of trees upon the bottoms of the bays so that there may be something to which the floating spawn may attach themselves and grow. One great trouble with oyster planting is the ease with which a thief may carry off the product at night or during a fog, but the possibilities of the extension of the oyster industry in Long Island Sound and in the Delaware, the Chesapeake, and the other bays along the eastern and southern coasts of the United States are very great and tempting to enterprise. Oyster culture is another example of an industry that depends upon good government and perishes with anarchy, —even a very short outbreak of anarchy. This is well shown by the better yields in the Virginia section than in the Maryland section of the Chesapeake Bay. In Maryland the political parties are evenly divided and the fishermen's vote is a factor capable of carrying elections, so that at times the state administration has hesitated to use the firm hand necessary to hold the oystermen in check. The oystermen have sometimes taken advantage of the weakness of the government to arm themselves, man their boats, and drive away the oyster patrol, after which these temporary pirates have proceeded for days at a time to load their boats with planted oysters whose owners dare not protect their property. Such outbreaks, however, must be regarded as temporary. A good piece of oyster bottom is too valuable a resource to be permanently wasted by a people more advanced than the Turk. The industry is long past the experimental stage. The United States Fish Commission reported in 1914 that forty-six per cent. of the quantity and sixty-five per cent. of the value of the American oysters were from planted grounds. The output of many states depended largely and some of them entirely upon oyster culture. In the New England States ninety-three per cent. were derived from private beds, on the Pacific Coast, seventy-three per cent.; in New York, eighty-six per cent.; in the Gulf States about fifty per cent. It is only in the Middle Atlantic and South Atlantic States, where oysters are naturally abundant, that the public beds are more productive than the private beds. If the natural oyster lands along the American coast were fully utilized, the production could be easily several times that of the present.

Clams and lobsters yield a greater cash return to the American fisherman than does the codfish. The clam is a cousin of the oyster but possesses power of locomotion and is caught by being dug out of the mud. It is especially important along the New England and Middle Atlantic coast.

The much-prized lobster, a great crayfish and cousin to the crab, lives along the seashore and, from the mouth of the St. Lawrence River to the mouth of the Delaware, is caught in a baited box trap called a lobster pot. The high esteem of the lobster causes it to bring about four times as much per pound as the codfish. The consequent keen prosecution of lobster fishing has caused the passage of severe laws to prevent its extermination along the coasts of the United States. These laws are, however, very difficult to enforce, and the fifty per cent. decline in the lobster industry of New Brunswick between 1897 and 1916 is a strong indication of the need of greater wisdom in the conduct of such an important food industry. Most of the present supply comes from Canada; the Newfoundland export of canned lobster is very important. Canada uses but eight per cent. of her lobster output; thirty per cent. of it goes to the United States, leaving sixty-two per cent. for overseas shipment.

THE IMPORTANCE OF FISH TO THE ATLANTIC PLAIN OF THE UNITED STATES

In the central part of the Atlantic Plain of the United States, unusual fish resources combine with many other resources to make the peninsula between the Chesapeake Bay and the Atlantic Ocean one of the most favored places in the United States or the world for the easy support of the human race under physical conditions that place no serious handicap on man. The climate is wholesome and invigorating; the varied soil, abundant rainfall, and satisfactory temperature permit the commercial production of an unusual variety of grains, fruits, and vegetables, while fish products reach their maximum of abundance. The bay with its many arms is the greatest place in the world for oysters, shad, and herring. Many minor fish are caught there, while the many breaks in the coastline permit fishing also in the open sea. Herring are so abundant that the laboring man has been able in the spring time to buy a thousand for from $2 to $5, and with a sack of salt and a barrel they can be preserved for the entire year. As herring and corn bread make a sustaining meal for a working man (materials costing two cents), living is exceedingly cheap. The shores of these waters are in many places marshy, making excellent feeding grounds for wild ducks as they pass in fall and spring between the wilds of Canada and the swamps of the tropics, so that along the Chesapeake in addition to its resources of land, bay, and sea, hunting is still an important source of support of the population because they can get ducks that, like the fish, are the emigrating product of another locality.

This peninsula differs but little from the tidewater region on the west of the bay and its advantages are in the main typical of the whole Atlantic coastal plain that extends from the fall line on the Atlantic rivers, to the ocean, and includes Long Island and Florida. When one considers that the average rural Negro of eastern and southern United States has a garden, can pick wild berries, go hunting and fishing, and is largely contented with corn bread and salt herring, it is plain how he is able to live without working much of the time, even during the stress of the Great War.

FISH IN COMMERCE

Foreign commerce in fish is not important in the countries having the greatest industry. The United States and Great Britain consume about as many fish as they catch, Canadian fish coming into the United States to replace the salmon and sardines exported. Before the war the United Kingdom exported herring to Germany and Russia and imported American salmon and French sardines in their stead. Labrador, Newfoundland, Nova Scotia, and Norway, lands of small population, export the greater part of the fish they catch, chiefly cod, with herring second in importance. The great fish-importing countries are Italy, Spain, and Portugal, where the Catholic Church lays certain restrictions upon the use of meat and the poverty of the masses of the people limits them to a food that is cheaper than meat. The Spanish-American countries and Brazil are also important fish importers for the same reasons that exist in south Europe and the added one that in such hot climates fresh meat and fresh fish spoil very quickly while the dried cod, resembling a piece of wood in hardness, appearance, and durability, keeps indefinitely even in hot climates. The dried cod or stock fish is, in combination with corn bread or corn meal mush, a staple article of diet alike in Venice and Valparaiso, Lisbon and Yucatan.

THE FUTURE SUPPLY OF FISH

Promises to be not unlike the future supply of potatoes or milk, almost as large as we have a mind to make it. It is probably true that we now have the possibility of increasing our fish supply five or ten, or fifteen, perhaps thirty or forty fold, without making any great increase in the part of a man's daily wage needed to buy a given amount of nourishment in the form of fish. This increased supply depends upon four factors.

1. The application of COMMON SENSE in the question of what is food, and eating all the fish that are good for food. In this connection the present campaign by the United States Fish Commission and the arrival of the shark and the whale upon our tables are examples of a method that may easily double our fish-supply.* Predictions of so many more fish rest upon the great basic facts that the sea is vast and the species of fish therein are many. The United States Food Administration says:

> There have been cases where a ship has sailed for over twenty-five miles through waters the surface of which was literally alive with fish, *of one variety only*. And when you stop to think that this was but one small group of fish among all those which roam and school in both surface and bottom areas, it is easy to understand how impossible it is that commercial fishing should dangerously deplete our total supplies of edible salt-water fish.†

> " We catch lobsters wastefully and neglect the chief enemy of the lobsters—the Squalus, an excellent fish for the table, but not as yet used for food because its ugliness of mien is so depressing to the finer sensibilities of the deep-sea fisherman." ‡

Eating the lobster's enemy and then eating the lobster sounds like good business.

* The Japanese are putting tough and muscular fish like the skate through the meat chopper, after which it is canned or made into sausages or loaves called " Kamaboka "

† *Literary Digest*, June 15, 1918.

‡ Letter of R. T. Morris:

" We shall change all that when we are forced to drop sentiment in favor of nitrogen. Aside from great quantities of unused fish, the bottoms of millions of acres of shallow waters are studded with albuminous jewels called clams. There are parts of the northern coast from Maine to Labrador where these are so abundant that they actually constitute a considerable proportion of the floor of the bays, and yet they are for the most part unused."—R. T. MORRIS, *Surgeon's Philosophy*, p. 239.

Man has only begun to draw upon this self-replenishing mine.

2. New Methods. We are just learning how to catch fish. It is indeed surprising to think that man only began to catch sardines on the coast of Spain in 1862, and that for forty years they were taken in little rowboats manned by two or three men. In 1900 there came a revolution through the introduction of a *sailing vessel* of forty to sixty tons with twenty-five men. In 1915 they introduced the first steam vessels, which could go eighty or one hundred miles from shore, and produced a great increase in the catch. These facts may almost be said to be typical of the fishing industry, and when one remembers how long Spain and Portugal have been hungry they become almost difficult of belief. Improvements have recently been made in the operation of great nets hundreds of yards long between steamers that scour the open sea.

3. The Fish of Warm Climates and Distant Places. The greatest revolution of all lies in the ice chest—artificial refrigeration. The people of the West Indies have eaten the dried fish of Labrador and Norway largely because Labrador and Norway had a cool climate in which fish would not spoil the same afternoon it was caught. Largely for this reason the teeming fish of tropic waters have busily eaten each other up almost undisturbed by man. Now the steam-driven fishing vessel with its engines and ammonia pipes can dump the fish into an ice room, or into freezing tanks and imbed them in a mass of solid ice in a few hours, to be kept a week, or a month, or a year, and sold in this continent or the next, as market conditions may dictate. There is no reason now why fish that sport around the shores of Florida, or Hawaii, or far Fiji, may not be imbedded in ice blocks, loaded into holds of European steamers at Havana, Honolulu, or any South Sea Island bight, for consumption three months later in Belgium, Italy, or Bulgaria, or if the markets do not require them in fresh condition they can with the aid of ice be carried from the reefs where they are caught to some tropic canning factory for manufacture into forms desirable anywhere. Thus a new canning factory is being erected in Hawaii, to be supplied in part by steam vessels that go off for a two-weeks' cruise, visiting uninhabited islets several hundred

miles to the south. Experiments by the United States Fish Commission in the drying of squids, thus far used almost entirely for bait, but really very nutritious, shows yet a third way of bringing fish to the distant market. These three methods, artificial drying, canning, and refrigeration, really throw open to the world market the entire fishing resources of the tropic, the greatest of the zones, with its unnumbered islands, shores, and bays, and its almost inconceivable quantities of fish. In Hawaii alone there are one hundred and five varieties of edible fish; and as an example of tropic abundance the following statements by the American consul, Mr. Chapman, at Mazatlan, on the west coast of Mexico in 1917, are probably typical of a thousand such localities:

Fish are so plentiful in these waters that it is a common sight to see men catching them with loose lines in the surf across the street 200 feet from the consulate windows, or to see sardines flipping out of the water by the hundreds in their efforts to escape the larger fish that prey upon them; sea-birds gather at the scene of the disturbance, and in a few minutes each morning catch as many of the little fish as they want.

There are some 40 or 50 shrimp fisheries along the Pacific shore line within this consular district, with the trading center of the industry at Mazatlan. Most of the shrimp are collected during the rainy season—from July to November—in numerous shallow lagoons along the seashore. They are brought in from the adjacent waters of the Pacific Ocean by the currents. It often happens that there are large areas of the sea literally filled with them.*

In the consideration of ultimate fish supply we should never lose sight of the Pacific, vast, fifty million square miles of it, with such a multitude of islands that they are still unnumbered, uncharted, and to some extent unknown. As a measure of the amount of fish that may be produced from parts of this area the Guano Islands off the coast of Chile are suggestive. A little group of bare rocks, in a rainless sea, called the Chincha Islands were for a long time inhabited by colonies of sea-birds that roosted and nested on the rocks and lived on the fish in the surrounding waters. As there was no rain, the droppings and remains of the birds accumulated to the extent of many millions

* Commerce Report, June 23 and August 24, 1917.

of tons of dry matter, which actually sold as Guano during the last half of the nineteenth century for $600,000,000 in gold. If colonies of birds can continuously catch such quantities of fish around two bare little rocks, what may we expect from the world ocean if we search it systematically and scientifically?

As an interesting example of one faraway unused but usable resource, the American consul at Punta Arenas on the Straits of Magellan calls attention to the opening for a cannery to use "the centolla, an eight-footed crustacean resembling the crab. Its flesh, however, is much more delicate and of finer flavor than that of either the crab or the lobster."

There is good reason to believe that the herring resources of the Alaskan coasts are quite the equal of those of the similar coasts of Norway, but we have not yet needed them or made any serious start to use them.

4. FISH CULTURE. We have yet the last resource, one which, indeed, in some places man has already tried with great success:—namely, the artificial raising of fish just as we artificially raise chickens.

Many centuries ago the Chinese and Japanese found out that fish growing in ponds and rivers is one of the easiest ways of getting meat in a densely peopled country. Oyster culture was an art among the Japanese a century before the declaration of American independence. The German people are also systematic fish growers, devoting themselves chiefly to the carp, a fish that can be fed in a pond like poultry in a yard. There are many fish growers' associations in the empire and the total area of fish ponds approaches two hundred thousand acres. In Saxony one-half of one per cent. of the area is covered with fish ponds. (Compare with the three per cent. under cultivation in Cuba, or the two and one-half per cent. of United States area in wheat in 1917.) The fish are fed upon corn, vetches, potatoes, malt, snails, slaughter-house refuse, and many other foods. The average yield is about one hundred pounds of fish per acre per year and much higher yields are sometimes made. But this is the intensive and expensive way. It is cheaper to help the fish take care of themselves.

The threatened extermination of many valuable species of fish has led to systematic study of fish by the government of the

United States and many other progressive countries. The United States Fish Commission began by investigating the life history of fish so that it might recommend to Congress the methods of restocking our almost empty streams. These investigations soon brought us face to face with the fact that the best way to restore fish was to take the mature eggs from the fish, artificially hatch them, then care for the young during the weakest period of their infancy when they are such an easy prey to many marauders, including their own parents. The United States Fish Commission now hatches billions of fish eggs each year and releases the fry in streams and lakes to replenish the supply. There are several salmon hatcheries in Oregon and Washington, shad hatcheries in the Eastern rivers, lobster hatcheries upon the New England coast; and the Great Lakes fisheries receive more aid in this respect than any other locality. The governments of Canada, Norway, Switzerland, and Germany are also aiding the industry by the same means.

The salmon, although a sea fish, has very peculiar habits which in some cases enable private individuals to hatch them for private profit. For many years there was a hot dispute among the salmon fishers as to whether the young salmon did or did not return exclusively to the stream where he was born. Finally the salmon answered it, for it was found that small metal tags placed in the tail of an eight-inch fry as he went out to sea in autumn remained until he returned several years later full grown to the stream of his nativity to breed. Furthermore, he returned to no other stream. Thus two or three fishing companies operating at the mouth of the river can safely raise young salmon, turn them out to pasture in their unknown feeding grounds of the great deep, sure that if they return to land at all they will come back to be caught by the men who turned them loose.

Thus far the artificial hatching of fish has been chiefly limited to river fish and some of the more easily caught river-running sea fish like the shad and the salmon. Scientists know how to reproduce the fish of the open sea, such as the mackerel or that greatest of all food fish, the herring. Thus far there seems to be no decrease of the supply which would indicate the need of artificial reproduction of these species. If the need arises, however, artificial reproduction will be resorted to. We do not yet know to how many other species these methods may be applied, but probably to nearly all. It is quite conceivable that a century or two hence there may be hundreds or even thousands of combination fish canneries, fish dryers, and fish hatcheries, shaded by the coconut palm trees on the coral atolls of the Pacific and Indian oceans, the hatcheries supported by the same international organization that polices the world sea and keeps the world peace. There are interesting elements of completeness about this picture. The coconuts might furnish the oil for fish canning. The fish before being canned would give up their eggs which man would hatch much better than nature would. The lagoons within the coral islands might serve sometimes as harbors for fishing vessels, and sometimes as storage-ponds for the young fry from the hatchery.*

Still another element of completeness is furnished by the very important fact that agriculture must *intensify* by increase of cost. This fish culture is like the United States range cattle business of 1880—man turns out the young, and *nature* produces the crop.

The impending meat scarcity previously described is not so alarming as at first appears, if the fish supply is capable of indefinite expansion with small increase of cost. The Japanese have shown us that a nation can live on fish instead of meat with no impairment of vigor.

I have yet to mention what is possibly the most promising ultimate source of sea food, perhaps an almost unlimited supply—the minute forms of life that we now entirely disregard. The vast mass of sea life is called plankton, a blanket name for hosts of species of small plants and animals, often microscopic and living in what we call clear sea water. Dr. Robert T. Morris claims that plankton also is edible.

I am not sure whether the plankton food which I wrote about only half seriously would be used as soup, vegetable, or meat. As a matter of fact it might be dried and used in various ways, but different waters at various times would furnish different groups of minute algae and

* I must add that this is not orthodox. The scientists of the Bureau of Fisheries point out that the tropic fish are very hard to catch. But what would they have said about the sardines of the open seas in 1850?

infusoria and small members of higher forms. In the north I have seen the surface of the sea so full of pteropods that they changed the color of the surface of the sea. Everything from whales to codfish were feeding upon them and I tried them prepared in two or three different ways and found them first rate.—Robert T. Morris, letter of March 27, 1919.

A thousand years from now many of the neglected mollusks and still lower forms of animal life in the sea will be served in the form of delicious tempting repast upon our tables . . . The relative value between sea foods, which cost man little or nothing to raise, and land meat which costs man a great deal to raise, show no considerable differences excepting in the large fat content of land meat.—Robert T. Morris in "A Surgeon's Philosophy."

Alfred G. Mayor, Marine Laboratory of the Carnegie Institution of Washington, one of the leading American Marine Zoologists, says in a letter of April 10, 1919:

There is of course an immense amount of good food in the ocean which we never think of using. Practically all of the minute crustacea are probably edible and we need only to strain them out of the water in order to obtain them. Most of these forms, however, are very minute—less than ⅛ of an inch long. Pteropods, for example, rarely are ¼ of an inch in length and are translucent creatures with thin shells of parchment-like consistency. See "Depths of the Ocean" by Sir John Murray and J. Hjort, pp. 37, 309, 358-366, 372-377, 772-776.

CHAPTER XVI

VEGETABLES, PULSE, AND SMALL FRUITS

VEGETABLES AND GARDEN PRODUCTS

THE people of America have just discovered garden vegetables. For a few decades they have had so much bread, butter, and meat, lard, fried potatoes, sugar, and coffee that they scarcely felt the need of vegetables. But for years the price of bread and meat, especially meat, has been rising. Then came the war, bringing a shortage of breadstuffs, meat, and sugar, and also of that backbone of American cookery, fat for frying. The Americans turned to vegetables, as other peoples for thousands of years have done. In addition to rising prices and shortage of food staples, there has been a third reason why America may be said to have just discovered vegetables. Experts on nutrition have found in them great values hitherto unknown. Vegetables, as well as milk, contain the mysterious and necessary vitamines, especially the water soluble B, but also in some cases the fat soluble A as well.

The use of vegetables depends largely on the relative cost of other staples. Where men are scarce and land is plentiful, pork, beef, mutton, potatoes, and bread of wheat or corn abound. In the midst of such plenty, man does not care much for vegetables. Where bread is high and meat is scarce, almost to the vanishing point, man eats garden vegetables, which, unlike meat, can be produced in a limited space. It is thus plain why the Japanese and Chinese use more vegetables than do the people of Europe, and similarly why the people of Europe use more vegetables than do the people of the United States and Canada. In the future, America will resemble Europe in this respect, for both economic and intellectual reasons. The land situation indicates that Americans should eat more vegetables; the Food Administration recommends the changes; and the dietitians agree. The first and last of these incentives will be permanent.

Nearly every farm has a vegetable garden and some plants are cultivated and eaten by almost every people. Owing to the large yield of a small plot of ground under intensive care, such gardens are very common in the villages and small towns of both Europe and America. During the war they have increased by hundreds of thousands in every trading land because of the scarcity of staples, the cessation of trade, and the necessity of making home supplies go as far as possible. They have very greatly added to the food supply of many countries, have given many city people an agricultural education, improved the quality of the food supply, afforded some needed exercise, and yielded a surprising cash income. School gardens have long since demonstrated that at pre-war city retail prices a child can on a few square feet produce about ten cents' worth of vegetables per square foot per season by intensive production.

In the city of Gothenburg, Sweden, with a population of 180,000, there were 5,000 war gardens on city property alone in the season of 1918. The figures of war-garden yield help to explain the difference between the cost of living in the city and in the country or village, where a family with a garden and poultry can live on a surprisingly small cash income. Through the food and income from this source, the retired farmer of America is able to live comfortably without regular employment in a country town on a cash income that would make him a starveling or an artisan in a city.

In the European and American gardens are to be found many species of plants, representing in their origin or development every continent and almost every country in the world. Many of them have been cultivated until they bear little resemblance to their original form. Among our vegetables is found in edible form every part of a plant—roots, leaf stalks, leaves, blossoms, pods, seeds, stems, both above ground and below ground.

THE NITROGEN-PRODUCING LEGUMES OR PULSE

The most important of all the plants which we commonly call vegetables is the group of legumes, comprising the many kinds of peas and beans called pulse in the Old World. These differ from all other vegetables in the large amount of protein or nitrogenous food, meat substitute, which they contain. (See table of food analysis.) Nitrogen, as food for man, beast, or plant, is expensive to buy, yet over three-fourths of the air is nitrogen, which, owing to its chemical inertness, is hard to obtain in available forms. Hence its high cost in all its forms, whether in the cow's food as cottonseed meal, wheat bran, and peanut cake; or in man's food as meat, eggs, milk, and cheese; or in the plant's food, as the nitrogenous fertilizers. A peculiar faculty of the legumes makes them one of the great factors in the support of life upon this earth. They have the ability, great for the present, and greater for the future, of producing upon their roots nodules which are colonies of the microscopic plants called bacteria. These particular organisms catch nitrogen freely from the air and thus enable the legumes upon which they live to render to mankind a service of incalculable value by giving nitrogenous food for man, beast, or plant. By the aid of these bacteria the legumes can grow in poor soil and leave it the richer in nitrogen because of the nodules on the roots that remain in the ground.

FIG 107.—Peanut plant, showing fruit, nodules of nitrogen-gathering bacteria, and some of the leaves so much prized by farm animals. (U. S. Dept. Agr.)

What really happens is that the bacteria on the roots of clover catch nitrogen from the air, the clover gets it from the bacteria, the cow gets it from the clover and turns it into milk and meat, the child drinks the milk and grows. In addition, the legume enriches the ground for non-leguminous plants like wheat, which may follow it, so the nodules are partly responsible for our bread. Furthermore, experiment has shown that in mixed stands of legumes and non-leguminous plants the non-leguminous are richer in nitrogen because of the free gifts they get from their immediate plant neighbors, who seem to conduct a free-lunch counter beneath the earth. If planted in sterile soil without the inoculating germs to start bacterial growth, the legumes perish. In ordinary soils where they lack the germs they grow but poorly, but an inoculated plant becomes several times as large as its uninoculated and therefore poverty-stricken neighbor.

FIG. 108.—Top of a soy bean plant with an unusually large crop. (U. S. Dept. Agr.)

The pulse plants are represented chiefly by peas in northern climates and by beans in southern climates. They have been less used in the United States than in any other civilized country, because the people of the United States get their nitrogenous food in the expensive forms of meat, cheese, and milk, of which they use more per person than does any other large group of people.

In the United Kingdom, before the potato was introduced, pulse plants were more important than they now are, but there are several thousand acres of them grown each year and thousands of tons of peas and beans were regularly imported before the war; the peas chiefly from Canada, half of the beans from Egypt and Manchuria. During the war the British meat shortage has been reflected in the great increase of pulse imports.

IMPORTANCE OF PULSE TO POOR PEOPLES

The pulse plants are much more important to the inhabitants of the Mediterranean countries than to the richer peoples of northern Europe. The lower wages and the scantier resources of the Spaniards and Italians make it impossible for them to buy meat from abroad, as do the British, and the dense population, combined with the lack of grass, make it impossible to rear at home adequate numbers of meat animals. This animal shortage is very pronounced. Before the war, Italy had only about one-twentieth as many sheep as the United Kingdom and two-thirds as many cattle, and Spain, while it has as many sheep per million people as the United Kingdom, has not one-thirtieth as many cattle. But the poverty of the Spanish and Italian people causes them normally to export some of the little meat they have, whereas rich England, with more meat animals, is the heaviest meat importer in the world. To get their nitrogenous food, the Spaniards, Italians, and other peoples of the Mediterranean turn therefore to the cheaper forms of peas and beans. The gram or chick pea is said to be the leading article of diet in Spain, and is also greatly used by the peoples of Morocco, Algeria, and Tunis, whence it is carried by caravans into the desert in exchange for dates. The European supply of this, as of other staples of food, is insufficient. In 1908, Spain imported 10,000 tons from Mexico alone. England imports chick peas especially for making soup, while France before the war imported no less than 35,000 tons per year from northern India. During the war, despite the reduction of her agriculture, France has increased her crops of dried beans. Lentils, vetch, and lupine, other pod-bearing pulse plants somewhat like our peas and beans, are grown throughout all Mediterranean countries. From the Isle of Cyprus there is considerable export of the sugary pods of the carob tree, a legume sometimes called locust, which is said to have been the food of John the Baptist in the Wilderness. It is widely used as a substitute for oats for horses and is still eaten to some extent in Mediterranean lands.

As the people of the United States are able to buy even more meat than those of England, they use less pulse; and as the people of England, being richer than the peoples of the Mediterranean, use less pulse than their southern neighbors, so in their turn are the peoples of the Mediterranean richer than the hordes who occupy southeastern Asia. To the latter, accordingly, foods of the pulse family are a necessity, without which the people would perish. Rice, a substitute for bread and potatoes, is deficient in nitrogen; but peas and beans supply this need. In India, the chief among many legumes is the lablab pea, the product of a climbing vine, eaten by both man and beast.

In China and Japan the chief dependence is the soy bean, a nutritious legume with three times as much protein as wheat. This bean is as new in American dietary as the areoplane is in transportation, and promises to be as revolutionary in its field. The enthusiastic vegetarian healer of men, Dr. J. H. Kellogg, praises it as follows:

> Chemical analysis shows in its composition one-third protein, or more than is found in beef, and one-fifth its weight in fat. And so the soy serves the Chinaman for both beef and butter. Another point in favor of the soy bean is the fact that the protein which it contains is a complete protein. That is, it is capable of fully supplying the place of lean meat, milk or eggs. It is for this reason that Chinese and Japanese are able to prepare from the soy a very good substitute for milk. A very fine cheese is also made from the soy, which is in many respects superior to ordinary cheese.
>
> The fat or oil of the soy is of excellent flavor and is more easily digestible than animal fats. . . .
>
> A few months ago the interesting discovery was made that by cooking the bean under pressure it became remarkably tender and toothsome. A temperature of about 225 degrees F. is required and the cooking must be continued for four to six hours.

This student of American health is not giving us mere personal theory, for the soy bean has been an important article of diet in China for at least 5,000 years—perhaps for 50,000. The *Year Book* of the United States Department of Agriculture for 1917 (p. 106) says:

In Asiatic countries, especially China and Japan, the soy bean and the various food products made from it are so largely consumed that it is second only to rice in importance as a food crop. The soy bean is eaten to only a very small extent like other beans; but in China and Japan it is elaborated into a great variety of products, all having a high percentage of protein and making a well-balanced diet when eaten in connection with the staple food, rice. Some of these products are said to be eaten at every meal and by rich and poor alike. Of these numerous preparations, only one, "shoyu," or "soy sauce," has been introduced to any extent in other countries. It is quite possible that some of these products would appeal to the American taste and with proper exploitation become established on the American market.

Although the soy bean as an article of human food has attracted attention from time to time in the United States, thus far it has been used but little except as a special food for invalids. The beans contain only a trace of starch and are highly recommended as a food for persons requiring a diet of low starch content.

This report shows the fitness of the soy bean to join with rice in making a balanced diet, rice furnishing starch and the bean protein and fat—in other words, bread, butter, and meat. The *Year Book* continues its praise (pp. 108-10), as follows:

When properly roasted and prepared, the dried beans of any of the varieties make a good coffee substitute. Those fond of cereal beverages pronounce it equal to many of the preparations on the market.

In China the beans are soaked in water and roasted, the product being eaten after the manner of roasted peanuts. . . .

When soy beans are three-fourths or more grown, the seed makes a most palatable and nutritious green vegetable. As such it may be used as is the green pea or the lima bean. . . .

If the dried beans (yellow or yellowish green varieties) are soaked for a few hours, then finely crushed (as in a meat grinder) and boiled in three times the amount of water as of bean material for about 30 minutes, a milky emulsion is obtained which is very similar in appearance and properties to cow's milk. This liquid, separated out by means of a very fine sieve or through a cloth filter, is the soy-bean or "vegetable" milk used so extensively in China. . . .

This "vegetable milk" can be used successfully in numerous preparations, such as breads and cakes, in creaming vegetables, in milk chocolate, and in custards. If allowed to remain in a warm place the milk becomes sour, like animal milk, and in that form may be employed just as is sour milk or butter-milk. In Japan a concentrated or condensed milk is obtained by evaporating the soy-bean milk in a vacuum. This condensed vegetable milk, though not so light in color, resembles in nutritive value and keeping qualities condensed cow's milk. . . .

The addition of magnesium or calcium salts (about a 1% solution) to soy-bean milk when hot precipitates some of the proteid substances, forming a grayish white curd which settles out, leaving a yellowish watery liquid. This curd, after being drained and pressed, represents the tofu, or bean curd, which is so extensively eaten and forms the basis of numerous unfermented, smoked, and dried cheeses in China and Japan. . . .

Soy or shoyu sauce is a dark-brown liquid prepared from a mixture of cooked and ground soy beans, roasted and pulverized wheat (barley is sometimes used), salt, and water. This mass is inoculated with

Fig. 109.—Soy bean curds and cheeses in a Japanese factory. (U. S. Dept. Agr.)

a culture known as rice ferment and left in casks to ferment from six months to a year or sometimes longer.

In odor and taste this sauce suggests a good quality of meat extract, though perhaps more salty and a trifle more pungent. Soy sauce is largely consumed by the Chinese and Japanese, being used in cooking and as a relish or condiment to increase the flavor and palatability of the diet. This product may well serve as the basis of sauces of the Worcestershire type and as a flavor with many American vegetable dishes.

The manufacture of soy sauce is conducted on a large scale in China and Japan, and to some extent in India. The yearly production of Japan is said to amount to nearly 2,000,000 barrels. The brewing of this sauce has also become a well-established industry in Hawaii. Although there are no factories in the United States, considerable quantities of the sauce are imported annually, and it can be obtained at Chinese stores in most of our cities.

The United States Department of Agriculture reports satisfactory experiments in the making of bread in which white flour was mixed with one-third to one-half soy-bean flour, thus adding protein and making a loaf with the combined values of bread and meat.

If some one is inclined to say that too much space has been given to this lowly bean, let him remember that it is a great factor in the lives of as many people as are to be found in United States, Canada, Australia, Britain, France, and Italy. Furthermore it was hoary with age when Christopher Columbus set forth upon his adventure.

We should not overlook the use of soy oil as a butter substitute, as discussed in the last chapter. In addition to all these services, the soy bean in the Orient fills the place taken by our garden beans and, moreover, the plant is a field crop of great importance. For example, the Manchuria crop of 1910 was estimated at 1,500,000 tons, of which 1,127,000 tons were exported, an amount one-half as great as the United States wheat export for 1911. Korea exported $2,500,000 worth in 1910, nearly all to Japan. The growing of soy beans in the United States has increased rapidly, but the importation during the war has increased much more rapidly. Our soy-bean import of 2,000,000 pounds in 1914 increased to 5,000,000 in 1917; that of the cake from 3,000,000 to 11,000,000 and of oil from 16,000,000 to 162,000,000 pounds. In Manchuria and Korea the beans have been crushed between heavy rollers to extract the oil, and the resulting cake has for centuries been carried in junks to Japan to feed cattle or to be used as fertilizer by the Japanese garden farmers. Recent British experiments have shown it to be more economical stock food than linseed cake or meal, long the great staple of British stock feeding.

The suddenness with which this Oriental farm product sprang into importance is almost startling, and shows what a resource we have in commerce with our Mongolian brother when a reciprocal relation has been established. The trial shipments of beans to Europe in 1907 were followed by 100,000 tons in 1908, 245,000 tons in 1909, and in 1910, 800,000 tons to England alone. Although Japan does not grow enough beans for her own use, she exports many beans, for she serves chiefly as a gatherer and sorter for the products of North China, Korea, and Manchuria, whose great plain is the one important piece of undeveloped agricultural land in eastern Asia. The best bean lands there yield thirty bushels of seed to the acre.

The plant is easily grown and is at home in the whole of our cotton-belt, also in regions of low rainfall beyond it and in the corn-belt to the north of it. Eight thousand acres were grown in Vermont in 1918. It is making rapid advance in American agriculture. The meat shortage due to the war has brought it into prominence and has shown its great possibilities. It has been selling at prices regularly two or three times the cost of production under good conditions. In 1918 the price was even higher, so keen was the demand. Its use as a food for both man and beast may be expected greatly to increase. Experiments have shown it to be so superior to our favorite navy bean as food that it may in time largely replace this staple of New York agriculture and New England diet.

The food alarm of 1917 and the campaign for increased production showed greater results in the pulses than in any other important food crop save peanuts. Between 1916 and 1917 the bean acreage of Maine increased from 11,000 to 33,000 acres; that of Colorado from 38,000 to 190,000 acres; that of Michigan, from 470,000 to 690,000 acres; that of California, from 340,000 to 558,000 acres, and the crop was worth $60,000,000. The total American acreage in one year jumped from 1,100,000 to 1,830,000, with a crop sufficient to furnish some export and to break the market the ensuing spring.

The dried beans of America are grown in three regions: one in western New York, and one in central Michigan, in localities where the climate is a little too cool for corn, so that the bean is cultivated in its stead. The third, a region of great importance, is in southern California, where it is too dry for corn. It should be noted that the greatest increases in bean acreage were in regions outside the corn-belt, for both crops require horses, plows, and cultivators at the same time. There is no reasonable limit to the number of beans that might be produced if the demand for them should result in prices relatively higher for them than for some other staples. In large areas in the southern part of the United States, a crop of beans can be grown the same year on the same ground as corn. Beans can (if needed) be grown for export over large areas in the tropics where they are now grown only for home consumption. Thus Brazil, under the stimulus of war prices, exported 63,000 tons of beans, worth $7,000,000, during the first six months of 1917, although in all her history she had never exported beans before.

In the discussion of pulse we should never lose sight of the peanut, which we discussed in the chapter on Edible Fats, because of its fat content, but which has in addition to its forty-five per cent. of fat about thirty per cent. of protein, more than twice the amount in wheat flour. The peanut really is a legume and a bean despite its name. The use of this plant is increasing even more rapidly than the use of dried beans. The acreage in Texas jumped from 20,000 to 200,000 between 1916 and 1917, partly because of the price rise and partly because the cotton boll weevil had destroyed cotton crops. For a long time the peanut was merely an extra to be eaten at the circus and other unmannerly places, but it is rapidly advancing (as diet changes go) toward a place of importance in the American dietary. It appears on our tables in the form of salted peanuts, and ground into paste called peanut butter, which is increasing in favor as a meat substitute. The United States Department of Agriculture recommends that peanuts be mixed with white flour, one-third to one-half, to make bread. Dietary experts give them a high place, saying that they need only inorganic salts and fat soluble vitamines to make them a sustaining food. Its possibilities are enormous in the agriculture of the American South, where it is entirely at home in large areas of sandy soil of low fertility that will not grow grain or grass to good advantage. As with corn, there is no danger of overproduction. If the supply overreaches the direct demand, we have the ever-increasing demand of the pig, who loves to root up peanuts and pass their protein and fat on to us in other and better-known forms. One of these is the famous Smithfield ham, which derives part of its merit from the fact that the porkers finish the harvest of the Virginia peanut crop in their progress toward the ham sack. The fact that the value of the peanut crop rose from $12,000,000 in 1908 to $56,000,000 in 1916, suggests future value of billions, if the scarcity of animals makes it necessary for us to eat our protein from direct rather than indirect sources.

The qualities of the other vegetables are less impressive than those of the pulses. No non-leguminous vegetable can rival the pea and bean in nutritive content. Most of them are largely water; many of them containing more water than is to be found in milk, and some of them, such as the turnip and watermelon, are ninety-five per cent. moisture. Despite this poverty in calories, we could not get along without them and they promise to become much more valuable to us in a more rational future. It is through them that we get a number of mineral salts, without which we could not exist. They furnish acids, flavoring, tonics, stimulants, and regulators, and aid in digestion of other foods. They are great carriers of the indispensable vitamines and they furnish woody fiber, another element of the human diet to which science has recently given a high place, on the theory that the human animal ought to have food resembling that for which he was by nature intended. There is important evidence to prove that man originally ate fruits, nuts, and perhaps also meat. Certainly he was accustomed to much coarse vegetable fiber which our modern diet of bread, meat, dairy products, and sugar lacks, and which beets, turnips, parsnips, radishes, spinach, celery, lettuce, cabbage, and all other green vegetables contain. It is claimed by Dr. Irving Fisher, of Yale, that we need at least an ounce of this fiber per day.

Some Sicilians have lived for generations on corn-meal products, plus an abundance of green vegetables and oil. This diet of corn and greens closely resembles the horse's diet; it really consists of his grain and a little of his hay. The Chinese even more closely resemble the horse, in their practice of using alfalfa tips as a vegetable. Persons familiar with the dietary of working men in the Southern States of the United States have often observed the great importance these people attach to cabbages and spring "greens" from the fields, which are of value for their bulk, mineral salts, and vitamines, especially in connection with the Southern mainstay of corn bread and fat pork.

THE COMMERCE IN VEGETABLES

On account of the large bulk and perishable nature of fresh vegetables, they have been unimportant in commerce until the recent improvements in transportation made it possible to carry perishable stuff a long distance. Owing to the fact that statistics of domestic trade in America are hard to get, Europe gives us the best opportunity to see the magnitude of the present commerce in these products. In the United Kingdom alone the importation amounted to from $60,000,000 to $70,000,000 per year before the war. In addition to this there is a lively local trade between south and southwest England and the Channel Islands, and the colder parts of that country. The Channel Islands (in the English Channel, near the French coast) have a relatively mild climate, because surrounded by a comparatively warm ocean. Their crops, therefore, mature early and they are able to grow those usually found further south; these newer garden crops are offering severe competition to the islands' old specialty of dairying. Daily steamers now take large quantities of garden stuffs, grapes, small fruit, and flowers to the English cities. Other islands share this advantage, such as the Azores, Madeiras, and Canaries, where fertile but unfortunately small, hilly, and volcanic areas in a frostless climate right in the pathway of South African and South American steamers give market opportunity which is far better than their producing opportunity. The high prices of midwinter vegetables and fruits make these islands push every acre to an extreme limit of production for this exotic trade. Most of the vegetables imported into Britain come from the south of France, Spain, and Italy, at whose coasts English steamers stop. The whole region north of the Alps receives large quantities of these southern products. Especially favored are the shore plains facing the Mediterranean and protected from the north by mountains, such as the Spanish plains near Cadiz, Malaga, and Valencia, where irrigation and flood plains give opportunity for the most intensive garden-farming. France has a large traffic in early vegetables from her warm colony of Algeria, sheltered from the cold north winds by the waters of the Mediterranean. Egypt's sunny climate is of value on account of the 80,000 (1910) tons of early onions she exports between March and May to Liverpool, London, Hull, Hamburg, Trieste, and even the United States.

RESEMBLANCE OF FLOWER AND VEGETABLE INDUSTRY

Before the war, the French had a flower industry so closely akin to vegetable growing in its economic and climatic aspects that it merits mention here. Every night during the winter months the "Cut Flower Limited Express" picked up ten car-loads of flowers along the Mediterranean coast between Nice and Toulon for delivery in car-loads to Paris, Frankfort-on-the-Main, Munich, Berlin, Vienna, St. Petersburg, London, and Manchester, via Calais. This industry began about 1880 and had made such progress that before the war a single commune (Hyères) had in its sheltered plain between the mountains and the Mediterranean 3,000 irrigated acres on which nearly 6,000 persons were busy raising violets to sell between November and March.

The war has, of course, greatly disturbed all this vegetable industry, chiefly through the congestion of the railroads of France and Spain and the shortage of ships. As a result, England has greatly increased her garden acreage each year of the war. Disturbances in this trade wrought interesting changes in Dutch agriculture. The acreage of grain showed a slight decline, but there was a high increase in the production of beets for cattle and potatoes for man. The acreage of peas and beans was increased nearly fifty per cent., but there was a more than compensating decline in the amount of land devoted to seeds for export, such as mustard, poppy, and canary seed. On the whole, export movements were curtailed and intensive food crops were increased in all western European countries.

THE AMERICAN TRADE IN VEGETABLES

In the United States the foreign trade in vegetables and garden products is no index of their importance. Trade between different states in Europe is foreign, but similar trade between the states of America is domestic and hence not covered by statistics.

Fifty years ago each town and city depended upon its immediate locality for vegetables, and there is still a large area near almost every city where farmers grow fields of peas, beans, cabbages, and other garden crops to sell. The vegetables from these market gardens are usually consumed in the nearby market in the season of ripening, but months before the local supply is ready similar products are sold in the city market. The best are produced in nearby hot-houses, but the great bulk is brought by the refrigerator car, express freight, and the coasting steamer, which make possible the purchase of almost any vegetable any week in the year in all the large American cities. In emancipating the city from dependence on local fields, these transportation facilities have caused the development of an enormous trucking industry in rather concentrated areas throughout the whole length of the Atlantic Plain, from the eastern end of Long Island to the tip of Florida, and also in scattered localities from Alabama to Texas. So important has this traffic become that sometimes a passenger train full of millionaires bound for Florida has to take a siding while an express freight loaded with cabbage, lettuce, and tomatoes rushes north.

VEGETABLE PRODUCTION ON THE ATLANTIC PLAIN

The Atlantic Plain is a nearly level area lying between the Atlantic Ocean and the first stratum of hard rock that limits the sands and clays of the plain. This dividing layer of rock extends in a nearly straight line from New York southwestward through the cities of Trenton, Philadelphia, Baltimore, Washington, Richmond, Raleigh, North Carolina, and Columbia, South Carolina. This plain, largely composed of sandy soil, is one of the least developed parts of the United States. Much of it is still in pine forests * because the sandy soil contains little plant nutrition and when first cleared is unsuited to the growth of grain or of grass. Fortunately, however, in this sandy soil will grow excellent peas, melons, cabbages, strawberries, etc., which can be planted and harvested much earlier on light sandy soil than on heavy clay soil, since the latter does not dry so quickly

* The wild deer lives within fifteen miles of New York City, on land smooth enough to permit the easy use of agricultural machinery.

nor get so warm as sand. Thus the Atlantic Plain has an advantage over the nearby Piedmont and Appalachian districts, with their fertile but heavy clays.

The advantage of sandy soils for garden products is shown by the practice of some New Jersey growers, who harvest on the same field a pea crop on June 1, a cantaloupe crop on August 15, and turnips on October 1, and at the same time have the

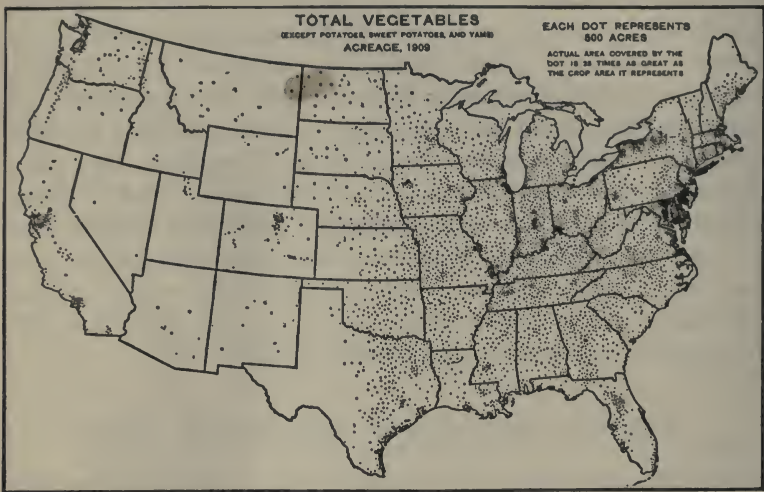

FIG. 110.—This industry is scattered by local city markets and special agricultural conditions. (Finch and Baker.)

land well set in crimson clover, a legume which gathers nitrogen and makes humus when plowed under the next April or May. Another New Jersey truck combination is Canada peas picked in May and June, followed by a crop of corn with a legume side crop of vetch, cowpeas, or crimson clover to fertilize the earth. These are not common practices. They are exceptions, showing the effects of energy and intelligence applied to land most of which is not utilized.

From the southern part of this sandy Atlantic Plain comes throughout the cooler part of the year a procession of vegetable products that follows the advance of the seasons.

When October's breath of winter turns the fields of New Jersey and Long Island brown, the huckster and the groceryman of the Northern cities begin to sell beans, lettuce, eggplants, and cucumbers from southern Florida, and at Christmas come strawberries, which New Jersey can produce only in May and June. The Florida truck farmer often has a rapid rotation of crops. A typical farmer ships heads of lettuce in January; immediately sets the ground to tomato plants, which he ships in March;

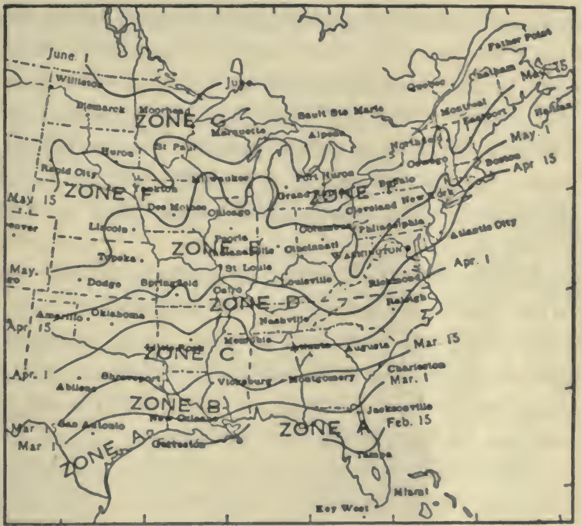

FIG. 111.—Planting zones for vegetables in the eastern half of the United States This gardener's guide shows how we can have green things from South Florida all winter—if they don't have an unusually cold day. (U. S. Dept. Agr.)

then plants potatoes for shipment in May, while, through the summer, the velvet bean, a rapidly growing legume of the tropics, makes food for his mules and leaves nitrogen in the soil for the crops of the succeeding winter.

The truck harvest follows the spring in its advance northward. After the supplies of Florida come those from Savannah, Georgia; then the Charleston, South Carolina, district, including the nearby islands, have their turn, followed by New Berne and Wilmington in eastern North Carolina, while Norfolk, Virginia, with steamboats running to Washington, Baltimore, Philadelphia, New York, and Boston, is one of the greatest trucking centers of the United States. This port ships enormous quantities of early potatoes and strawberries to the Northern cities, until the peninsula between the Chesapeake Bay and the sea, known as the ''Eastern Shore,'' takes its turn. This peninsula, with railroads on the land, with its ramification of navigable bays and estuaries, has one of the finest systems of transportation and is one of the best agricultural districts of the United States. Lastly comes the heavy shipment of truck crops from the fields of southern and eastern New Jersey, Long Island, and the smaller areas near the New England manufacturing cities.

The bulky nature of products of this class gives a great advantage to the producer who can haul the crop to market in his own wagon. Hence there is a much greater concentration of production near the larger cities, especially within a thirty-mile radius of Philadelphia, where good truck land is within easy reach of city market.

The truck crops grown for distant markets usually come from centers with marked localization of production. It requires accurate knowledge to grow and to pack crops in the best way; hence where strawberries or tomatoes or celery are grown, there the people know the best method, and the seed, plants, fertilizer, and baskets can be had to the best advantage. There the buyers come, and above all full carloads can there be shipped, even though many growers combine to make them. The full carload shipment is essential to long-distance truck business. The full carload goes straight through; the shipment, less than a carload, is often transferred a time or two. The full car may go to market in forty-eight hours, whereas the smaller shipment, at a higher freight rate, might take three days or a week. This centralization is very marked in Florida, where the traveler will pass for many miles through almost unbroken pine forests, then come out upon a settlement where scores of farmers are busy growing one or two vegetable crops. Then the train plunges on into the forest, until many miles away it comes to another truck center, where the farmers, by clustering, greatly increase their opportunity of profit.

THE INFLUENCE OF CLIMATE

The price of the vegetables varies from season to season, indicating that the business is uncertain. The earliest products on the market bring the best returns; hence the truck grower always tries to be as early as he can, and therefore is in constant danger from the frost. A promising harvest may be blackened by frost, which may occur in almost any truck season somewhere along the United States Atlantic coast, causing damage

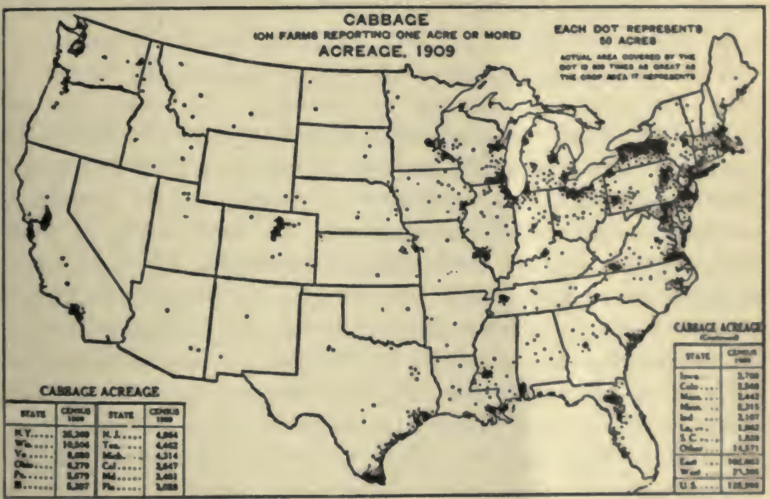

FIG. 112.—Our most staple green food has a widely distributed production. (O. E. Baker, *Year Book* of U. S. Dept. Agr.)

measured by hundreds of thousands, or even millions, of dollars. In some seasons the growers in some districts of Florida have planted the same crop four times in succession, and then made money, but at best the business is precarious. Rains and cool weather in one section at times retard the development of the plants, causing the produce of two or three great centers to mature at the same time and to supply more than the market demands; in that event the price may go down to the point where the shipments are not worth the freight charges.

THE VEGETABLE INDUSTRY OF THE MISSISSIPPI VALLEY

Chicago and the central part of the United States draw off-season supplies partly from certain sandy districts in Tennessee, Mississippi, northeastern Texas, and southern Texas on the Gulf Plain near the mouth of the Rio Grande. In the main these central trucking districts duplicate the products of the Atlantic Plain, but the Rio Grande district is developing a specialty of onions, and southern Georgia makes enormous shipments of watermelons in the early summer after the Florida supply is in and before the Maryland crop is ripe.

THE CALIFORNIA VEGETABLE INDUSTRY

The open winter of California gives that state an important vegetable industry, which probably reaches its highest development on the reclaimed delta lands ("tules") at the mouths of the San Joaquin and Sacramento rivers. These deltas are especially suitable for the production of asparagus, which is grown in fields of a thousand acres; it is shipped to the Atlantic States, and also canned. A great disadvantage to the California trucker is the long distance and high freight rates to the Eastern markets; nevertheless, 350,000 tons were shipped in 1916. Freight rates are less of a deterrent to traffic in dried beans, concentrated and non-perishable, which are grown in great quantities on the semi-arid lands near the sea in southern California.

AMERICAN FOREIGN TRADE IN VEGETABLES

The building of a new railroad through the whole length of Florida and out across the coral keys to the island city of Key West, where it connects with car ferries to Havana, gives the frost-free fields near Havana a chance to compete with the truck districts of the United States. This competition has been the cause of bitter complaint by Florida growers, who pay more for the carriage of their product from Tampa to Chicago than the Cuban pays for similar freight from Havana to Chicago via Tampa. To get the Cuban goods, the road must bid low against New Orleans, and to make up its profits it charges a high rate to the Tampa shipper, who has no alternative. Porto Rico also exports some vegetables to the United States. Other West Indian and Caribbean regions have excellent resources for these crops, but as yet lack marketing facilities, a condition of affairs that was until recently found also in Porto Rico, where the vegetable growers and the steamship lines each quite naturally waited for the other to begin. The European and American trade in vegetables is a luxury, relatively small in the world's trade, and small in the life of the people who consume this food. It is a phase of the high standard of life of rich people. To see vegetables performing their greatest function, we need to go to China and Japan, although there the trade is chiefly local because of the small use of the railroad and the steamship, and the dependence of the farmer on his own household industries and of the city upon its immediate environs. To the Chinaman peas and beans, cabbage and greens, and a host of other vegetables play a dietary rôle of which we have little conception. These people are the most skilful gardeners in the world, growing dozens and dozens of vegetables of which we have never heard and cultivating the land with an intensity which we shall not reach until our population has many times increased. Three or four or five crops a season are not uncommon, and two or three crops on the same ground at the same time is a widespread practice, but one that can be followed only with arduous labor. Cucumbers and other running vines which we permit to sprawl over our gardens are by the Chinese made to climb up on poles, thus saving space. The robber agriculture of the West depends upon commercial fertilizer gathered from the ends of the earth, freshly supplied each year and eventually sent off to the sea as sewage, but the Chinese have for 4,000 years supported educated men and an established civilization on the same patches of ground, which are kept in high fertility by the careful return to it of everything that has been taken from it. Human as well as animal excrements are carefully saved for fertilizer and laboriously applied to the crops, usually in a liquid form and often poured at the root of each plant with a dipper. Instead of spending millions to dispose of sewage, the foreign settlements of Shanghai sell it for $30,000 of gold per year to contractors who carry it away in boats at night to fertilize the delta of the Yangtse-Kiang, which in some places supports as many as 3,600 agricultural people per square mile.

The future supply of vegetables, which in America and Europe is capable of indefinite increase, will be discussed in the chapter on Canning.

SMALL FRUITS

Classed with vegetables in their growth, marketing, and dietary use, is the group of small fruits—strawberries, raspberries, blackberries, gooseberries, and currants. All the ordinary vegetables of the garden are annuals. All of these small fruits require at least two seasons for their fruiting; but if once started they will live in the same location for many years. The raspberry, blackberry, and strawberry send up fresh shoots each year for next year's fruit, while the currant and the gooseberry establish enduring bushes that last for many years. The growth and marketing of these crops respond to the same influences that control the growth of other garden stuff. They often form a part of the farm or village garden; and, where vegetables are grown wholesale, they also are likely to be found occupying whole fields. As is the case with the other truck crops, they do well on sandy soil, which tends to make a small plant of fruitful habit rather than one with large growth of stalk. Like vegetables, they are usually grown in centers, such, for example, as the strawberry centers of New Berne, North Carolina, and of Bridgeville and Georgetown, Delaware, from each of which whole trainloads of strawberries go to market in a single day in the height of the season; the total crop amounts to millions of boxes a year. Near Hammonton, New Jersey, is a similar centralization of blackberries and raspberries.

CHAPTER XVII

THE APPLE

FRUIT growing is one of the most scientific of industries, and it is becoming more so for two reasons: (1) the necessity of combating the enemies of the tree, (2) the problems of marketing. The enemies seem to be steadily increasing in number because of importations of new pests from new parts of the world, along with new plants from those regions. An example is the San Jose scale, so named because of its first appearance in America in certain nurseries in San Jose, California. It came on trees from China, was introduced over all the Eastern States before its activities were discovered, and for years killed fruit trees by the tens of thousands. This insect helped greatly to advance scientific fruit growing because it brought the necessity of victory or complete failure. This particular little insect crawls about for a few days in infancy, then, like the oyster, it settles down, attaching itself to the branches or fruit, and spins over itself a silken shell or scale which protects it against weather and many enemies. Under this tent it proceeds to suck the life juices out of the tree. How to combat it was a sore problem in the last decade of the nineteenth century. Horticulturists had just learned how to spray their trees with poisonous compounds, chiefly arsenic, so that the ordinary surface-eating insect would be killed. But here was the San Jose scale under his tent eating in safety. He could not be poisoned, but by a thin coating of oil he could be smothered, and a combination of lime and sulphur would eat him up in the winter when leaves were off the tree, leaving the bark of the tree uninjured.

After working great havoc for decades, this insect is now safely under control by all commercial orchardists, and is beginning to disappear in response to a common law of pests: when an insect is introduced into a new region it often finds its old enemies absent, and so by the almost appalling rates of increase common to insects, it breeds without limit for a time until other insects, finding unwonted food supplies, also increase and restore the balance of nature. Entomologists were sent to China and Japan to find the enemies of the scale. They did so

FIG. 113.—Spraying an apple orchard in Virginia with poisonous mist to kill insects and fungi. (U. S. Dept. Agr.)

introduced them into this country, and helped to reduce the scale to relative harmlessness.

The problems of marketing fruit in distant places also need much scientific study, especially as it requires co-operative action, a thing especially difficult to Americans.

Fruit growing is a capitalistic as well as a scientific business because the trees must be planted and cared for for a number of years before they yield. This period, by the way, is much longer than advertisements indicate. The United States has at times been deluged with booklets telling how one could make a living from a few acres of apple trees at the end of five years. It should be known that, on the average, only prospectus trees make profit in five years. Orchard trees more usually make profit in ten, and many of them never make profit at all, because of the mishaps of location, discouragement, and the ravages of rabbits, bugs, cows, borers, fire, root rot, blight, and many other troubles. Hence only a small proportion of the people have the necessary qualifications for apple growing, including the capitalistic mind, which is willing to wait a long time for returns on labor or money. For these reasons fruit growing particularly appeals to educated people, especially city people and professional people who retire to the farm. The orchard has a charm for all those who love trees. At blooming time a sloping expanse of the blossoms of peach, apple, cherry, or pear, particularly apple, is a thing of beauty never to be forgotten. At ripening time the increasing burden of many-colored fruits brings again a different and more substantial beauty, with the flavor of bank balances in it.

The apple is the most important fruit of the cool temperate zone. A native of southwestern Asia and adjacent Europe, it has been cultivated from time immemorial. Charred remains of the fruit are found in the prehistoric lake dwellings of Switzerland. Now widely cultivated and almost infinitely variable, it is grown in every temperate climate.

The varieties of apple trees actually on sale in North America in any year are not far from one thousand. Each great geographical area has varieties which are particularly adapted to it; in the northern Mississippi Valley, for example, few of the Eastern apples thrive.

DISTRIBUTION OF THE APPLE TREE IN AMERICA

The apple tree is the longest lived and, excepting the cherry, the largest of all our fruit trees. Its trunk frequently attains a diameter of two feet (a girth of over twelve feet is known in

Pennsylvania). A large tree will often produce ten to twenty barrels of fruit and records of more than thirty barrels have been well established. From New England to North Carolina it is not uncommon to find trees healthy and bearing at the age of one hundred years. The tree is hardy and adapted to a wider range of soil and climatic conditions than any other important fruit. It grows wild along the fence rows and in fields from Nova Scotia to North Carolina and throughout most of the Ohio Valley and much of the Mississippi Valley. In the long and humid summer of the cotton-belt it is not at its best, and is grown only to a limited extent for local use. It does well (when the buds are not destroyed by frost) on the plains and prairies of the corn-belt, reaches a high degree of perfection in the Ozark Plateau, while the handsomest and highest-priced apples in America are produced in the Rocky Mountains, in the Pacific Coast States, and in British Columbia.

In the northern part of the North Central States the combination of severe dry cold waves in winter and hot waves in summer has somehow served to make the trees short-lived; there are few varieties that can survive even for short periods the rigor of that climate. During the early settlement of Dakota one man planted some thousands of apple trees and seeds each year, getting varieties from all parts of the world; as a result of many years of experience he found just one apple tree that could resist the winter climate. That survivor has become, through deliberate plant breeding, the parent of most of the apple trees in that part of the country.

A new variety of apple is formed by a chance seedling that, after the manner of seedlings, happens to differ from the rest of its kind,—for plants differ from each other as people do, and have about as many individual characteristics as people have, so that each natural tree is a law unto itself. When a fine tree has been found, however, the process of making an orchard like it is simple. In three minutes' time an uneducated worker can, by grafting or budding, put a living piece of the desired tree into a wild tree, so that it will grow, feed on the vulgar sap from the sour crab, and produce the most luscious yellow Bellflower, Red Winesap, or spicy Greening.

There are over fourteen hundred varieties of apples in the

United States, most of them of local value only. Unfortunately the complete list of qualifications for a commercial apple: namely, vigor of tree, ease of transplanting, rapidity of growth, resistance to disease, earliness, regularity, and evenness of bearing, beauty of fruit, firmness and good shipping qualities of fruit, are difficult to combine with the other and greatest of all objects, namely, flavor. As a result, many varieties of delicious quality produce such small quantity that they would have to sell for $20 a barrel to make profit for the grower. Others are almost impossible to ship or keep any great length of time. Consequently, some of the varieties grown for market are of very poor quality. Any person who desires good apples must become acquainted with several good varieties so that he can recognize them, for the retailer, particularly the retailer who sells bad apples, is strangely ignorant of their names, his mistakes tending somehow to run toward good names for bad apples. Some growers manage to have fresh fruit on hand from their own cellars throughout the entire year, and, while this is uncommon, it is easy with the aid of cold storage. Apples are now in the market of most cities every day in the whole twelve months.

THE APPLE AS A SUPPLY CROP AND AS A MONEY CROP

In regions where the tree will thrive, a few apple trees for the family supply were, until the recent arrival of new pests, a part of the equipment of almost every American farm, just as a garden is also a part of the family equipment, but not one of the real farm operations for a source of cash income. The growth of perfect apples and the packing and transportation to market without bruising is difficult; the packages are expensive and the fruit has large bulk in proportion to its value; hence the development of apple growing as an industry to supply distant markets is comparatively new and tends to be concentrated in a number of special districts. Since we have such a wide territory suitable for apple culture, the development of apple-shipping districts has depended on some minor advantage of location or on the enterprise of some pioneer grower who showed the people of his locality that this crop could be profitably marketed. After the specialty of a given locality has become well established, the inhabitants will usually assure you gravely and in the best of faith that there is some unusual advantage of soil or climate that makes this place unique not only in the whole United States and Canada, but in the entire world. Such a statement is almost invariably a gross inaccuracy. The industry was started and has succeeded. That is all. Other places with equally good climatic and soil conditions can usually be found nearby and far away.

Commercial apple growing is an important industry in localities as widely separated as Nova Scotia, Ontario, Delaware, Virginia, northern Georgia, Missouri, Michigan, New Mexico, Arkansas, California (Watsonville, near San Francisco), Washington State, British Columbia, France, Austria, Chile, New Zealand, and South Africa.

APPLE GROWING IN NEW YORK AND MICHIGAN

New York is the leading American state in commercial apple growing; four counties on the shore of Lake Ontario in the western part of the state have for a number of years been the most important shipping districts in the United States. The Erie Canal and the railroads that followed it gave this region an early advantage of transportation to New York and other Eastern markets, and also resulted in low prices for the grain and animal products that had been staples there. In addition to this disadvantage for growing staples, and the advantage for apple transport, there is also an advantage in conditions of production. The large bodies of water, Lakes Erie and Ontario, with their melting ice in spring, cool the air, and serve to delay the blossoming time until there is small danger of injury from frost. The advantages for apple growing were not fully appreciated until after the Civil War, when grain growing had become unprofitable, on account of competition from the new, rich, cheap lands of the West. The farmers in New York had to find some other crops than grain in order to realize satisfactory profits, and in this district of the Lake Shore Plain the alternative was apples, as in other districts it became dairying. But even here, although apples are the chief money crop, there is no county in which the orchards cover over a tenth of the land surface, a rather surprising fact, tending to show how rarely any locality is entirely dependent on only one crop. The prediction has been made that within fifty years the southern shore of Lake Ontario will become one continuous fruit orchard. The present profits of the business there, the rapidity of planting, and the rising price (now several hundred dollars an acre) of land suitable for orchards make this prophecy appear reasonable.

The western side of the lower peninsula of Michigan, facing

FIG. 114.—All important commercial apple growing in the United States is within the shaded areas. (Courtesy *Country Gentleman.*)

Lake Michigan, is important in the production of apples for reasons very similar to those prevailing in western New York. This region produces about one-fourth as many apples as New York, but, having similar climate, it grows the same great Northern staple apples, Baldwin and Rhode Island Greening.

OHIO, PENNSYLVANIA, AND VIRGINIA

A small field in apples is a not uncommon feature of farms in both Ohio and Pennsylvania, which rank high as apple producers. In the hill country along the Ohio River in southern Ohio, where the orchards are kept in grass, there is a locality which makes a specialty of shipping the Rome Beauty—an excellent baking apple. The chief commercial apple-growing district of Pennsylvania is in the southeast in a part of a region called the Shenandoah-Cumberland. Most of the apples are grown in the great Appalachian Valley, in sections drained by the Shenandoah River of Virginia and West Virginia—a region comprising Frederick County, Virginia, Berkeley County, West Virginia, Washington County, Maryland, Franklin County, Pennsylvania, and Adams County in the same state, just east of the Blue Ridge. In the immediate vicinity of the Potomac this district also extends westward into the many ridges that lie between the Cumberland Valley and the front of the Allegheny Plateau at the city of Cumberland, Maryland. Parts of this district rival the shores of Ontario or the valleys of Nova Scotia or Washington State in their complete dependence on this crop. Along the south slope of the Tonoloway Ridge, a short distance west of Hancock, Maryland, seven apple orchards in a continuous block save for one pasture field have the following acreage:

Acres	Trees	Barrels 1918 Crop
20	500	200
70	2,000	600
700	53,000	31,000
100	5,500	4,500
350	20,000	10,000
80	5,500	4,500
100	3,000	2,000
1,400	89,500	62,800

The origin of apple growing in this region is typical of the beginning of most fruit districts. Just west of the cities of Winchester, Virginia, and Martinsburg, West Virginia, is a low ridge called Apple-pie Ridge. This suggestive name is one hundred and fifty years old. On the slope of this ridge some fifty years ago an enthusiast planted a large field of apples which first brought him much ridicule and eventually brought him many thousands of dollars. His example impelled his neighbors to plant apple trees, until now the ridge for twenty-five miles is an almost unbroken succession of apple orchards; they are also being extensively planted on the ridges to the west of the Great

Valley. The chief apple of this district is the York Imperial, an excellent cooking apple, and the Grimes Golden, a yellow fall dessert apple of unrivaled quality. Along the eastern slope of the Blue Ridge Mountains in central Virginia, with Crozet near Charlottesville as center in the region called the Piedmont, is another apple district from which large quantities of fine-flavored varieties are annually exported to England. The chief apples of this region are two dessert apples, Winesap and Albemarle Pippin, called after Albemarle County, Virginia, but grown in the West under the name of Newtown Pippin. Thomas Jefferson grew this variety near Charlottesville, in Albemarle County, before the Revolutionary War, and the American minister to England in the first year of Queen Victoria's reign, coming from that county, presented her royal highness with several barrels of Albemarle Pippins, which pleased her so much that she had the duty on apples removed; from that time to this the Albemarle Pippin has gone to England in steadily increasing quantities. It is said that where the Chesapeake and Ohio Railroad crosses the Blue Ridge Mountains west of Charlottesville, one can walk along the slope of the mountain for seven miles and pass continuously from one apple orchard into the next. In the Blue Ridge country of western North Carolina is an interesting district of mountainside orchards where many of the orchards were planted to produce fruit to be distilled into a kind of brandy called apple-jack. Since this beverage has gone out of style, the apples are sometimes hauled twenty or thirty miles over the mountains to the railroad stations. Despite much local faith to the contrary, none of these Eastern apple districts has any known advantage either of production or transportation over other territory in the United States where the business has not happened to be tried. The same may be said of nearly all American fruit localities.

THE OPEN MISSISSIPPI VALLEY AND THE OZARK PLATEAU

On the southern edge of the corn-belt in Illinois, northern Missouri, Iowa, and Kansas some very extensive apple orchards have been planted, some of them covering more than a square mile; but the cold waves that sweep unimpeded down the open

Mississippi Valley have frequently frozen the fruit buds in April and May, so that some of these apple districts are not prospering. In the winter of 1910-11 one corn-belt orchard of 64,000 apple trees (1,600 acres) was pulled up because a total of two crops in ten years showed it to be less profitable than corn. In the Ozark Mountain region of Missouri and Arkansas, however, an extensive apple culture has developed. About 1880 a pioneer in commercial apple growing planted an apple orchard of 1,400 acres. He took magnificent specimens of the fruit to the World's Exposition at Chicago in 1893 and advertised to the world the virtues of the Ozark Mountains as a place for apple growing. This country appeared especially attractive, because land was cheap and the coddling moth was not there. The coddling moth is the mother of the apple worm, which hatches from the eggs she lays on the skin of the apple. Upon hatching, the grub bores into the core and when full grown bores its way out, preparatory to sleeping through the cocoon stage before emerging as a flying moth ready to lay four hundred eggs.* The census of 1900 showed that Missouri led all the states in the Union in the number of apple trees. Orchards of from one hundred to one thousand acres in size are common. The rapid extension of the industry was made possible by the very low price of the land in the Ozark plateau and ridges, an old, worn-down mountain system ill suited to grain farming, but very well suited to the production of fruit. The elevation and the protection of the mountain location causes it to escape many of the frosts that are destructive on the open plains to the north and east. The crop of the year 1907 was almost obliterated in the open valley from the Appalachians to the Great Plains and from the Ozarks to Canada; but a single Arkansas county in the southern Ozarks, immune from this particular May cold wave, produced over $2,000,000 worth of apples. Describing the results of this particular frost, a citizen of a rich county in Iowa (Muscatine) declared, with accuracy: "There were not enough apples on the many thousand trees in this county to give a little boy a stomachache." There is also a large orchard district north of

* Unfortunately the moth can travel, and in a few years she reached Missouri and settled with all her generations. But this discovery was made *after* enormous apple plantings on the Ozark hills.

the Ozarks along the Missouri River in Missouri, Kansas, Nebraska, and southeastern Iowa. Together with the Ozarks it produces about one-third as large a crop as New York State; the variety grown is chiefly Ben Davis, an apple which no one should eat without knowing its name.

THE ROCKY MOUNTAINS AND THE NORTHWEST

In the newly settled states of the Rocky Mountains and the northern Pacific coast are many irrigated districts that produce beautiful apples, commonly sold in boxes. Some of these regions, for example, the Hood River Valley in Oregon, the Yakima and Wenatchee valleys in Washington, and Bitter Root Valley in Montana, have already become well known in the eastern part of the United States on account of the beautiful fruit they send out. Parts of Idaho, Utah, Colorado, and a few sections of northern California are equally well fitted for growing this fruit. California production is centered chiefly in the Watsonville district of the Pajaro Valley, close to the Pacific Ocean near San Francisco. This Western region is now capable of producing nearly one-third of the crop of the United States. Because of the bright sunshine of the semi-arid district, the apples grown here are the most beautiful produced in America. The large profits yielded by these orchards when they first began to bear caused some of them to sell at remarkably high prices. This fact has been utilized by land speculators, who took possession of large tracts of cheap land, advertised it prodigiously through the eastern parts of the United States and even in Europe, and sold five- and ten-acre plots of orchard to be turned over at the end of five years to absentee owners who had no means of taking care of it, and who for a number of good reasons have usually lost their money. Increased production has reduced prices below those quoted in the prospectuses, and has put the business on a really competitive basis. Many orchards on this account have been pulled up and the land put into alfalfa—a crop for which all conditions are admirable. These Western fruit districts, unlike those of the Central and Eastern States, are of restricted area, as they are limited to the valleys where they can have proper soil requirements, irrigation, water drainage, air drainage, and protection from strong winds.

Owing to the small population of the Rocky Mountain and Pacific region, the extensive plantings in the irrigated valleys of the Northwest depend for their market very largely on the Eastern States and Europe; they are therefore subjected to a much heavier transportation cost than must be borne by their competitors in the East. This is a permanent disadvantage.

Fig. 115.—Furrow irrigation of four-year-old apple trees at Wenatchee, Washington. (U. S. Dept. Agr.)

Of late years much attention has been given to the prevention of frost in orchards, particularly apple orchards, by building fires on frosty nights. This method requires a great number of little fire-pots per acre, each of which is charged with crude petroleum ready for the match at 2 or 3 A.M. as the temperature approaches the danger point. Unfortunately this is an expensive and perhaps a temporary device. It takes great moral courage to burn up two or three hundred dollars' worth of oil in a night, when perhaps, after all, it might not be cold enough to freeze. It takes more courage to repeat the process on the next night and again the next week. Moreover, the prospective scarcity of oil because of the enormous demands for automobiles and other uses may easily make the fires so costly that the orchard in the frosty location cannot compete with the more naturally protected locations on lake shores, warm peninsulas, and thermal belts on mountain sides.

THE EXTENT OF THE AMERICAN APPLE INDUSTRY

Ordinarily, one or two bushels of apples per capita are grown each year in the United States. The crop of the year 1900 was one hundred and seventy-five million bushels, of which thirty-nine per cent. were grown in the three states of New York, Pennsylvania, and Ohio. These figures prove little, because the apple crop of any locality normally fluctuates from twenty to one hundred per cent. of a full crop. An apple tree will rarely bear two heavy crops in succession; this fact, in addition to occasional injuries by frosts, makes it exceedingly rare for all the different apple districts to have a full crop at the same time. When they do, as in the year 1896, the crop exceeds the demand, and the apples have almost no value (seventy-five cents per barrel in March, 1897).

The difficulty of growing, packing, and shipping apples is transferring the business from the small orchard of the general farmer to the large orchard of the specialist in the better located fruit districts. There has resulted a rapid increase in the commerce in the apple, which is more generally used by all classes in the United States than in any other country. In the last two decades the sale of apples in country stores in the farming districts has become quite common.

THE EFFECT OF REFRIGERATION

Each year in the United States millions of barrels of apples are placed in cold-storage plants at a temperature of 33°, which greatly prolongs their keeping qualities. Under good storage conditions some varieties of apples will keep well for a full year, so that cold-storage warehouses, refrigerator cars, and refrigerator ships have made possible the easy distribution of American apples all over the United States and western Europe, and have also made possible their sale and use every day in the year. The United States normally exports one or two millions of barrels each year, chiefly to the United Kingdom and Germany, and a few thousand barrels each year to Cuba, Brazil, Mexico, and other tropical American countries, where the apple cannot be grown.

The greater distribution of fresh apples has caused a marked falling off in the use of dried apples.

CANADIAN APPLE GROWING

Nearly as many apples are exported from Canada as from the United States. The fruit thrives from Lake Huron to the mouth of the St. Lawrence; and two localities have utilized their special advantages to develop the apple as a money crop for the foreign trade. The most famous of these is the Annapolis Valley in Nova Scotia, with a capacity of from one to two million barrels. This narrow valley in the western part of the peninsula is protected from north and northwest winds by the Bay of Fundy and a sheltering mountain range. These advantages, together with an early start, convenient access to the seacoast, and relative unfitness for other forms of agriculture, have resulted in a development of apple growing that has made its product famous in Britain. The apple is the chief money crop and financial dependence of its people. The second Canadian apple district is near Niagara Falls on the peninsula between Lakes Erie and Ontario, where it has the protecting influence of the water similar to that which benefits the New York lake shore apple belt, of which it is really an extension separated only by the Niagara River. In British Columbia there is to some extent a duplication of the apple growing in the valleys of Washington State. The industry was largely carried on by English younger sons, mostly bachelors, many of them sorely disappointed in their orchards; when the war broke out they enlisted in such numbers that in some places the population was reduced one-half.

EUROPEAN AND ASIATIC APPLE GROWING

Apples are at home in Europe and Asia from Edinburgh to the Mediterranean, from the Bay of Biscay to Tokio. They are quite commonly grown throughout western Europe, being the chief fruit crop of the two hundred thousand acres of British orchards. But western Europe does not supply enough apples for its own use. The regions of greatest production on the continent are the mountain valleys in the highlands of southern Germany, of Switzerland, and of the eastern Alpine regions in Austria. The individual orchards of Europe are much smaller than those of the United States because of the small size of the farms in all these apple regions. But the total European production is large and there is a heavy traffic to the cities of Berlin, Paris, and London, and to the numerous small towns of the manufacturing districts of the Rhine Valley and the adjacent territories of France, Germany, Holland, Belgium, Switzerland, and Austria. In some cases canal boats are loaded with apples in bulk, taken to the city, and tied up to the bank until the load is sold to consumers, who carry the apples home in their market baskets. This lesson in economy demonstrates the foolishness of the American practice of making expensive packages to be used once and then broken up, and of paying costly railroad transportation and local delivery costs.

In some parts of Germany and near Paris, apples of exceptional quality and local repute have been grown under conditions which typify the painstaking methods of the European gardener, fruit grower, and small farmer. When of the finest quality and size, these apples used to bring the fabulous price of a dollar a pound in the markets of London and Paris. Only a few such apples can be grown on each tree, which by careful pruning is sometimes made to resemble the grape vine in form.

In a recent year frost destroyed all the buds on the trees in one district in the Rhine Valley; but the growers avoided the apparently inevitable loss of the crop by methods which could have been practised only by the painstaking gardeners of Europe or the Orient. From another part of Germany where the buds of this variety had not been destroyed were secured twigs bearing good buds. These twigs were grafted into branches of the frosted trees so that they lived and bloomed. A second branch of the tree was side-grafted into the bud-bearing graft to nourish it. By this method each double graft was made to produce one of the precious apples. Such costly production makes it clear why Europe can be supplied with apples produced by American wholesale methods of agriculture, whereby the orchards are

FIG. 116 and 117.—These two trees were planted the same day, side by side. They are of the same variety, had the same treatment, except that one had about 2½ pounds of sulphate of ammonia per year for five years. Photographing and measuring of the crop were fairly done. (Courtesy The Barrett Manufacturing Company.)

cultivated with tractor-drawn plows, poisonous sprays are put on the trees with gasoline engines, the apples are run through engine-driven sizing machines that can sort from one hundred to one thousand barrels a day, and are raced off to the freight car in motor trucks for full carload shipment to great markets.

From Constantinople eastward throughout the central regions of Asia the apple grows wild in many mountain districts and can be grown in almost any location where there is sufficient water, but in the lowlands this must usually be supplied by irrigation. The fruit is quite commonly grown by the Chinese farmers of the Upper Yangtse Valley and in all cooler parts of China, and

Fig. 117.—See opposite page.

to some extent also in Manchuria, Korea, and Japan. Although important to the local population, it has not in this region of undeveloped transportation become an important article of commerce.

THE APPLE IN THE SOUTH TEMPERATE ZONE

The south temperate zone, with the reverse arrangement of its seasons, can send its fresh autumn fruits to the North at the end of the winter when ours are gone or have been long in storage.

The south temperate zone has spots with climate and resources well suited to the apple, particularly in New Zealand and the island of Tasmania. This latter island is about as large as West Virginia, which it resembles in its combination of mountain and valley, its good rainfall, and its mountain orchards. Its orchard area is one-tenth that of Britain. Tasmanian apples are sent to Australia and in limited amounts to England. Southern New Zealand, with a similar climate, sends more to the British market. The total export from the Southern Hemisphere, however, is small in comparison with that from the United States and Canada.

South Africa also has an apple district. The apple is said to grow wild in parts of southern Chile, and to be largely grown for local use on the fine plains near Santiago. It is quite probable that when Panama Canal traffic is well established, this district, which will then lie almost as near as Italy, and commercially nearer than Pacific Coast districts to New York, Philadelphia, and New Orleans, will begin to send us apples at the season when the trees of New York, Virginia, and Washington are just beginning to bloom. Small shipments are already coming to New York occasionally from Cape Colony and Tasmania.

FUTURE SUPPLY AND ADAPTATION TO NATURAL RESOURCES

The apple and other fruits are unlike meat and grain, in which we have nearly or quite reached a limit of resource, so that greater production must result from greater effort. The yield of the apple (one to five hundred bushels per acre) is many times that of grain. It is capable of being produced on rough unarable land, of which there is a large amount, especially east of the Mississippi River. Some of the finest apples grown in the eastern part of the United States are produced on hillsides which are quite steep and rough and wholly unsuited to grain growing. In many cases they are rarely plowed and in some cases they have never been plowed. This suggests that as our agriculture becomes better adjusted to the geographic conditions of the country, the hillsides are likely to produce a greater and greater proportion of our fruit, leaving the level lands for broad tillage and grain production. The large yield from small area (with great land resources unused) suggests that low prices may be expected, and overproduction is possible. In this respect the apple belongs with the potato, the truck crops, and all the other fruits. A few years ago a fear of overproduction caused a general stopping of planting in nearly all parts of the United States.

CHAPTER XVIII

PEACHES, APRICOTS, PLUMS, CHERRIES, AND PEARS

THE PERISHABLE NATURE OF THE PEACH AND ITS COMMERCIAL EFFECT

The peach is a delicious fruit which is regarded as more of a luxury than the apple, partly because it is difficult to produce, partly because it is so very good, and partly because on account of its perishable nature it cannot so easily become a staple of commerce. It is a great misfortune to man that the peach will not keep as well as the apple. While some apples will keep for a full year, even for two years, the standard market peaches cannot be kept in good condition longer than ten days or two weeks without excessive cost, while most of the best varieties are so soft that they cannot go to market at all except in the immediate vicinity of the place where they are grown. But the fruit is so highly esteemed that, though a few years ago it entered into commerce but little, since the coming of fast trains, refrigerator cars, and steamships, it is being marketed over the whole United States and Europe and even sent across the ocean. Because of the perishable nature of the peach, there is often only one day on which it can be picked for distant market. The day before it is too green; the next day it is too soft; consequently peaches sometimes rot by the thousands of bushels because they cannot be sent to the markets. A thousand-acre peach orchard must have a perfectly planned succession of varieties, so that the labor may be fully employed from the first ripenings in July to the last in October, when the little army of peach pickers break camp and the men disperse to their distant homes. Wide demand, in combination with difficulty of production, gives a high value to the peach and makes it an excellent money crop in the favored localities that can successfully produce and market it.

CLIMATE AND THE PEACH CROP

The peach tree is an exotic, delicate, with many enemies. The peach, unlike the apple, yields well only in restricted localities under special climatic conditions. The tree is easily injured by the severe cold of winter and the crop is injured by extreme cold as well as the late frosts of spring. It is apparently a native of Persia, and grows from the Atlantic coasts of Portugal and Africa to the Pacific coasts of Japan; but, like the apple, the peach is nowhere throughout this vast region an important article of commerce except in small sections of Europe. Not only do spring frosts often destroy the buds or young fruit, but a warm summer is required, with much sunshine for proper ripening. This condition does not exist in Germany, Holland, Belgium, the north of France or Great Britain, and the fruit can be grown in these countries only artificially in hothouses or on the south side of walls, where the tree is trimmed so that it spreads out like a fan against the flat surface, being thus protected from north winds and catching the direct rays from the sun as well as the heat reflected from the wall.

The European settlers brought to the United States varieties that had for several centuries been growing against the walls of northern Europe. A recent discovery by an American professor of horticulture shows the debt of industry, particularly of agriculture and fruit growing, to science. The peach tree in northern Europe needs heat; by the strange adaptation to environment of which plants are capable, it gradually acquired a reddish bark, which absorbs more heat from the rays of the sun than a light-colored bark can absorb, just as light-colored clothing reflects heat and is therefore cooler than dark clothing, which absorbs heat. But, in acquiring in England ability to absorb heat, the peach was fitting itself for destruction in America, where, over the whole eastern half of the country with its continental climate, a great danger to the peach is its tendency to bloom in the first warm days of spring and have the blossom or young fruit killed by a subsequent frost. It has been discovered that the red twigs of European varieties get warmer in spring sunshine, bud earlier, and are destroyed oftener than varieties with a light green bark. This has set the plant breeders to searching for green-bark varieties of peaches to replace the prevalent red-bark ones, so that the tree will be less subject to frosts. At best the peach can become an important money crop only in regions somewhat free from early frost. The United States has at least eight such districts, where the industry is already developed.

THE PEACH-BELTS OF THE GREAT LAKES

Two of these localities where peach growing is specialized, and has become an important money crop, are near the Great Lakes, whose cold surface and melting ice result in the cool spring temperature that delays the blooming of the peaches until after the frosts. The peach area is rapidly increasing in importance in the part of western New York where apples are grown. Some peaches are also grown along the shores in southern Ontario, and along the so-called Finger Lakes of central New York.

The second peach-belt, determined by the Great Lakes, is on the eastern shore of Lake Michigan, where the prevalent west winds, blowing inland from the lake, give the necessary temperature control over a belt less than ten miles in width. In the same latitude on the opposite shore of the lake the peach is not grown at all or is of small importance. Both of these districts have the great disadvantage of an occasional winter temperature far enough below zero, to kill the buds and ruin the crop, for unfortunately the peach cannot stand temperatures much under 10° F. below zero, even in midwinter. These districts are, however, unusually accessible to markets: from Michigan by steamer across the lake to Chicago and from western New York by the many railroads to Buffalo, New York City, and New England.

The history of peach growing in this Michigan district furnishes another good example of the dependence of industry on science. A mysterious, incurable, and fatal disease called "the yellows" spread from peach tree to peach tree. Unchecked, it worked destruction in the western Michigan peach-belt and reduced the number of trees in one county from 600,000 in 1870 to 30,000 in 1884. This reduced to the value of $10 or $20 per acre land which had been worth from $50 to $100, and brought communities to the verge of bankruptcy and social disorganization. Then it was discovered at the State Agricultural Experiment Station that if every tree having the yellows was removed when the disease was first discovered, only one or two per cent. of the trees per year would be killed, and the peach industry could thrive. The Michigan peach industry rose again. The county that had but 30,000 trees in 1890 had over a million in 1906, and throughout the peach-belt prosperity again prevailed and continues. Nearly every farm there has its money crop of peaches, which are sent in boatloads to Chicago, and in carloads and trainloads to New York and many other distant cities.

THE CHESAPEAKE AND ALLEGHENY PEACH-BELTS

The third peach-belt is on the peninsula east of the Chesapeake Bay in the states of Delaware and Maryland. Here, upon sandy soil ill suited to grain, grass, or livestock, and somewhat protected from frosts by the adjacent waters of the Bay, arose shortly after the Civil War the first great centralized peach business in the United States. It has been discovered within recent years, however, that the cooler climate of the ridges in the Allegheny region, to the west of the Great Valley, delays the blossoming of the peach tree more than the Bay does and makes an orchardist sure of four crops in five years, while the greater prevalence of frost on the low peninsula east of the Chesapeake Bay reduces the average number of crops there to about three in five years. The advantage of the hill over the plain is due to two climatic factors: First, the elevation, whose coolness delays spring growth; second, frost drainage. Cold air is heavier than warm air; hence, on still frosty nights, it settles to the lowland where fruit buds freeze, while the hills are frost free. Sometimes the frost line of crop failure is marked through the orchards along the side of a ridge almost as sharply as if it had been the level of flood waters. On account of this advantage, the fourth peach-belt is developing rapidly on the mountain slopes of the Blue Ridge and the Alleghenies in the Potomac drainage basin in southern Pennsylvania, western Maryland, and the eastern part of West Virginia. Here are some of the most highly organized of all agricultural industries. Single peach orchards comprise from 100 to 500 acres and there are cases of single orchards 1,000 acres in extent.

SOUTHERN NEW ENGLAND HILL PEACHES

The ability of the peach to do better on mountain tops than on lowlands has led to the discovery that it can be grown on many of the higher hills of southern New England. Consequently prosperous orchards are now yielding occasional good crops on the hilltops overlooking the Connecticut Valley in the state of Connecticut, an area which has never before known a commercial peach production. It has the great advantage of being close to markets, so that a good crop brings a high price with almost fabulous returns.

Some peaches are also grown in certain sheltered spots usually on high benches overlooking valleys in the central Rocky Mountain region, especially Colorado and Utah. The distance of these localities from the centers of population is a great drawback.

THE OZARK AND ROCKY MOUNTAIN PEACH DISTRICT

In the central part of the country the Ozark ridges furnish some frost protection to a vast plain where cold waves would be perilous to the peach. There is an enormous peach production in Arkansas and southwestern Missouri, but the crop is less certain than that of Appalachia or New York.

THE SOUTHERN PEACH DISTRICTS

In all these Northern peach-belts the main crop is not ready for the market before August. Since the express service has been perfected by the railroads it has been found possible to grow fine crops of peaches on cotton land in central and northern Georgia and market them in Northern cities some weeks before the crops of Maryland, New York, or Michigan are ready. These Northern and Southern regions are, therefore, not competitors in the fresh fruit market. Georgia's chief advantage is the absence of rival producers rather than surety of production. The uncertainty of the peach crop is shown by the uprooting of a

2,100-acre Georgia peach orchard in 1911, and the planting of the land to the more reliable corn and cotton. In the Southwest, in eastern Texas, a seventh peach-belt is coming into prominence. This is a counterpart of the Georgia belt and normally supplies the southwestern and central part of the country, but the practical certainty that there will never be a full crop in all of the peach districts at one time causes each peach district to have a certain market for its product. If one or two districts happen to have a monopoly the profits are very large and a light crop is often more profitable than a heavy one.

CALIFORNIA PEACH GROWING

California has the eighth and last peach-belt in America. Its crop is probably the most certain of all, even more so than that of the Potomac Valley. It has one clear advantage: the lack of the severe winters which sometimes destroy the buds with zero temperatures. Bordering on the Pacific Ocean with the prevalent warm westerly winds from that great body of water, this state has a normal oceanic climate nearly free from the cold waves and strong winds that spread over all territory east of the Rocky Mountains. Peaches can, therefore, be raised with fair assurance of getting a crop, though destruction by frost is known even there. By a peculiar compensation of nature, this district suffers by being far from market, so that it is not in a position to reap the great advantage of its regular crops except in rare seasons when there is failure in the East. California peach orchards are of great extent, and, owing to the perfection of the methods of picking, packing, and shipping, their product is, in seasons of short crop in the East, sent by carloads and trainloads to all the larger Eastern cities and at times even as far as London. But a full crop in the Eastern districts makes it impossible for California growers to pay the freight; millions of pounds of the fruit are then dried and canned.

The force of this limiting factor of freight charges for Pacific Coast fruit growers is shown by a New York market report of August 20, 1911. "The losses to recent shippers of pears and plums from the far West have in some cases been as much as $300 per car."

The exacting care required to market successfully the peach crop has a tendency to cause the commercial growing of this fruit to be the chief occupation of the grower, who must be a specialist and business organizer of ability. Chiefly because of the difficulty of marketing, peaches rot in the United States by the hundreds of thousands of bushels each year of good production.

On September 19, 1914, fifty-five cars of Utah peaches were shipped on contracts to St. Louis commission men in the most approved style of co-operative associations, but the peaches were thrown back on the railroads to collect the $15,000 freight, and brought the owners twenty-five cents a bushel.

EUROPEAN PEACH GROWING

In England the peach is always a high-priced luxury, the small import into that country coming chiefly from the south of France, and from Italy. There appears to be no good reason why proper development of transportation facilities should not give western Europe a cheap and abundant peach supply from Spain, Portugal, and North Africa. It is merely one of those surprisingly numerous unused opportunities in European agriculture. The increasing export from the United States and Canada shows that the fruit can stand the transportation, and it is a real puzzle why such industry has not been organized long ago.

THE PEACH IN THE SOUTH TEMPERATE ZONE

The peach does as well in the south temperate as in the north temperate zone. It is said that peach-tree wood was for many years one of the chief sources of wood supply for the city of Buenos Aires, and peaches of excellent quality are grown in Chile, South Africa, Australia, and New Zealand. Thus far, the only country in the south temperate zone that has been able to market its peaches in Europe or America is South Africa, whence the British mail steamers in February and March bring small quantities of excellent fruit to European markets. They are even sent to the United States, but many of them decay in the three to four weeks spent in transit, with the result that they retail at exorbitant prices (often twenty-five cents each) and the market is naturally very limited. The improvement in ocean service and the opening of the Panama Canal may lead before many years to much quicker and cheaper transportation of this much-prized fruit, particularly from the less distant peach region of Chile, and to a consequently enlarged importation in the spring months when Northern frosts still prevail or our trees are only beginning to stir from their winter slumber.

The supply of peaches in the United States could easily be increased many fold so far as land is concerned, for the very same ridges that make the excellent Potomac Basin district run northward and southward for scores, sometimes for hundreds, of miles. These unused ridges are good for peaches almost from end to end. The problem is one of market and demand rather than of supply.

THE APRICOT is closely related to the peach botanically and as a food, but it has to a greater extent the greatest weakness of the peach itself; namely, the tendency to very early blooming in the spring, making itself thereby a prey to frost. It is therefore not grown at all commercially east of the Rocky Mountains, but is limited to California, whence it is shipped fresh in small quantities to the East before Eastern peaches are ripe in quantity. Most of the crop is dried.

The plum is a fruit of great productivity and many varieties, from three entirely different sources—Europe, Japan, and America. Wild plums, good, and big enough to eat, grew in dense thickets in many parts of the United States when the white man came. There is one, a beach plum, that grows on the dunes of the north Atlantic coast. Others even pushed up the streams of the Mississippi Valley beyond the limit of large forests and withstood the ravages of blizzards sufficiently at least to reproduce themselves, and occasionally made great crops which were much prized by the settlers of 1860-1900. One of these native varieties, important in orchard growth for a time at least, was called the Wild Goose plum, because the parent tree grew from a seed taken from the crop of a wild goose that had fed upon the fruit. Plum trees, like peach trees, are subject to many enemies, but with care they can be grown in great quantity. Some of them produce so much fruit that if the branches are allowed to grow full length, the burden of fruit breaks them down even if a prop is put under the limb. Throughout much of the eastern Appalachian region half-wild damsons are so abundant that in some seasons they go begging in the towns at $1.00 a bushel.

The only plum of any great importance in the food supply of America is the prune, whose great surplus crop can be dried for future use. This species has long been grown in the Mediterranean region of Europe. It was introduced to California from France in 1854. Commercial plantings began in 1870, and have long since abundantly met all our needs for this food; production can easily be increased several fold if desired.

The plum appears to be very important commercially in Bulgaria, plum butter being one of the important exports. The plum crop of 1917 was reported to be fifty-five million pounds.

THE CHERRY is another example of a fruit of which a comparatively small quantity suffices to meet the commercial needs of the United States. There are two general classes: the sour and the sweet cherry. Unfortunately the sweet cherry as grown in the eastern part of the United States gets ripe in May and June at a season when damp days and frequent thunder showers are common, and fungi thrive at their best. The fruit of these cherries is tender, so tender that a fine crop on Saturday may rot on the trees by Monday morning, and it is difficult or impossible to market them. Since the drier summer of California is, however, much better suited to the marketing of this crop, there have been for many years regular shipments of California cherries into all the Eastern markets, although cherries of a similar quality grow easily from New England to Georgia, and from the Atlantic to the Mississippi. Over much of this Eastern territory a kind of European cherry called the mazzard, sometimes black and sometimes red (red-hearts and black-hearts), grows wild in the fence rows, roadsides, and even occasionally in the woods. I have seen single trees of this species in northern Virginia sixty to seventy feet high, which certainly had upon them two hundred gallons of fruit, most of which rotted and fell to the ground along with the crop of thousands of other trees in many parts of the Atlantic slope. As these native cherries are much more resistant to decay than the more delicate European varieties commonly grown, there would be no difficulty in growing this fruit for drying and canning in large quantities if desired, but it is not desired because of the even more easily grown and more productive sour cherry of which there are extensive plantings in the New York fruit-belt and elsewhere. They yield so heavily and the crop is so abundant that at times it is not worth picking.

The cherry crop of Wisconsin gives an interesting example of the influence of climate on fruit crops. It is concentrated on the little peninsula that projects between Lake Michigan and its arm, Green Bay. Here also apples and some other fruits are grown extensively.

Excellent cherries are grown in the Mediterranean regions of Europe, Africa, and Asia; Asia Minor being especially famed for the excellence of its cherries.

THE PEAR seems to have gone out of style. The chief reason for this decline is a villainous little bacterial organism called pear blight which lights upon the pear tree, goes beneath its bark and kills a twig, a branch, or even the main trunk of the tree. This pest has been with us for a century, shows no signs of abatement, and has killed most of the pear orchards of the United States in the last twenty-five years. One variety is almost exempt —the Kieffer pear, a hybrid between the Chinese sand pear and an American pear, probably the Bartlett. The Chinese sand pear is very hardy. Its fruit has all the delicacy of a spoonful of pure wet sand, partly hardened, and no more. The tree is as vigorous as a weed. It comes from the same place that the pear blight came from, and is immune to it. Its hybrid offspring, the Kieffer pear, is nearly immune, and the tree grows with such vigor and bears so abundantly that the fruit sells for a very low price in the market. Unfortunately it has such poor flavor that it is rarely sold for eating; but when properly handled it is good as a cooked fruit and if picked early and kept in the dark it is edible. It is unfortunate that most of the trees of good varieties of pears have been destroyed by the blight. Otherwise we should doubtless have much greater supplies of this excellent fruit, which can be in the market almost as large a part of the year as the apple. Perhaps in time we may breed new varieties immune to blight and as good as the tender and almost lost varieties of Europe.

CHAPTER XIX

THE CANNING OF FRUITS AND VEGETABLES

THE CANNING PROCESS AND ITS SERVICE TO MANKIND

Queen Elizabeth was a mighty monarch, but millions of us are glad that we did not have to eat in her time. Many of the greatest dietary benefactions of the race have come since her day—the peach, the orange, the banana, but especially the potato, and canned foods. Canned foods, particularly canned fruits and vegetables, have greatly increased the comfort of living, improved the health of whole populations, and have done much to enlarge the capacity of the world for supporting people in comfort as well as health. The process of canning food, which was discovered about the middle of the nineteenth century, consists in packing the food product, and then cooking it, often above the boiling-point of water, to destroy all bacteria. It is then hermetically sealed while still hot, and keeps almost indefinitely. By 1883 the methods of canning had been so improved that machinery did nearly all the work, including the soldering of the cans and even the pasting and trimming of the labels. This invention has revolutionized the food habits of millions.

Before the invention of canning, we had to depend upon the less appetizing and less convenient method of drying fruit and vegetables, and four other methods of very small importance: preserving in salt, in vinegar, in brandy, and in sugar. As cheap sugar is as new as canning, the last method was of small importance in the past, and the others, save drying, merely made condiments of the fruit.

Before the coming of railroads and steamboats and the process of canning, a crop of tomatoes could be consumed only within a few miles of the place in which it grew and within a few days from picking time. As the tomato became ripe while the farmer's garden was full of beans and roasting ears, and his orchard full of peaches and apples, it was a very small addition to the usable food supply of the race. That supply, like the chain, had its weakest link, namely, the scarcest time of year; it came at the end of the crop season in April and May, which was called starving time in Queen Elizabeth's England and for many centuries before her time. After transportation by rail and boat was organized and improved, the tomatoes might be carried several hundred miles, but they still had to be consumed within a few days. After the canning process was perfected and developed into an industry, the tomatoes and other perishable products of field or orchard could be preserved for consumption at any time within two or three years and in any corner of the world to which they could be cheaply carried. This elimination of the time-limit on the consumption of perishable commodities has revolutionized agriculture in many localities by suddenly giving these products access to the world market. Instead of three rows in the garden the farmer can grow whole fields of such crops. The distribution of crops and of production now depends on geographic and economic conditions which make certain localities best able to produce certain products, rather than upon the more artificial conditions that recently compelled their production close to the market of the nearby city.

The change in food supply is even more marked. Most parts of the world can now have many kinds of cheap foods previously unused or even unknown. The workers in a paper mill in the woods of Maine may now eat the tomatoes and peaches of Maryland, the cherries of Wisconsin, and the apricots of California. The gold digger in the Klondike, the engineer on the Panama Canal, the rubber-gatherer in the jungles of the upper Amazon, and the whaler who spends a season in the Arctic Sea have the same opportunity.

The recent discovery of silver in the cold and inhospitable woods of upper Ontario has caused the building of a railroad and growth of a mining town at Algoma; the fact that it is now far beyond the farm line does not prevent this town from having a good food supply of canned goods. A century ago, the whaler after a voyage of a year or two often came home, if he came at all, sick with scurvy, a disease due to dry food of insufficient variety. But after Nansen and his men had drifted in the

Arctic ice for years in an attempt to reach the North Pole, they returned in perfect health because they were nourished with all kinds of canned and preserved meats, vegetables, fruits, fruit juices and extracts.

The Allied armies in France had back of them millions, almost uncountable numbers of cans of food in the greatest variety. Their number was so great that a human being would have died before he could count them all, if they had been spread out before him. If they were put in a single row they would have reached from the most remote part of the United States to the battle line. War owes a part of its destructiveness to canned foods, because they permit us to support armies in greater number and greater effectiveness. In past centuries armies bred sickness, almost pestilence. Today a well-managed army is one of the healthiest groups of men to be found anywhere.

Canning, more than any other invention since the introduction of steam, has made possible the building up of towns and communities beyond the all too narrow bounds of varied production.

THE EXTENT OF THE INDUSTRY

Practically all classes of food—fruits, vegetables, soups, fish, meat, and even bread, sweet potatoes, and pudding—are now preserved by canning. The industry has world-wide distribution. It really makes very little difference in the final cost of the dish on our table whether the canned pineapple was grown by a grandson of Spain in Porto Rico, a Japanese gardener in Hawaii, or a Chinese immigrant in the environs of Singapore. In ordinary times the steamship carries the cases of canned goods half-way round the world at a cost that adds little to the price of the can the grocer hands over the counter to us. We depend on the very ends of the world not only for the staple foods, but for the salads and desserts. Rubber planters in Singapore, especially the Chinese, find it very profitable to plant pineapples for two or three seasons between the young rubber trees. The boats and carts carry the pineapples into the nearby city of Singapore, whence about three-quarters of a million cases of canned pineapple are exported yearly. In Hawaii in 1917 the United States navy let one contract for nearly two million pounds of canned pineapple, and the total production for the season amounted to about two and one-half million cases.

Canned fruits and vegetables are an important export from the United States to Great Britain and many other countries. England herself is an important manufacturer of preserved fruits—preserves being fruits so rich in sugar that they will keep without hermetic sealing. Certain brands of English jam and preserves made from the fruits grown in the south of England and even on the mainland of Europe are known throughout the world, are widely exported, especially to British colonies, and are extensively consumed in Britain, where bread and jam is a favorite combination of foods.

Canned fruit pulp is imported in large quantities by the English jam manufacturers from the Spanish fruit districts, especially Malaga, and from Bulgaria in peace times.

The Great War, which made it necessary to keep men in camps and to replace cut-off food supplies, brought about the building up of the canning industry in nearly all of the old centers and many new ones. For instance in the town of Leeton, New South Wales, at the beginning of their midsummer, February, 1918, a new canning factory was being equipped with American machinery, and was expected to employ five hundred girls and can five thousand tons of peaches.

THE CANNING INDUSTRY IN THE UNITED STATES

The canning factories of the United States prepare yearly from twenty to thirty pounds of fruits and vegetables for each man, woman, and child in the country. We can better appreciate their importance as food when we remember that in New York City the money spent for canned goods exceeds that spent for the two great staples of bread and milk combined. Among the vegetables the tomato is most important, corn ranks second, and peas and beans third, while among the fruits the peach leads, followed by pears, apricots, and apples. The output amounted to over a hundred million dollars per year before the war, and now comes from nearly all parts of the United States. Canning tends to be scattered in small towns wherever a surplus of some product is available, as in a district of truck farms or orchards. Furthermore a factory can be operated on a comparatively small scale. Small canning outfits are of many varieties, with capacities from a few dozen cans a day to several thousand a day. If they desire, one or two people can from their own gardens or orchards produce canned goods for the market without difficulty. Because of the seasonal nature of the supply, the labor is nearly all done in the summer time, often by new immigrants who flock to the country towns from nearby cities for temporary residence of a few weeks or months.

Although widely scattered, the canning industry in the United States has three distinct belts that show greater development than other regions. The first of these regions to develop the industry was the Atlantic Plain. Maryland is the center and most important part of this canning district, which extends from North Carolina to New York. This section has become important for the same reasons that made it important in the shipment of truck crops to the city markets, namely, an accessible location, a good rainfall, and a sandy soil which is exceptionally suited to vegetables, but not well adapted to the growth of other agricultural staples such as wheat and grass. Maryland is the leading state in canning partly because it has so much suitable land and partly because of the many steamboat lines which, by centering in Baltimore, have made it the only important city center of the canning industry in the United States. Ordinarily, canneries are located at small railway stations wherever a few farms grow a surplus of any crop. But the ease and safety of navigation on the many far-reaching arms of the Chesapeake give Baltimore remarkable facilities for assembling farm products. They are brought in steamboats from points as far away as Fredericksburg, Richmond, and Norfolk, in Virginia, a great number of places on both sides of the bay in Maryland, while the Chesapeake and Delaware Canal opens a way for the Baltimore fruit boats to go up the navigable creeks of New Jersey to such towns as Salem and Bridgeton.

The Baltimore canneries have another advantage in the fact that oyster canning gives employment to both labor and equipment in winter season—a cost factor of great importance. The same combination of advantages—sardines and other fish at one time of the year, and vegetables at another time—is enjoyed by the people of Brittany, who were busy during the war in preparing supplies for the French army.

The sandy southern part of Delaware gives that state an importance in the canning industry quite disproportionate to its small area. Maryland and Delaware are important also because they are large peach- and pear-growing and fruit-canning states.

THE NEW YORK, NEW ENGLAND, AND LAKE REGION

New York, in which both vegetables and fruits are grown, is the center of the northeastern canning-belt, the second region of great importance. This state leads all the others in the canning of apples, pears, and corn. It is rather surprising that this state and the New England States exceed the corn-belt in the canning of corn.

The Northern-grown canned corn is better than that of the corn-belt proper, because in the North with its cool summer the corn remains for a much longer time in the proper edible condition than in hot Illinois where the plant rushes quickly to maturity and must be gathered on the very day it is ready. As sugar corn for canning is more valuable than common corn for the market, a small sugar-corn crop on a New York or New England farm is as valuable as a somewhat larger crop in Illinois.

The cooler summer that makes part of New York, Michigan, and Wisconsin rank as second-class corn producers, makes them first-class producers of peas. If the same factory can lengthen its season by canning several kinds of fruits and vegetables it has a great advantage through the better utilization of the equipment. Thus a plant at Janesville, Wisconsin, begins its season in June with peas, and ends it late in autumn with sauerkraut; it usually packs the following, employing two hundred and fifty to three hundred persons in the height of the season:

35,000-40,000 cases peas=600 acres peas.
65,000-80,000 cases corn=1200 acres sweet corn.
50,000 cases canned kraut=300 acres cabbage.
pickles=900 acres cucumbers, 75,000-100,000 bushels.

Northwestern Ohio furnishes a good example of the specialization of agriculture with reference to the canning industry.

Near the western end of Lake Erie, especially in Sandusky County, the black swamp land with its mixture of sand is well suited to cabbage, with the result that there now are six large sauerkraut factories within ten miles; and three thousand acres of cabbage are annually grown.

PACIFIC COAST

The most important canning district is in California. The importance of this state is due to the combined influence of the climate, excellent for the growth of fruits and vegetables, and the great distance from Eastern markets, which makes it possible to ship in the fresh condition only the early crop, constituting an uncertain fraction, and that the most perfect, of the total crop. This state cans nearly all the apricots, and many of the peaches and other fruits, except apples and berries; its output of canned tomatoes, peas, and asparagus is also very important. In 1916 four and one-half million cases of canned fruits and vegetables were produced. Each year the industry is extended. Recently, new machinery for removing all the dirt from the leaves of spinach has been perfected, with the result that three thousand acres of spinach were grown for canning alone in 1918; most of this supply was produced near the city of Sacramento. The canning industry has large possibilities in the other Pacific Coast states also.

THE POSSIBILITY OF INCREASED PRODUCTION AND OF OVER-PRODUCTION

Talk of possible famine and declining supply of fruits and vegetables is so far from truth that it is almost laughable. It is true that we have had temporary shortage during the war, great disturbance of price due to inflation of currency because of the war, and we have been compelled to choose among good things. Thus we can't use the same money to buy a Liberty Bond and clothes in the latest style, to buy rubber tires or gasoline, and canned peaches. The most conspicuous feature of the conditions of living in America, and to a large extent also in England, France, and Germany during the last twenty-five years, has been the rising standard of living—the greater variety and amount of goods used by the people. Perhaps the best single example of this higher standard is the acquisition of some five million automobiles by the people of the United States within a very few years, without any appreciable reduction in the sale of any other kind of goods, save carriages. Another example is found in the millions of phonographs in the homes alike of workmen and millionaires. It is true that we cannot indefinitely increase our acquisitions in all directions. We may have to choose some day between more and more mechanical goods and more and more food. We hear a great deal in these days about declining food supply. As has been pointed out elsewhere in this book, there is increasing scarcity of meat, there will be increasing difficulty in the securing of bread, but for a long time to come there is no reason to expect any important increase in the actual difficulty of producing larger supplies of fruits and vegetables.

Instead of undersupply, the great haunting fear of the grower of fruits and vegetables throughout the world is oversupply, the glutted market, and crops for which he cannot get the cost of production. The loss from limited market and large crops, explained quite fully in the case of potatoes, is even more a danger with peas and beans, tomatoes, and all the other garden stuff.

The experience of the cantaloupe growers of the Imperial Valley, California, shows how the limiting factor works:

1905	297	carloads	of	cantaloupes were shipped	
1906	577	"	"	"	
1907	644	"	"	"	
1908	1891	"	"	"	and all growers lost money.
1909	1411	"	"	"	
1910	1621				
1911	2580				
1913					
1914	4490	"	grown on 8300 acres, and all shippers lost money.		

Colorado was in an equally bad situation: for, in the same year, there was one hundred per cent. increase to eight thousand acres. Many crates were sold at thirty-five and forty cents when transportation costs were forty-six cents a crate. During this period, retail prices were kept up by the grocers, and the surplus went to the dump, even though some of the shipping from Colorado was done by associations using the most approved co-operative methods.

An example of large crop and low income occurred in 1890, when we had 105,000,000 bushels less corn than in the year before; but the crop brought $21,000,000 more. In 1912 we had 677,000,000 bushels more than in 1913; and the crop brought $171,000,000 less.

The possibilities of increase in the production of fruits, vegetables, and canned goods in the United States are very great—provided there is need for the food. Granted market, these articles can be produced in almost indefinite quantity. Of the sandy Atlantic Plain, so admirable for the growth of small fruits and truck crops, but a small portion is now used and the production is kept down only by the unprofitably low prices which result from the rather frequent glutting of the market. If, for example, the farmers of the United States could be assured of a price per bushel for tomatoes for the next ten years equal to one-third of the daily wage of a good farm laborer, it is probable that the production of this fruit would be increased tenfold, for tomatoes are now commonly grown for less than that price, and occasionally the crops are so great that the factories cannot handle them and the fruit rots upon the ground by the hundreds of tons. This condition is a great deterrent to industry and helps explain the statement that half the fruits and vegetables grown in the United States never get to market. A recent estimate by a member of the United States Department of Agriculture showed that about two per cent. of the fine sandy loam of Atlantic Coast Plain was used for truck farming. This loam, one of the finest of truck soils, has a wide distribution for several hundred miles up and down the plain. But why grow the food if you cannot eat it nor sell it?

Mr. Horace Roberts, one of the largest and most successful growers of fruits and vegetables in the world, operating more than one thousand acres within ten miles of Camden, New Jersey, wrote in August, 1915:

I had hundreds of acres of cabbages, peas, beans, and other vegetables this summer that did not pay the cost of gathering and marketing, so that we lose our land, seeds, fertilizer, and work. We are selling potatoes below the cost of production. Gooseberries and strawberries were unprofitable.

If this was happening to a man who could haul his own products to market in his own motor trucks it is clear that growers who had to pay freight and accept lower prices because their goods arrived in poorer condition, must have met still greater losses.

Even with the aid of the outlet afforded by canning, the small fruit and vegetable industries yield so enormously that overproduction, with its glutted markets and frequent losses, is a factor which, like frost, is ever in the mind of the producer and almost annually visits each locality of varied production.

A most convincing illustration of overproduction in agriculture comes from Britain, which we properly think of as a chronic food importer and jam user. "The light soil of the Blairgowrie (Perthshire, Scotland) district is well adapted to the growing of raspberries and strawberries. In 1900 the strong demand for raspberry pulp for jam manufacture turned attention particularly to the cultivation of this fruit, and new plantations were made. Raspberry growing requires much labor, as well as an abundance of good fertilizer, the annual expenditure for these purposes exceeding $100 per acre. Plantations yield one and one-half to four tons, or an average of about two and one-half tons per acre. Up to 1900 the fruit was grown principally on land leased at the agricultural rate of $5 to $7.50 an acre per annum. The large profits realized led naturally to higher rents, which in 1906 reached $58 per acre for land near the town of Blairgowrie, and $30 per acre farther out. In 1903 the price of raspberries had been as high at $209 per ton, yielding enormous profits to the growers and attracting other horticulturists and farmers into the flourishing industry. In the three succeeding years a profit of $195 to $245 per acre was not uncommon. One plantation showed per acre in that period for one year: Three tons of raspberries, at $136 per ton, $408; expenditures, including rent, $146; net profit, $262. The value of plantations, apart from the land, at full-bearing (in the fourth year) a few years ago ranged from $195 to $487 per acre. About one thousand acres in the district were devoted to raspberries alone, the annual shipments to English jam factories exceeding twenty-five hundred tons.

"Falling prices in 1907 marked the beginning of the decline of the industry. In 1909 the supply largely exceeded the demand, with disastrous results to the growers. Up to 1906 the average price was about $112 per ton. In 1907 it fell to $92.50, in 1908 to $68, and in 1909 to $44. Plantations became unsalable. Many fruit-growing tenants asked proprietors to take over their plantations as they stood (five-year-old bushes), without payment of any kind, and to let them terminate the leases, which were rated at only $24 per acre. In one case a plantation which was bought three years before at $487 per acre was offered at $49. Land rents have fallen about one-half, which may enable the industry to recover in the course of a year or two from its present state of collapse.*

This is an admirable description of the agricultural cycle of boom, overproduction, and glut, which has been repeated with variations of detail thousands of times; for example, blackberries at Hammonton, New Jersey, 1895-96; apples in British Columbia, 1912-15. Unfortunately it will probably continue to be repeated, for there seems to be almost no land that is immune. In Valencia, Spain, in May, 1913, I found onions so abundant from the crop of the preceding season that the pigs could not eat them all. In Sicily, tomatoes, potatoes, and artichokes are at times grown in unprofitably large quantities, and overproduction of fruit and vegetables is common even in China. Professor Joseph Bailey, of the Department of Agriculture, University of Nankin, writes:

> I have known onions to be so plentiful that they could not be sold for even 50 cents Mexican gold (20 cents) for a picul of 133 pounds. This happens only rarely. The market gardeners around Shanghai are very cautious not to overproduce.

If we want a hundred-fold more canned spinach, cabbage, tomatoes, peaches, or pineapples, empty land fit to produce them awaits the hoe and the tractor of the husbandman.

* United States Consular Report, 1910.

CHAPTER XX

DRYING OF FRUITS AND VEGETABLES

In the drying of food, particularly of fruits and vegetables, we have a source of supply which was once important, has declined, and now promises to return many fold with all the force produced by new and better processes.

Before the coming of steam transportation, when the inhabitants of each locality lived to a great extent upon the local resources and the farmer's family lived almost entirely upon the products of the farm, the drying of fruits in humid America and Europe was almost as common as their production. In those days the trays of apples, peaches, pears, or cherries, on the garden fence and the back porch roof, were common sights throughout the fruit-growing world, and for many centuries the kitchens of Europe and later of America were festooned in the autumn with strings of dried pumpkin, dried apples, and many other kinds of dried food. These products were dried in an amateur way, under conditions ill suited to the business; but the food was saved, even though the humidity and summer thunder showers of damp climates made it very dark and unattractive and sometimes of really inferior quality. This home industry has declined like so many other home industries, because of the superiority of the factory product and the advantages of production in locations where the climate is very favorable. Steam transportation and world commerce have worked a quick revolution by developing a large traffic in dried fruits from those parts of the world having the favorable conditions for their production.

AN INDUSTRY SHIFTED BY SUNSHINE

For a few decades it has been easier to dry fruit in the sunny and rainless summer of countries having the Mediterranean type of climate and to ship it great distances than to combat the difficulties of drying it at home with artificial heat in evaporators or in the sun between showers. The only exception was the drying of apples, a by-product industry suffering from the competition of the commerce in fresh fruit, and still most extensively carried on in the Eastern apple districts, especially New York, from which state thousands of barrels of dried apples have been sent to Europe, chiefly to Germany, Holland, and Belgium, where they are used for food and for the making of wine. From some isolated farming districts in the Appalachian Mountains and the southern and eastern parts of the United States, there are still small shipments of dried peaches, apples, cherries, and even dried blackberries laboriously prepared over the kitchen stove or on trays in the sun, but the humid air and the cloudy days with occasional showers blacken these products, so that they bring a low price in the market.

In almost any grocery store in the United States today, boxes of dried prunes, apricots, peaches, dates, raisins, figs, and currants may be seen, and the names and addresses stamped on the boxes will show that they have come into these American communities from many distant parts of the world, nearly always from districts with a long dry summer, in which fruit exposed on trays beside the trees is dried by the constant sunshine with great ease and no labor except piling the trays and covering them on those rare occasions when rain threatens.

COMPETITION OF CALIFORNIA WITH SOUTHERN EUROPE

California names predominate in the list of addresses on dried-fruit boxes, although thirty years ago the labels usually showed European names. These industries grew up first in southern Europe and have very recently come to southern California, where they have developed with surprising rapidity and now supply almost the entire home market and a surplus of some varieties for export. The total product of dried fruit in this state alone amounted to 260,000 tons in 1912, but had increased to 340,000 tons in 1917 (raisins, 147,000; prunes, 109,000; peaches, 38,000; apricots, 16,000; apples, 8,000; figs, 8,000, and various others, 4,000). One of the first California dried fruits to compete with those of Europe was the raisin. This highly nutritious food had for centuries been produced only in the Mediterranean region. There had been an important export from Almeria, in eastern Spain, where the peasants for genera-

FIG. 118.—A rainless summer permits fruit to be dried upon trays in the orchard and helps to locate the dried fruit industry. California scene. (U. S. Dept. Agr.)

tions have kept vineyards and dried the grapes. Sultana raisins, produced from a seedless variety of grape, come from the eastern Mediterranean coast, the chief center being Smyrna, in Asia Minor, with other centers of production on the Greek Islands in the Ægean Sea, and to a lesser extent in Greece itself. In 1880 the United States took 1,200,000 boxes of Malaga raisins alone, but in 1894 the crop of California raisins, which had been grown first in 1870, had become great enough to supply the needs of the United States. As long as the United States was importing some raisins from Spain, California growers had the advantage of a tariff (usually) and the freight rate across the Atlantic. When they oversupplied the home market, they lost the tariff advantage and suddenly found their price set by the European market, minus the freight to it. For a time there was depression and despair among the Californians, especially around Fresno, where the greater number of the raisins are grown. Diligent advertising has, however, greatly increased the consumption of the raisin, which is peculiarly valuable in a period of sugar shortage, because the fruit is not considered ripe until it has twenty-three to thirty-four per cent. of sugar. To make raisins grapes are picked, laid upon wooden trays, and exposed to the sun from ten to twelve days.

The second dried fruit of importance in the California district is the prune, which has long been exported from several Mediterranean districts, chiefly France, where Tours is the best-known center of production. Italy ranks second in prune production, and Germany produces some prunes for home consumption. They are also grown in Spain and the Balkans, especially Bosnia and Servia. The recent large export to the United States has almost entirely ceased, and European fruit growers must depend chiefly upon the European market, to which American prunes now go in years of European crop shortage. The American prune is by no means limited to California; it grows also in Oregon, Washington, and Idaho. The increase in production has been striking. In 1880 it was 200,000 pounds; in 1890, 16,000,000 pounds, with an import of about five times that quantity. By 1900 the American capacity was 130,000,000 pounds and the limit was set not by land but by market. In comparison with canned fruit, the dried fruit has the disadvantage of becoming wormy in summer, unless carefully protected, but it is much more concentrated and more easily transported than canned fruit. Prunes in large quantities go from California in steamships to the Eastern States and Europe.

THE APRICOT AS AN EXAMPLE OF DRIED FRUIT TRADE

In the United States this early blooming fruit is a good crop only in California, where enough apricots are produced to supply the whole country with dried apricots for the whole year and a few fresh ones during the early months of summer. Some, both fresh and dried, are also exported. The apricot is grown in many other parts of the world. In the date oases of the Sahara it thrives beneath the partial shade of the thin leaves of the date palm; dried apricots are an important ingredient of the ragout which is so large a part of the diet of the almost vegetarian oases dwellers. It is also grown in northern India. Caravans toil over the snowy and perilous Himalayas carrying the dried fruit to Thibet and western China, where the product is greatly prized.

The communities of central Asia afford a good example of the effect of dry climate and good transportation facilities on the fruit industry. The Russian Government, after its conquests in central Asia, built a railroad connecting the Black Sea with the Caspian. A line of steamers on the Caspian Sea connected at the port of Krasnovodsk with another railroad that crosses the desert to the oases of Bokhara, Khiva, and Samarkand. These are densely peopled communities living upon lands where streams fed by the snows upon central Asian mountains permit the irrigation of a few square miles of the level plain. These newly conquered cities on the oases are among the oldest settlements in the world. Before Rome was built, these cities were carrying on a caravan trade in valuable products, like metal work, silk, wool, rugs, leather, skins, and tea. The cheaper rates on the new Russian railroad made it possible for these regions to become in part the California of the Russian realm. Within a few years dried apricots which had been a local food supply for millenniums became an important export to Russia.

THE FIG

Commercially the fig is a sub-tropic product but the tree is hardier than the orange tree. It grows over most of southern Europe and even survives in sheltered places in England, Texas, and many parts of the southern United States. Nevertheless the growing of figs was successfully established in California only at the end of the nineteenth century. For many years the trees had grown well but bore no fruit because of the absence of a certain insect that lives in Mediterranean lands, and crawls into the hollow cavity of the fig and fertilizes the many blossoms therein contained. The establishment of fig growing in California waited for the successful acclimatization of the insect, which was difficult and required many expensive attempts. The industry in the large sense is still an Old World industry. Fig drying, during which sugar exudes from the fruit and clings upon it in white particles, has until the present time had its chief commercial center in Turkey and Asia Minor, where in the valley around Smyrna figs are largely produced, making Smyrna the best fig market in the world. The process of drying figs is not difficult, and they are an important crop along the Mediterranean from one end to the other. They are exported largely from the hill country of northeastern Algeria. In the Balearic Islands alcohol is distilled from figs, and the residue is fed to pigs. In the region around Malaga an important local food supply suddenly became an important export because of the shutting off of the Turkish supply by the war. In the United States and most cool countries, the fig is used as a sweetmeat, but it is a standard article of diet in many lands having the Mediterranean type of climate. It is so abundant in Chile that, although its nutritive value is high, it is in some localities considered food for beggars.

THE DATE AND ITS IMPORTANCE IN DESERT COUNTRIES

The greatest of all dried fruits, in its service to mankind, is the date, and the date tree is the king of all crops. The fruit, which is more nutritious than beef (see table of food values), is produced by a tall palm growing in many hot arid lands. It is the bread of the desert, and also food for the beasts. Even milch cows in Oman, Arabia, are fed principally on dried fish and refuse date kernels. The date is called a tree of the desert, but it really requires much water, and is a tree of the oasis. Underground streams of water occasionally reach the surface in the Sahara Desert, either by natural flow or by pumping, and create most fertile oases. These are often carefully cultivated and support a surprisingly dense population.

"Now as for the last five or ten thousand seasons, the date-tree owner begins his year's work in the springtime by climbing his tall trees to fertilize their blossoms. The ascent is easy because of the natural steps furnished by the notchings left by the stubs of the leaves of past years. The blossoms of the fruitful female palms are fertilized by a dust of pollen shaken from a sprig of male flowers in the hand of the husbandman. This economical device permits a very small proportion of male trees to suffice and the garden can be filled to crowding with the productive female trees. Once the blooms are fertilized, little more is done for the tree but watering at rather frequent intervals, and this is often a light task, the mere diversion of a stream. Many of the palms are cultivated only one year in three, but with this small labor they are heavy yielders. The open feathery palm leaves permit much light to filter through, so that oranges, figs, and apricots grow beneath the palms, and garden vegetables can grow among these lesser fruit trees. The vegetables pay the cost, the rest is profit, hence the oasis garden sells for a very high price.

"Thus the date garden leads all other kinds of agriculture in the amount of food produced, and this tree merits the title of King of Crops. Small wonder that the prehistoric Semite called it sacred. Pound for pound, the date is as nutritious as bread, and the harvest is three to twenty-fold that of wheat. After a score of years or less, the best wheat lands are usually exhausted by continuous production; but we know that certain oases have yielded dates regularly since they were visited and described by Roman writers, a score of centuries ago. They are today so prized that the Arab owner will refuse $5,000 in gold for an acre of good date garden. Its yield warrants the valuation. In May the oasis housetops beside the date garden are covered with drying apricots; in July and again in September the figs are drying; in late autumn comes the great event of the year, the date harvest." *

The scattered oasis locations make possible the caravan routes

* Smith, J. Russell: "The Agriculture of the Garden of Eden," *Atlantic Monthly*, August, 1914, p. 258.

which cross the great deserts from oasis to oasis. Millions of date trees yield the chief crop, both supply crop and money crop, throughout Sahara and Arabia. The French Government has recently built railroads across the Tell, or fertile agricultural plain which faces the Mediterranean throughout the whole coast of North Africa and Tunis, through the Atlas Mountains, with their pastures and cork forests, down the oases in the edge of the Sahara. To these railroad termini the dates are brought by camel caravans from many other oases and are shipped by rail to Tunis and Algiers, thence by steamer to Marseilles for distribution to many lands.

The date grows through the desert parts of North Africa and Western Asia as far as Persia. It is the chief export from the little independent Sultanate of Oman in southeastern Arabia, whose arid coasts look like the desert itself and whose population and products are to be found in the irrigated fields of a few inland valleys where the date tree enables the Arabs to have food and also purchase the goods left at Muscat by the steamships from England, France, Germany, Italy, and America.

In Southern Persia, a land of aridity and oases, the date, as in Morocco and Algeria, is one of the important food products, but Mesopotamia is at the present time the chief source of the world's commercial supply of dates. To the city of Bagdad with its river steamers and to Basra with its ocean steamers, caravans of camels and mules bring the dates (worth, before the war, three to four cents per pound) for shipment by steamer to the Western World. The war interfered with the supply of dates very much as it interfered with the supply of figs.

INTRODUCTION OF THE FIG AND DATE TO THE UNITED STATES

There is good prospect that before many decades we shall be as independent of the Old World for a supply of dates as we have already become for a supply of raisins and prunes, the product of plants more easy of reproduction, but also more short-lived than is the majestic date palm. The date tree, like the fig and the olive, has been found to grow well in southwestern United States, where the climatic conditions resemble those of western Asia and the Sahara. The American date region is limited to the basin of the lower Colorado in Arizona and southeastern California, and possibly a small territory in the tip of Texas along the lower Rio Grande. The greatest single tract of date land is the Imperial Valley, which greatly resembles in climate the delta at the mouth of the Nile, and is sometimes described as having eleven months summer and one month of late spring. Here the almost continuous sunshine and blazing heat and the abundant waters of the Colorado River give the proper conditions for the date which have been described by the Arabs as "having its feet in the water and its head in the fires of heaven." Date culture has scarcely passed the experimental stage in the United States, but the results are very promising. It is easily possible that the American imports of these Old World desert fruits will be reversed as was our import trade in prunes, raisins, and apricots, of which we now export a surplus, which amounted as long ago as 1911 to prunes, $3,300,000; raisins, $1,000,000; apricots, $2,100,000.

EACH CONTINENT HAS A NATURAL DRIED FRUIT DISTRICT

Since each continent has its region of summer drought and irrigation there is prospect of world competition in dried fruits as other countries of the world become better developed. In the Australian state of Victoria, for example, the well-known colony of Mildura on the Murray River has under irrigation a quarter of a million acres of land under the same kind of sunny climate that prevails in California, Spain, and Asia Minor, and the people are already producing dried prunes, dried peaches, dried apricots, dried currants, and raisins for the Australian market, and occasionally exporting them to Great Britain, where they compete with the products of the Mediterranean countries and California.

South Africa is engaged to a limited extent in producing the same crops, while Chile has her California on the plains and irrigated fields near Valparaiso and Santiago. Over the Andes from these Chilean orchards are the settlements of San Juan and Mendoza in Argentina producing raisins, dried fruit, and wine for that country. The South Americans have as yet exported no dried fruits worth mentioning, but the natural resources are there, awaiting the labor and care of man. Guaranteed a moderate price, there is no reason why the production of all the dried fruits might not increase many fold without any serious increase in the amount of effort and, therefore, in relative cost of production.

DEHYDRATED VEGETABLES

While the ancients and also our grandmothers dried fruit and some vegetables successfully in the sun or around the kitchen fire, they made out but poorly with vegetables. In the last few years new processes of drying commonly called dehydration have been perfected. Their utilization promises revolutions greater even than that caused by canning vegetables, for the reason that it seems to do all that canning will do, and do it more cheaply, thereby opening the way for abundant food supply for greater numbers of people at little expense. The process of dehydration is surprisingly simple. It consists in exposing the leaves of cabbag, lettuce, or spinach, slices of potatoes, even juicy tomatoes, to a current of air at comparatively low temperature, but driven rather rapidly by fans which cause it to take off the moisture and leave the fruit ready to absorb water again at the first opportunity, and resume to a surprising degree its original color, bulk, and flavor. It has all the time kept its nutritive value and its vitamines, less disturbed than when canned, because not subjected to the injurious influence of great heat. The chief trouble with dehydrated vegetables now is not their quality, price, supply, or nutritive value, but the conservatism of all of us who are instinctively prejudiced against a new article of diet. The ups and downs and possibilities of the vegetable food supply and of dried vegetables are well illustrated by the case of the tomato as told by David Fairchild, in the *National Geographic Magazine*, April, 1918, as follows:

"Fifty years ago we refused to eat the tomato because we believed it was poisonous; then we became so fond of it that we demanded it both in and out of season, even though it had to be grown thousands of miles from our markets, in the South or under glass. And for our epicurean tastes we paid exorbitant prices.

"Then we learned to can this vegetable in great factories, and because we want our tomatoes stewed instead of as a sauce for macaroni or rice, we insist that the vast majority of our put-up product shall be in form for immediate use—emergency ration shape; in other words, canned without being concentrated into paste, which is the way the Italians use their tomato flavor. In this dilute form 360,000,000 cans of tomatoes are shipped over the country.

"There are two pounds one ounce of tomatoes in a can, or a trifle over 1.8 cents' worth, and in a case of twenty-four cans, which sells for $4, approximately 43 cents' worth of tomatoes as picked in the field.

"This not only means that we ship the tin cans in which the canned tomatoes are contained, but that we first ship the same number of tin cans from the factory where they are made to the cannery where they are filled.

"We have never learned and have never had to learn, until war's necessities forced the matter to our attention, that the tomato can be successfully sliced and dried; that it retains its characteristic flavor and aroma when so dried; that when soaked in water for four or six hours it comes back and makes a delicious sauce or soup, slightly sweeter than the canned tomato. For many of the ordinary uses of the household the dried tomato is as satisfactory as the canned product.

"One ton of good tomatoes, after peeling, trimming, and packing in cans, will weigh approximately 2,300 pounds when crated for shipment, whereas the same quantity, when dried and boxed, is reduced to only 200 pounds, or about one-twelfth as much. In bulk the saving depends upon whether the slices are compressed or not.

"If left loose in the packages, the equivalent of ten carloads of the canned tomatoes could be packed in a single car, and when the car space required for moving the empty tin cans, block tin, and packing-case materials is considered, this number of cars is practically doubled.

"Likewise, cabbage and its fermented product, sauerkraut, can be dried successfully and brought back without losing their flavor. In a trial at one of the army hospitals five pounds of dried cabbage formed a ration for four hundred and twenty-eight men.

"Dried carrots, beets, peas, and string-beans are practically indistinguishable from the fresh; spinach, which is so often tasteless when canned, turnips, onions, cauliflower, Brussels sprouts, mushrooms, squash, pumpkins, and parsnips—all are successfully dried, particularly so by the newer and better-regulated power-fan drying processes which have been adapted and invented by various American drying firms.

"These commercial products are more uniform and of much more attractive appearance than the home-dried products, taken as a class, for the reason mainly that they are dried more rapidly, under more carefully controlled conditions of moisture and heat; and when put into water they come back to almost, if not quite, their original dimensions and appearance. . . .

"The evident advantages of purchasing dried vegetables instead of fresh vegetables are that they will save the householder the labor of preparation in the kitchen, for they are all peeled and sliced and have only to be soaked before cooking; they will lessen the weight of her market basket by the water that has been taken out, which varies from fifty to eighty-five per cent., and also by the absence of the peeling and tops; they will keep indefinitely if protected from moisture and insect contamination; they will lessen her garbage; when out of season they will cost less than the fresh and much less than the canned at any time, and they will insure for the children, at all times of the year, the 'fat soluble A' and the 'water soluble B,' both essential to growth.

"It would be fortunate if the time were soon to come when the drying of vegetables by means of drying plants of suitable size, with adequate safeguarding appliances, should be a local industry wherever vegetables are grown. The result would be a stabilizing of prices of those perishables which are so often grown at a loss because of overproduction or a faulty system of distribution. . . .

"What is needed now, however, is concerted effort to induce the American public to use dried vegetables, really to want them, and, having once tried them, continue to use them. The demand will bring the product, and this product may be expected to improve in quality and attractiveness as the art develops, just as has been the case with every other food which American ingenuity has developed.

"When fresh vegetables go too high for your pocketbook, buy the dehydrated ones, which have the same food value and are more convenient, and as time goes on the demand so created for a product which is so pre-eminently economical and good will become a regular part of our diet and we will not any more question * the dried vegetable than we do today the canned vegetables, or the dried apricot, fig, apple, prune, or raisin. . . .

"Old prejudices die hard, but we are now eating some things which our forefathers scorned or of which they had never heard. They were unfamiliar with celery and with olives. They did not dream of the grape-fruit, nor the soy bean, nor the wild rice of Minnesota, nor the kafir corn, nor the cassaba melon, nor the avocado, nor the banana, nor the Chinese cabbage—all these and scores more have come into our dietary within the last generation, not to mention the arrival of the whole canned fruit and vegetable galaxy, with its bewildering variety of flavors and colors. . . .

"When once we learn to like dried vegetables—and if they are properly dried and properly cooked they taste so nearly like the fresh ones as to be almost indistinguishable—there will be unlocked vast storehouses of food in the sweet-potato areas of the

* "There is, no doubt, much to be learned in the kitchen about the handling of dried products. They are not to be handled as though they were fresh vegetables, and they require a different treatment from the vegetables which have stood for months in the water of a tin can. The moisture has been almost entirely taken out of them, and it requires time for this moisture to be reabsorbed. This process takes from six to twenty-four hours, and cannot well be hurried.

"Then the cooking should be slowly done, approximating in this respect the process of the fireless cooker. In the drying operation some of the flavor is lost, but in many vegetables there is a surplus of flavor anyway. The cabbage and cauliflower, the turnip and carrot, the tomato and onion are strong enough to lose a little of their flavor without detriment. But in cooking, the vessels in which the dried vegetables are prepared should be kept closed and as little steam as possible allowed to escape.

"The tendency to be guarded against is that of having the vegetable too concentrated—adding too little water or allowing too much water to escape in the form of steam.

"The most serious difficulty which attends the introduction of the dried vegetable is not different from that which attends the introduction of any new food. The danger is that the first attempt at cooking may be unsuccessful, and this failure be taken as a fair trial and the product condemned as not fit to eat, when in reality the fault lies in its preparation."

South and equally vast supplies of Irish potatoes in the North, now threatened with complete or partial loss.

"It is extremely difficult to predict the course of events in any change of human habit. Could Sir John Hawkins have dreamed, when he introduced a Peruvian tuber as a curiosity

FIG. 119.—Dehydrated mixed vegetables as manufactured for British and American armies. Compare the ease of handling this and the green vegetables themselves. This one Pacific coast firm prepared twenty-five million pounds of food in four years for Allied armies. (*Dominion Products Limited,* Vancouver, British Columbia.)

into Ireland, that his great-great-great grandchild (if he has one) would see 155,000,000 bushels of potatoes produced in that island alone?"

Dried vegetables were extensively used in the Allied armies in the latter part of the war. The shortage of shipping made it necessary to economize space as much as possible, and the advantages of dried vegetables for this purpose are obvious. The indefinite keeping qualities are also of great advantage for army uses. A bit of rust may eat a hole in a tin can of food, and spoil it utterly within a few hours by fermentation and decay, but dried vegetables can be kept in barrels with much less danger of loss, and the keeping qualities are remarkable. It is reported that some barrels of mixed dried vegetables prepared for the British army in the South African War (1899-1902) have recently been opened and used, being as good as when first prepared.

If canned fruits and vegetables have given us access to the ends of the earth, dried vegetables make that access readier, because cheaper. Vegetables for the British army in France were dried by the million pounds in British Columbia. One plant at Chilliwack turned out hundreds of thousands of sealed tin cans each containing a standard mixture of 15 pounds comprising:

3	pounds	Carrots
2½	"	Turnips
2½	"	Potatoes
1	"	Onions
3	"	Peas
3	"	Beans
15	pounds	

Each vegetable is evaporated separately, because of different heat requirements. This mixture stewed with some meat, handed out in a tin cup with a spoon and a chunk of bread, contains everything that is necessary to keep a man in fine physical trim. The scurvy of the ancient army is no more. The appearance of the American soldier in 1918 vindicates his food.

It is almost impossible for us to appreciate the full value of this source of food—cheap, durable, wholesome, and easily prepared—a means of support to tens and hundreds of millions of people in the towns, cities, and even on the farms of the Western World. It is another great vindication of the factory as a substitute for the kitchen. The low cost and unlimited supply make the dehydrated vegetables, perhaps, the peer of the locomotive as a factor enabling the earth to support vast numbers of men.

It meets the last whim of fashion to pay $8 a crate for fresh string-beans from the tip of Florida, or the island of Madeira in midwinter, but a paper package of nicely dried beans contains the same elements of nutrition at a fraction of the cost. A ton of cabbage in the dehydrating plant in the fall costs no more than a case of canned goods in the spring.

If the cost of animal production should cut down the milk supply, these dried vegetables will become even more important, because they seem to have the necessary ''fat soluble A'' and ''water soluble B'' in great quantities, and if dairy products are cut out of our diet, at least thirty per cent. of our food, dry weight, should according to McCollum be greens, and, according to present belief, they are as good for us dry as fresh products.

CHAPTER XXI

CITROUS FRUITS AND THE GRAPE

THE COMMERCIAL ADVANTAGES OF CITROUS FRUITS

The citrous fruits, including the orange, the lemon, the lime, the grape-fruit or pomelo, and several others of small commercial importance, are the advance guard of the tropic fruit supply. We prize them for their acid flavor, which is sometimes so strong as to require sugar, as with the lemons and limes. Sometimes, as in oranges, there is enough sugar along with the acid to make them palatable in the natural form. These fruits are not important in the actual amount of nourishment they bring us. They belong rather in the class of regulators. They are good, refreshing, stimulating tonics, and distinct aids to health as well as to the pleasures of the table. In actual importance the orange perhaps renders its greatest service as food for babies, supplementing pasteurized or boiled milk, which loses some of its vitamines in heating.

People of the north temperate zone can have the benefit of these fruits because of the tough, thick, oily, and bitter skin which serves as an effective protection against insects, bruises, and decay. A host of other delicious tropic fruits remain practically unknown to commerce because they lack such natural protection, so that they could not enter commerce until recently and now only with difficulty. From 1800 to 1850 an orangery, an artificially warmed building for orange growing, was a part of the equipment of the luxurious rich men of Europe and America. At that time oranges entered commerce only occasionally and always at great risk of spoiling on the slow and uncertain sailing vessel. A steamship now can carry oranges easily from Japan to the United States, from the West Indies to Europe, and the orangery has almost ceased to exist. The fruit is to be had at almost all seasons of the year, since an orange tree carries ripe fruit and green fruit while it is in blossom.

THE ORANGE

The orange is a native of southern Asia, possibly China, where, as in India, it has been used for many centuries. It was brought by the Portuguese to Europe in 1458, and became an important industry there, as it now is in the United States. The orange now grows wild throughout the tropics and the edges of both temperate zones, and is everywhere much prized by the inhabitants. It was even growing wild in Florida a hundred years ago, having escaped from the plantings of the early Spanish settlers. Like many other fruit trees, it produces fruit of finest flavor near the colder limit of its production, so that the fruit of the United States is superior to that of the West Indies. This fact, in combination with the desire to produce as many of our things as possible at home, has caused the orange industry in both Europe and the United States to push itself northward into climates where there is constant danger and occasional great loss from freezing.

Its wide distribution makes possible an almost unlimited production, but inasmuch as the fruit is quite bulky and its commercial handling expensive, it, like the banana, can only enter commerce in large quantities where transportation facilities are of the best. Consequently, while it is important in commerce, the world's great supply comes from a few localities readily accessible to the world's great markets. It is quite certain that more oranges waste beneath the tropic orange trees than are eaten by the people of the north temperate zone. This wasting frequently occurs even in such nearby places as Jamaica and the other West Indian Islands, whence "it appears almost impossible to get a profitable outlet for oranges except in the very early weeks of the season." * Jamaican oranges could, however, come to the United States but for the American tariff. In Paraguay, a country far up the Paraná River, north of Argentina, oranges are regularly used for fattening hogs, and are fed to the donkey and any other animal that will eat them; it is only from the districts adjacent to steamboat landings on the banks of the great river that they are sent by boat to Argentina and Uruguay. Paraguay is for these countries a sub-tropic

* United States Commerce Report, October 7, 1910.

garden spot whence they receive, as does New England from Florida, and Britain from Spain, the fruits and vegetables of a warmer clime.

IMPORTANCE IN THE MEDITERRANEAN COUNTRIES OF ORANGE GROWING

It is in the Mediterranean countries that commerce in the citrous fruits was long most important. The combined warming influences of the Mediterranean Sea, the Sahara Desert, and the Atlantic Ocean make these Mediterranean countries the most northern of all regions for these fruits. A short distance away are the millions of people of northern and western Europe, connected with the orange lands of the South by steamer and numerous railroads.

The orange is found on the western coast of Portugal as far north as 40°. Orange districts skirt the southern and eastern coasts of the Iberian Peninsula, but the interior, except the plain of Andalusia, is too high and cold for this fruit.

The most important Spanish orange-growing districts are Malaga and the shores of the Gulf of Valencia, near the central part of the eastern coast. The steamship lines that skirt this coast carry thence to Great Britain half the orange supply used in that country. Much British marmalade is made of Spanish oranges and the people of Holland manufacture a drink called curacao from the skin of the bitter orange, which is grown for this purpose in Spain. So important is the bitter orange marmalade with which the British make bread and butter palatable that even during the shipping stress of 1917 the British Government provided steamers and on its own account imported thousands of tons of bitter oranges from this coast. As an example of the limited area necessary to produce important staples, it may be stated that about six thousand acres of bitter oranges in Spain supply the world market and at times oversupply it so that the fruit is thrown away.

THE IMPORTANCE OF ISLANDS IN EUROPEAN FRUIT GROWING

It is upon islands that the growing of citrous fruits has reached its most extensive development in Europe, chiefly because the surrounding waters afford protection from frost. The Azores have long been important shippers of oranges. Orange growing is important on the rainy side of the Balearic Islands. Malta has long been famous for the excellence of its oranges; in Sicily and the neighboring shores of Calabria is the greatest development of the Italian orange and lemon industry. This industry is quite as important to Italy as to Spain, Italy possessing an orange or lemon tree for every two persons in the whole country. Although the orange reaches its highest northern latitude in 44°, on the protected coast of Italy not far from Genoa, it is not important north of Rome, and the lemon, being more susceptible to cold, will not grow north of Rome at all. Sicily predominates over the mainland in the production of both these fruits, having almost a monopoly of the production of lemons. From this island they have for a century been distributed to Europe and America. The Italian and Sicilian peasants give these fruits the greatest care. South of Naples they can only be grown in the few spots that can be irrigated, for both of these trees are greedy for water. In Sicily a patch of irrigable land the size of a football field, with an orange climate, is regarded as a fortune. The ground is usually cultivated with the hoe and the spade. Garden crops are often grown between the trees.

AFRICA AND ASIA

France receives a large part of her orange supply from the African colony of Algiers, the chief center of production being near the port of Oran. The orange grows beneath the date trees in the oases, along the edge of the desert from Morocco to the Euphrates. With the exception of the Barbary States, Africa is beyond the limits of orange transportation under present conditions of production, although there are large areas where it grows. A few Asiatic oranges go to England in times of peace, from Jaffa on the Syrian coast; and from southern Japan a few come to the United States. Otherwise Asia, the native home of the orange, has almost no foreign commerce in this fruit, although it grows from the Mediterranean to the China seas.

The United States began to import oranges from Italy and

Sicily (where the industry has long been established) about 1835, when the American sailing vessels were perfected to great speed. With the development of the steamship this import became large and regular, and the West Indies also sent a supply, the chief sources being the nearby Bahama Islands and the British colony of Jamaica. Recently home production has almost ended the import into the United States, and we may at no distant date compete in foreign markets with the centuries-old orange centers along the Mediterranean, for we have two orange districts, one in Florida and the other in California, in each of which the area suitable for orange growing is much more than enough to supply our own needs.

THE INFLUENCE OF RAILROADS AND COLD WAVES IN AMERICAN ORANGE GROWING

In the great wave of development that followed the Civil War, orange planting on a commercial scale was begun in Florida and met with great success. Prices were high and profits were large. The indefinite amount of cheap land in Florida, added to this initial success, furnished the conditions for an agricultural boom, which received the further stimulus of the lure of distance and the charm of the palm—two considerations hard for the Northerner to resist. The completion of lines of railroad from the North to Florida, offering an express train service, was also an important factor in this orange boom.

The winters for several years prior to 1880 were almost frostless, and the rains abundant all the year round, so that the growth of well-cultivated young groves was phenomenal, and the northern half of peninsular Florida gave itself up to orange culture with reckless enthusiasm. It was estimated that the orange at twelve years of age would pay from ten to one hundred and fifty per cent. interest on a valuation of $100 for each tree, and in the case of individual trees even the highest figure was sometimes realized.

The first check came in 1886, when a three-days' blizzard from the northwest swept over the state and injured or at least defoliated all the orange trees down to the twenty-ninth degree, and still further south in all but the most protected localities.

This injury, however, was only temporary in most cases, and while much of the crop of 1885-86 was lost, there was no diminution in the crop of the following year, although the trees themselves had received an evident check in growth.

In December, 1894, a still more severe northwest blizzard defoliated all the trees as far south as the Manatee River, and this blizzard was followed in February by another similar storm, which caught the trees covered with tender shoots and young foliage, with active sap, and killed most of them to the ground from Tampa north, and, moreover, so enfeebled them from repeated shocks that the majority were unable to rally. The loss to the Florida orange industry by this double disaster is reasonably estimated at $100,000,000.

The crop of 1894-95, the largest produced up to that time, was estimated at six million boxes, each measuring two cubic feet. The following year about seventy-five thousand boxes were produced, all from south of the latitude of Tampa, and it was only in 1900-01 that the crop again reached one million boxes, ninety-five per cent. from regions south of Orange County, a proportion the reverse of that observed "before the freeze."

Stimulated by the early success of Florida, the commercial orange industry promptly spread to other Gulf States. The product of this Southern region is excellent if it ripens; but the occasional cold waves coming from the center of the continent and bringing freezing temperatures to the Gulf shore and to nearly all of Florida, have been disastrous to the orange orchards of the whole Gulf region, excepting a part of Florida. If not in rapid growth at the time, the orange tree can resist some frost, but in the occasional heat and moisture of the Gulf climate the tree may grow rapidly at any time during the winter. Fortunately the industry in most of the other Gulf orange districts had not progressed so far as in Florida, when the one devastating winter of 1894-95 altered the prospects of the state by killing practically all the orange trees in the northern part of the peninsula and bankrupting many of the growers. Many Florida groves were renewed; and, despite occasional injury to the crop and sometimes to the trees, there has been no other such destruction as that of 1894. Many growers now protect their orchards with artificial heat.

Florida again became and still is a heavy shipper of oranges; and by 1911 the competition between our two orange-growing regions had become keen. The early development in California was much like that in Florida. A small garden industry received access to the markets of the country through the development of through railroad service, and large plantings were then made.

The orange groves of California and Arizona are subjected to greater winter cold than those of Florida, but suffer comparatively little damage from it, since the winters are more uniformly cool and dry and the trees are consequently dormant, while the occasional warmth of a Florida winter keeps vegetation more or less constantly in active growth, and hence more sensitive to sudden frosts. In Florida in 1894 not only orange trees, but peach and mulberry trees and old wistaria vines—all hardy as far north as Canada when dormant—were frozen to the ground. Naturally the desolation of Florida in 1895, after the American people had become accustomed to eating oranges, gave a great advantage to California, where the industry grew rapidly. Then, seventeen years later, as if to humble her and check her confidence in a good climate, there came, in January, 1913, an astonishing cold wave over the whole of the California citrous fruit-belt. This region is in a climate where the great cyclonic storms that bring the rains to the United States, also to Europe, always have their centers to the north, so that the wind always blows over California from the sea. Hence her constant west winds and her constant mild climate. As Florida gets winds from all directions the northern limit of the orange in that state is about 30° north latitude, while in California it is nearly five hundred miles farther north. The oceanic climate of the Pacific Coast enables the tree to grow as far north as 37°, north of San Francisco. On this one January morning in 1913, the weather conditions were reversed for the first time in forty years, and a cold wind blew down out of Nevada. The loss of fruit, estimated at from $20,000,000 to $40,000,000, restored for a time the equilibrium of the competition between the two regions. The danger of a destructive cold wave in California is, however, much less than in Florida, although frosts that destroy the crop are not uncommon in many localities. The best groves are in the thermal-belt along the slopes, as are the peach orchards of West

Virginia. The high price of oranges after the destruction of the Florida crop in 1894 led to large plantings in California, where the orange is grown with the greatest care on irrigated land of high value, the orchards often being valued at $1,000 or more per acre. This very high value is due not to scarcity of land but to scarcity of water, which amounts to scarcity of orange land,

FIG. 120.—Irrigation of Arizona citrous fruit tree by the basin method, economical of water. (United States Reclamation Service.)

since unirrigated lands cannot grow oranges. Great pains are taken to get and save water for the irrigation of the California fruit orchards. Tunnels are sometimes built into the hillsides to strike the underground flow, wells are dug, and pumps are used to lift the water to the land, where it is sometimes carried in pipes to the base of each tree, so that the smallest possible amount may make an acre prosperous. The great distance from the Eastern markets has made transportation costs high, so that only the best fruit can be shipped. To meet these conditions the fruit growers have formed associations which are good examples of co-operative enterprise. The grower surrenders his fruit at the shed of the co-operative packing house, where the oranges are graded, packed, labeled, sold, and of late even advertised. Thousands of growers combine to pay the cost of advertising campaigns on the trolley cars and many other places in centers of consumption thousands of miles away. Deliberate experiment has shown that a given amount of advertising will increase sales by satisfactory amounts. This advertising has been necessary in order to create an outlet for a product which has increased from an average of 26,000 cars a year in 1904-06, to 42,000 cars in 1915-17. The state of California has increased its shipments of lemons and oranges together from 22,000 cars in 1900-02 to 50,000 cars in 1915-17.

In the southern part of the California citrous district the lemon is now being extensively grown for the American market, but the continued import, almost entirely from Sicily, shows that the home supply is well under the demand.

THE FUTURE SUPPLY OF ORANGES

The development of the two American orange-belts cut down imports to the United States fifty per cent. between 1904 and 1908, and those of 1910 were less than a third as great as those of 1908. The small quantities still imported come from Jamaica, Cuba, Honduras, Mexico, Spain, Italy, and Japan. The steamship lines from Italy that once carried hundreds of thousands of boxes of oranges and lemons now come with a scanty cargo of lemons. It is likely that in a short time the United States will become an orange exporter and develop strong competition between Florida and California. Florida is more subject to frosts and, because of her moist climate, to fungous diseases which at times injure the trees, but she is nearer to the market in the great centers of population of the East and makes the claim that her oranges are juicier and that her grape-fruits are better than those of California. The professor of horticulture in the University of California declares that California is using for oranges only one-tenth of her suitable land. The orange land of Florida, with but twelve per cent. of her area in cultivation, with only fourteen persons to the square mile, an abundant rainfall, and about half of her area in reclaimable swamp of great fertility, has a much greater possibility of expansion than has the orange land of California. The comparison of Florida with Sicily is even more striking. Florida is nearly all level and capable of tillage, Sicily very hilly and rocky; Florida is well watered, Sicily is dependent on irrigation for all important crops but wheat; Sicily possesses twenty-five times Florida's population per square mile.

Manifestly the limit of orange production in the United States is to be set, not by resources, but by prices. Unchecked production in Florida and California can easily result in the same low price that prevails in the tropics, where oranges lie unused on the ground. The citrous fruit market is easy to glut, as is shown by the shipment of eight hundred thousand boxes from Sicily to the United States in three months in 1895, when the price went down to such a low figure that only shipping costs and duty were paid—a condition that at times faces the Cuban orange shippers.

In 1910 the United States had two and one-half times as many oranges as in 1900. We should note that this increase occurred during a decade when the number of meat animals declined and the price of grain rose.

CUBAN ORANGES

The fear of destruction of the orange crop by frost in Florida caused a boom in orange planting in Cuba in the few years immediately after 1899. Orange and grape-fruit groves were planted, chiefly by Americans, at an expense of $10,000,000; but the Cuban grape-fruit is said to be sweet and therefore not so desirable as that of Florida, while the tariff and shipping costs leave so little money for the Cuban growers that there seems to be small prospect of large orange shipments from that island to the United States, or to Europe with its Mediterranean supply. The Cuban orange, seems, like the Jamaican orange, destined to lie upon the ground rather than to enter foreign trade, unless calamities overtake Florida and California, or the manufacture of orange products is greatly increased.

THE GRAPE-FRUIT AND THE LIME

The speedy capture of the American market by the grape-fruit is one of the most spectacular and encouraging changes in food supply that has happened in the last twenty years. It shows that we can change our habits. This big brother of the orange, with its pungent, slightly bitter flavor, first came from Florida. It is probably true that Florida produces more acceptable grape-fruit than either of its rivals, California and Cuba.

The lime, excepting the new kumquat, the smallest of the commercial members of the citrous family, seems to thrive best in the tropics, the chief supply coming from the Lesser Antilles. The leading producer is the little island of Dominica, whose people, since the decline of the sugar industry, have given much attention to the production of the lime, which is well suited to the steep, rocky limestone hills of the island. Here are plantations and factories owned by the great candy manufacturers of Europe, who prepare lime juice for the preparation of candies, and sell citrate of lime and lime oil for use in the preparation of drinks, medicines, and some commercial products. The neighboring island of Montserrat also produces limes.

We are greatly in need of some process whereby orange juice concentrated, canned, or dried, can be made where oranges now rot, and cheaply brought like powdered milk or dried vegetables to remote places. It is reasonable to expect that the food scientists will give us such a commodity ere long, and thus place the orange in the most remote mountain cabins. The orange growers of Natal, British South Africa, were having conferences in 1917 over the possibilities of getting some manufacturing outlet for their oranges, and were considering the manufacture of jam and of citric acid.

THE GRAPE HISTORY AND THE REQUIREMENTS OF THE VINE

The great antiquity of the grape is indicated by the unfortunate relaxation of Noah after the strain of operating the ark. When Micah wished to draw a picture of earthly bliss he placed a man beneath his own vine and fig tree, and abolished war so that there should be none to make him afraid. The grape, probably the oldest of the domesticated fruits, is considered a luxury wherever it can be obtained, being a delicious food as well as material for the too highly prized wine. These two uses have combined with its laudation by classic writers to make the grape the most celebrated of fruits. Its patron, Bacchus, was a god.

The vine is indigenous in the United States, from the Atlantic to the Pacific, from British Columbia to the tropics, and in Eurasia from Hungary to Afghanistan. Grape seeds are to be found in the remains of the Swiss lake dwellings dating back to the bronze age, but it is probable that the Old World industry as we now know it began somewhere in western Asia. The many Old Testament references to the vineyard show its great importance among the Hebrews. The grape was early introduced among the Greeks and Romans and has spread throughout the world wherever the climate and soil permit its cultivation and even beyond the natural climatic bounds; for large quantities of most delicious and extensive grapes are grown in the hothouses of England, Holland, and France.

The chief requisite for the grape is a rather hot summer lasting into September. The vine sends its roots to great depth and can thus search out water in arid soil and will thrive in dry climates when surrounding vegetation is brown and dead. For this reason it grows in southern Italy and other Mediterranean lands without irrigation on the hills above the orange groves. In California, where irrigation must be used for many other fruits and crops, the grape crop is often grown without any artificial watering, even in some localities where there is no rain from blossoming time until harvest time. Accordingly, the grape is at home upon the edge of the world's sub-tropic belt in each of the three continents of the Northern and Southern Hemispheres. Too much moisture favors the growth of fungi which attack and destroy both the leaves and the fruit. On this account in the monsoon climate of India, China, and Japan, with its heavy summer rainfall, extensive grape growing is impossible. Even under the best of conditions, fungi sometimes appear and work great damage, for instance the fungus called the "oidium," which has practically destroyed the vineyards of the Madeira Islands and has wrought great havoc in other parts of the world.

THE LIMITS OF GRAPE GROWING

Although the grape is grown on the sheltered Channel Islands, the line marking the limit of the industry on the European mainland is curved from the west coast of France near the mouth of the River Loire northward to latitude 53° in eastern Germany. This northward trend is due to the increasing heat of the summer as we go eastward from the moderating influence of the ocean into the greater heat of the continental summer. In Russia, where the summers, though hot, are shorter, the line of grape cultivation descends to the Sea of Azof and thence runs eastward through southern Russia and Asia. In America, there is a similar bend of the boundary from 37° north in California to 40° in southern Ontario, where the lake-belt extends the region of cultivation northward. In the Southern Hemisphere grapes grow near the chief centers of population in Australia, South Africa, and temperate South America.

THE GRAPE INDUSTRY

In past centuries, including the nineteenth, grapes were chiefly important for the manufacture of wine. A change is now in progress, partly due to the growing opposition to alcoholic drinks, and partly to the increasing use of grapes as food, resulting from the greater facility of transportation. Grape growing and wine making are most important as national industries in France, Italy, and Spain—countries which produce five-sixths of the world's wine. Other countries prominent in the industry are Austria, Russia, Switzerland, and the United States. Italy depends more upon grapes and wine growing than does any other nation. The limestone hills and dry summer permit the grape to thrive better than most other crops; consequently it is grown in all parts of the country. Vineyards cover not less than fifteen thousand square miles or about one-seventh of the area of the kingdom, one-sixth of all used ground, and one-half as much land as all the grain crops combined. These figures become more significant in comparison with those of the corn crop of the United States, which covers about one-seventeenth of the area of the country. The Italian vineyard is usually cultivated with the hoe and the spade, garden crops are sometimes grown between the rows, and much of the soil is so steep that it is kept from washing into the Mediterranean only by the laborious building of terraces, sometimes held up by stone walls. It is chiefly this intensive agricultural industry that has given to rugged and arid Sicily a population of three hundred persons to the square mile.

France is the leader of wine-producing countries. While the grape area is only one-half that of Italy, the yield is greater than Italy's, on account of the superiority of French land, rainfall, and agricultural methods. The French grape crop covers only one-eighth as much land as that given to the grains. Although it does not extend into the northwestern part of the country, the famous province of Champagne touches the Belgian boundary. The high reputation of French wines, among them claret, burgundy, and champagne, makes wine, after textiles, the chief export of the country. Her foreign commerce and prosperity depend to so great an extent on this trade that a calamity to grape growing is a national calamity. Such was the phylloxera; an insect pest which came from America to Europe, where it spread through all the wine-growing countries, thence to Algeria, and finally reached South Africa, Australia, and South America. The phylloxera, a tiny insect of the aphis family, fastens on the roots of the grapevine and sucks the juices from them until the vine is killed. No cure has been found. France, which had nearly six million acres of vineyards in 1875, had less than two million acres of healthy vine, in 1885, and another million acres were invaded by the phylloxera. The only circumstance which prevented the practical extermination of the European varieties of grape was the fact that in the eastern United States, the home of the phylloxera, there were varieties of grape immune to its attacks. These were imported into Europe and set out by millions in the vineyards which the phylloxera had devastated; tops of the European varieties were grafted upon their roots, making a composite plant with American roots to resist the destroying insect and a European top to produce the desired wine grape. Thus, the industry rose again until at the outbreak of the Great War France had three-fourths as many acres in vines as she had in 1875 and the yield was four-fifths as great as at that time.

Spain is a wine producer, a great raisin producer, and also has an important commercial food-grape industry along her southern shore, especially near Malaga and Almeria, which usually supply most of the four or five million dollars' worth of grapes imported by England each year. The grapes usually go in casks, packed in cork dust, and are familiar in American markets; but in 1917 the ship shortage was so great that sixty per cent. of the crop rotted.

The style in grapes is a good illustration of the influence of habit and cultivated taste on industry. The Europeans scorn our Concords, Niagaras, and other native American grapes with their distinctive flavor, and while the roots of these same varieties are growing by the tens of millions in European vineyards, people look upon their fruit with contempt. On the other hand, I myself remember my profound disgust upon eating the much-prized grapes of the famous vineyards of Bingen on the Rhine. I did not finish my portion, and longed for a bunch of good Concords.

If the world's wine industry is to decline, as the war and changing opinion promise it will, many parts of Europe face the necessity of cultivating a greater grape-consuming habit or changing their agriculture, for the grape holds a place of astonishing importance and is often cultivated with the greatest labor.

HILLSIDE GRAPE GROWING IN EUROPE

In the northern parts of the European grape-belt the desired heat and sunshine can be obtained only by planting the vineyards on the southward sloping hillsides. There they are protected from the north winds and exposed, by the inclination, to the practically direct rays of the sun; they often get in addition the reflected sunshine from the surface of the Rhine, the Moselle, or the Swiss lakes. Switzerland has become a wine producer by utilizing the slopes overlooking Lake Geneva and the other lakes. Germany, with a production of one-twelfth that of France, furnishes probably the best example of hillside grape growing. The most famous of the German districts are on the steep southern slopes to the Rhine and its tributaries, the Neckar and the Moselle.

The vineyards on these riverside southern slopes prosper in latitudes where otherwise they could scarcely exist. Some of the Rhine terraces have been planted in grapes continuously for centuries, and so highly prized are certain brands of wine that new terraces have been built from time to time in places so forbidding that a retaining wall had first to be built and earth carried up from the river banks in baskets (often by women), before the vines could be planted. One particular mountain slope near Bingen produces the famous Johannesberger wine, and is valued at $7,000 per acre, the equivalent of $33 per front foot for a building lot one hundred and eighty-five feet deep. These terraces, so steep that horses cannot climb them, are cultivated entirely by hand; baskets of manure are carried up, strapped on the backs of men and women. So dense is the population of these districts and so great the pressure on resources that when the green ends of the vines are cut off in August to hasten the ripening of crops, they are carefully saved and fed to the goats, and when the vines are trimmed in winter the cuttings are sold for fuel. In America they are thrown away.

Owing to the scarcity of land, terrace vineyards are common on Italian hills and mountains. Nearly two hundred terraces, one above the other, may be seen on the southern slope of the Apennines, near Lucca.

A change in the purpose of European vineyards from drink to food would not augment Europe's possibilities of maintaining increased population, because of the high cash value of export wine.

GRAPE GROWING IN THE UNITED STATES

North America has a greater wealth of wild grapevines than has any other continent. For hundreds of years before the coming of the European settlers this land had been known among the Norsemen as Vineland. The early explorers were astonished to find wild grapevines reaching to the tops of tall trees and often attaining a thickness of half a foot or even more. I have myself known cows to get caught in their festooning stems so that they could not get away. When the European colonists on the shores of North America stocked their gardens with the plants and trees of Europe they were pained and astonished to find that all the grapevines promptly died from some mysterious kind of blight that destroyed the leaves. This calamity was a great blow to the hopes of Virginia colonists, who were counting on the vines to establish a wine industry, so that they might have something to export, as the basis of trade, to the then agricultural mother country. The death of the grapevines nearly broke up the colony by destroying this chance of trade; the colonists were about to go back when their success in growing tobacco saved the day.

Their grapevines had died from the effect of strange fungi, to which the plant had never been subjected in cool western Europe or dry southern Europe, but which throve in the heat and humidity of the eastern American climate. After several generations of failure with European grapes the people of the eastern part of the United States have succeeded in finding or selecting a number of native varieties of edible and of wine grapes, whose names—Concord (1854), Clinton, Niagara, Delaware (1850), Agawam, Catawba (1823), Early Ohio, etc.—show their American origin.

There are now two widely separated centers of commercial grape growing in the United States: the eastern, near the Great Lakes, and the western, in California. The grape is widely grown throughout the eastern and southern parts of the country as a garden crop, but the cold waves of the continental climate with their late spring frosts make it a little uncertain as a money crop except in localities where bodies of water give protection from frost. Consequently, the eastern grape-belt lies close to the shores of Lake Erie, Lake Ontario, and the five slender lakes of New York, called the Finger Lakes. The vineyards of the Finger Lake District grow on the southern and western slopes of the hills along the eastern shores of the lakes, the prevalent west winds blowing across the cold waters in spring giving the desired temperature. The fact that New York State possesses the Finger Lakes and touches the two Great Lakes, Ontario and Erie, gives it leadership in Eastern grape growing, while Ohio with a long stretch on Lake Erie is second, and Pennsylvania with one county on the lake is third. Along the southeastern shore of Lake Erie, especially on certain islands in the lake and even on the Canadian lee shore, the grape field is much the most important field on the farm and is often the entire dependence of the grower, who for many years before the Great War got about two cents a pound for the fruit. The grapes of this Eastern district are chiefly of the Concord and Niagara varieties, which are highly prized as table grapes and are widely shipped to the cities, small towns, and country districts of the Eastern and Central States. They are far cheaper, sweeter, and more generally liked than the European varieties of edible grapes.

California, with her Mediterranean climate, has become a second Mediterranean country in other respects as well as in the production of citrous and dried fruits. The climate has attracted Italian and Swiss vine growers who have formed colonies and grow the European grapes which thrive in this part of America.

Two hundred and fifty thousand acres of land, usually level, and for the most part in the Great Valley, have for some time been devoted to grapes with a yield per acre greater than that of any other region in the world. This high yield is due partly to the richness of the deep valley soil, new to grapes, and partly to the fact that the European growers devote themselves to varieties with special qualities but often with low yield. European varieties of grapes, grown in California, are sent over the whole eastern part of the United States, where they are sold at a price much higher than that of the Lake Erie grapes. Wine manufacture has been taken up with considerable success, and some of the product is exported, although the choice brands of Europe are still far higher in reputation and price.

The prohibition of the manufacture of wine has been postponed in California for a period long enough to give the wine grape growers a chance to change to some other industry, such as table or raisin grapes, which already take up about half of the grape area of California.

It is needless to point out that the possibility of increasing the quantity of grapes grown in the United States is quite indefinite. Good grape land many times as extensive as the present grape area awaits cultivation; but the farmer holds back because of the fact that the selling price ordinarily leaves small margin of profit. It is doubtless true that the grape consumption in the United States could be greatly increased if the fruit were more economically marketed. It is not at all uncommon for the farmer to receive a cent and a half a pound for the grapes which the consumer buys in a three-pound basket for five, six, or seven cents a pound. The putting of grapes into little three-pound baskets is a shameful waste of wood. Grapes usually keep many days, and might just as well go to market in a package requiring less wood per pound of grapes, and hence permitting them to be sold more cheaply and consumed more extensively.

Large areas of excellent grape land lie unused in the south temperate zone. Fine grapes are grown for wine and table use in the sub-tropic dry summer regions of Argentina, Chile, South Australia, and South Africa. It is probably true that each of these localities has an area of grape land large enough to supply all the United States or all Europe with table grapes and raisins, if the demand should arise. Table grapes from these regions, of course, would be ripe in our winter and the raisins could easily be shipped. There is now a small export in normal times of table grapes from South Africa to Britain in the winter season. There is no reason why this traffic might not be organized so that such cities as Chicago, or Edinburgh, could have good table grapes of the American varieties at six cents a pound retail in April. It is chiefly a question of the organization of marketing —a work which we have as yet barely begun.

CHAPTER XXII

SUGAR

SOURCE AND HISTORY OF SUGAR

MAN, as we now know him, has filled himself with protein ever since he began getting walnuts and snails from beneath the trees and fat grubs from under fallen logs, and with starches ever since he began to eat the wild acorn and the wild banana; but, although he has long known the taste of wild honey, sugar, as a staple of diet, is one of the new foods to the man of cool climates. The appearance and use of sugar affords a good example of the service of science to man and of the changes that we may expect in our food supply in this century. Sugar has been all around us for countless ages, but we did not know how to get it. The bees knew better than man how to get sugar; hence the high appreciation of honey in the Scriptures and other ancient literature, for it was about the only source for this toothsome sweet, sought alike by man and most of his beasts. In Queen Elizabeth's time a pound of sugar cost as much as a quarter of veal.

There was a time in the Middle Ages—and that is, after all, not many generations ago—when the only sweet things man had were honey, raisins, and such things as sweet fruits. Sugars were unknown and probably not liked by hosts of our ancestors—there are some today who do not care for sweets; but the sugar habit, like the tobacco habit or the chewing-gum habit or the alcohol habit, is going to bring about acute suffering in those who must give it up or curtail it, just as the bread habit and the meat habit are hard to change.*

When King John of France was being taken to England after the battle of Poitiers and one of the principal items of his expenditures was for sugar, one of the kingly luxuries of the day, could be possibly have imagined that the time would come when a descendant of a West

* Fairchild, David: "The Palate of Civilized Man and Its Influence on Agriculture," *Journal of Franklin Institute*, March, 1918, p. 312.

African slave, in a continent yet undiscovered, would remark in the language of his captors, "It just seems like somebody was dead in the house to have no sugar." These are consequences of food habits.*

In 1821 the people of the United States consumed eight pounds of sugar per capita; in 1850 the amount had increased to thirty pounds, and in 1915 to eighty. In the first ten months of 1917 sugar was being consumed at the rate of ninety-one pounds per capita, according to the great sugar authorities, Willet and Gray. This increase was due partly to the campaign for canned food, partly also to the greater earnings of the American working man, bringing greater opportunity to indulge in luxuries.

Sugar is almost the only article of our diet that is entirely digestible, and it is also very peculiar in that it is comprised entirely of one element, namely, carbohydrate, without a trace of either protein or fat. It therefore comes in the class of pure fuels and the amount we are eating at the present time, according to Lusk, is enough to give us twenty per cent. of the total energy requirement of the American people.

"Cane sugar is a valuable condiment, and when taken in small quantities every half-hour may delay the onset of fatigue." † This practice has been tested many times, and owing to the almost instantaneous digestibility of sugar, it nourishes almost as quickly as a stimulant stimulates, and is much better for us.

We get sugar at the present time from two main sources, sugar beet and sugar cane; but one or the other of these may at any time have a successor as a result of changes in science or agricultural practice, for sugar is one of the common elements of a great variety of plants. Nearly all plants have it in their sap at some time in their growth; consequently there are many possible sources of sugar. Many plants store sugar which can be used in other seasons, just as other plants store and use starch. All fruits contain some sugar, the grape being especially rich (see raisins), and some sugar is found even in the onion. The more important of the sugar-storing plants are beets, carrots, and parsnips, which hoard it for use in the second year of their growth to m[illegible]

* Fa[illegible]
grap[illegible]

and seed. The date palm, Palmyra palm, and coconut palm of the tropical zone are used to some extent for sugar manufacture in the lands of their growth. The American Indian took sugar from maple trees. The sugar cane, a plant much resembling an earless stalk of corn filled with sweet juice, grows throughout the moister parts of the tropics and in its natural condition is so superior to other sugar yielders that it was for ages practically the only source of commercial sugar supply, except the primeval sugar supply of honey (the sugar of blossoms), which was much more important in past centuries than it has been since other sources of sugar have been developed. In the shortage produced by the Great War the price of honey rose more than that of sugar itself, because its price and use were not controlled.

The general and heavy use of sugar among people of the temperate zone is recent, almost as recent as the discovery of petroleum, and it has rapidly passed from a luxury to a necessity. In 1700, fifty thousand tons per year were used in all countries of Europe. At the present time, that quantity lasts the United States about four days. During the last century there has been a sevenfold increase in the world's commerce in sugar, and the people of the world are using more and more per capita each year.

SUGAR

Exports:	Average tons, 1909-13
Austria-Hungary	848,000
Barbados	25,000
Belgium	154,000
Brazil	38,000
British Guiana	106,000
British India	26,000
China	14,000
Cuba	2,000,000
Dominican Republic	92,000
Dutch East Indies	1,412,000
Egypt	8,000
Fiji	78,000
F[illegible]	206,000 Beet

	Average tons, 1909-13
Exports:	
Netherlands	82,000
Peru	146,000
Philippine Islands	179,000
Reunion	41,000
Russia	293,000
Trinidad and Tobago	43,000
United Kingdom	32,000
Other countries	330,000
Total	7,472,000
Imports:	
Argentina	51,000
Australia	76,000
British India	715,000
British South Africa	30,000
Canada	297,000
Chile	84,000
China	343,000
Denmark	21,000
Egypt	43,000
Finland	50,000
France	186,000
Italy	9,000
Japan	176,000
Netherlands	200,000
New Zealand	62,000
Norway	52,000
Persia	109,000
Portugal	39,000
Singapore	81,000
Switzerland	118,000
United Kingdom	1,853,000
United States	2,987,000
Other countries	513,000
Total	7,989,000 *

Sugar cane

The Great War took place in the midst of the greatest sugar field of the world and the blockades stopped the greatest sugar trade—that between Germany, the greatest producer, and Britain, the greatest per capita user and a great importer. Britain had to shift from beet to cane sugar, from near to far sources of supply, and one of the first acts of her government

* *Year Book* of Department of Agriculture, 1917, p. 695.

after it entered the commercial field late in 1914 was to buy such quantities of sugar that her ports were choked.

UNITED KINGDOM CANE SUGAR IMPORT, BEFORE AND DURING THE WAR *

	1911	1913	1915	1916	
Cuba	3,000	224,000	359,000	553,000	long tons
Java	166,000		398,000	383,000	
Philippines	3,000		6,000	68,000	
Peru	27,000	27,000	31,000	50,000	
Mauritius	55,000	20,000	191,000	108,000	
U. S. A. refined			188,000	267,000	
	267,083	271,888	1,176,000	1,432,000	

THE PERFECTION OF THE SUGAR BEET

Sugar is one of the few commodities in which there is competition in production between the cool temperate and the tropic regions. During the last sixty years, cane-sugar producers and beet-sugar producers have striven for the markets; this rivalry will doubtless continue for decades to come.

It is probably due to the Napoleonic wars that the beet has become a great source of sugar supply. The military and commercial blockades of these wars cut off France and often the rest of Europe from the slave-grown cane-sugar supply of tropic colonies. At the order of Napoleon, French scientists examined hundreds of plants in the search for a promising sugar supply. Among them the grape and the beet were most seriously considered because of their large content of sugar, but industrial effort centered itself on the beet, which the Germans first used in 1799. In 1806 the French Government offered a bounty for beet-sugar production, and in 1811 Napoleon ordered eighty thousand acres of beets to be grown for sugar. Only one sugar factory survived the Napoleonic wars and the renewed competition of cane, but the industry lingered until finally by the middle of the nineteenth century it had become firmly established.

This beet-sugar industry affords a convincing example of the service of science to industry. The wild beet was a slen-

* "The American Sugar Refining Company," 1917.

derly rooted plant, growing in sandy soil in southern Europe and first cultivated about 300 to 200 B.C. In 1836 it took eighteen pounds of beets to make a pound of sugar; in 1882 about ten pounds sufficed; in 1904 less than seven pounds yielded a pound of sugar. This great improvement has been brought about chiefly in Germany, where on large sugar plantations trained scientists, often doctors of philosophy in chemistry, devoted their whole time to improving the sugar content of the beets. Samples are cut from the most promising roots and tested; the best beets only are saved to produce seed the next year—a process continued for generation after generation of the plant. This systematic selection has, within the life span of man, trebled the sugar content of beets and, along with improvements in the process of sugar extraction, has made possible one of the greatest agricultural industries of the temperate zone. The process of improvement has not yet ended. The percentage of sugar in the beet crop of the United States rose from 14.8 per cent. to 16.35 per cent. between 1901 and 1910. In 1917 it was 18.48 per cent. from the California crop. In eight years the percentage of sugar extracted from American beets rose from 10.95 per cent. to 12.56 per cent.—14 per cent. increase in the amount of sugar produced per ton.

CLIMATIC REQUIREMENT AND EUROPEAN DEVELOPMENT OF THE BEET-SUGAR INDUSTRY

While the beet will grow in a very wide range of territory from the tropic nearly to the arctic zone, the conditions for beet-sugar production are exacting—a moderate amount of spring and summer rain and a moderate heat, though not too hot, and a cool, dry autumn. Most climates suitable for corn, for example, are too warm in midsummer. The cool climates of England and Sweden suffice for the beet. It is therefore obvious that corn and sugar beets are rare competitors, except along the margins of the two zones as in lower Michigan. Irrigation in America gives the best conditions for beet growing, and the arid region rarely suits corn. In its soil requirements, the beet is also exacting—deep fertile loam, well drained and aerated. It also needs lime and an abundance of available plant food. In

Europe the best region for beets is the great northern plain from Normandy to central Russia. Germany is the leading producer, and in 1900 so great had the industry become that sixty per cent. of the German product was exported. Germany and Belgium began to export shortly after 1870, Russia in 1888, France in 1889, and Holland in 1895. Spain depended entirely on sugar from Cuba and the Philippines while she ruled them, but after losing these possessions in 1898, she began at once to grow sugar beets in her northern provinces with such astonishing rapidity that her local production rose from 2 million pounds in 1896 to 113 million in 1899, and 207 million in 1903, enough for the home demand. Southern Sweden and southern Denmark have also taken up the industry, but have not become sugar exporters.

RELATION OF SUGAR BEET TO INTENSIVE AGRICULTURE

The growing of sugar beets is an intensive agricultural industry. The soil must be finely prepared, and plowed so deeply that a subsoil plow must often follow the ordinary plow. Caring for the crop is most laborious because of the large amount of hand labor required. The young plant is so small that only human fingers can rescue it from the upspringing weeds, so that men, women, and children, especially women and children, go into the fields in nearly all beet regions, including the United States, and spend days upon their knees weeding the young beets. A little later, when the plants have become established, they must be thinned out with the hoe. Thus far the inventors of machinery have been unable to replace either of these kinds of hand labor.

After the plant is established there must be many cultivations. In the late autumn the beets are plowed out of the ground and the tops pulled off. The roots are then piled, covered with straw and sometimes with earth, until delivered to factories by wagon, train, or boat throughout the winter months. The beet-sugar factory to be economical must be large, costing before the war a million dollars or more. Hence it is to the factory owner's interest to encourage beet growing, and in America, as in Germany, the sugar manufacturer, through contracts with the farmer, controls the crop rotation, the method of beet growing, and, to the community's benefit, becomes virtually a teacher of agriculture. The beets are ground to pieces, the sugar soaked out of them in hot water, and finally crystallized and sent to the refinery to be put into final form. It is common for American beet-sugar factories to have refineries also.

The by-products of the beet field serve greatly to enhance the usefulness of this crop in the intensive agriculture of a populous country. The leaves and tops of the beets were worth for cattle

FIG. 121.—Europe, sugar-beet acreage. Each dot equals 1,000 acres. (Finch and Baker.)

food \$4.50 to \$5.75 per acre in Germany a few years ago. This figure makes an interesting comparison with the \$12.20 which was the farm value of the average acre of wheat in the United States in 1913.

The pulp from which the sugar has been extracted is taken back by the farmers and fed to cattle, and the average value of this food in Germany was \$10.40 per acre, whereas the average American hay crop in the years 1896-1905 was worth on the American farm \$14.41 per acre, a figure that is less than the value of combined pulp and leaves of the German beet crop.

It is, therefore, evident that beet growing plays an important part in the stock farming on the small farms of northern Europe. The European beet farms are almost always well cared for, because the beet-manufacturing companies, to assure themselves an abundance of beets, insist in their contracts with the grower that a certain rotation of crops shall be followed. Furthermore, the care and fertilizing required by the beet leaves the field in excellent condition for the production of a fine crop of small grain the succeeding year. This rotation results in such increased yields of grain per acre that it is said that the addition of beets to the crop rotation has not reduced the total grain yield of the beet districts. The beet acreage of the entire world is surprisingly small. With her huge sugar export before the war, Germany raised her whole crop on but one and one-third million acres of ground—a matter of two thousand square miles, less than one per cent. of her total area. Yet she was able to export to England nearly a billion tons of sugar in the year 1913.

THE ACREAGE, PRODUCTION, AND VALUE OF THE LEADING CROPS IN GERMANY FOR FIVE AVERAGE YEARS, 1898-1902

Crop	Per cent. tilled land in Germany	Area (acres)	Production		Estimated value	Average value per acre
Rye	23	14,696,478	345,771,316	bu.	$302,646,524	$21
Oats	16	10,223,409	485,647,752	"	259,898,923	25
Wheat	8	4,709,031	130,038,110	"	135,046,363	29
Barley	6	4,175,750	139,959,940	"	108,000,331	26
Potatoes	12	7,902,374	528,094,827	"	318,651,012	40
Sugar beets	2	1,091,632	14,893,089	tons	60,167,934	55

The small acreage actually and proportionally that produces the European beet crop is another proof of its fitness for intensive agriculture. Belgium, the most densely peopled of all Western countries, has only three per cent. of her area in this crop, but has long been a regular sugar exporter. Germany, with the most fully developed agriculture of any of the large nations, became a heavy exporter with a sugar area one-sixth the size of her potato area and one-thirteenth the size of her rye area.

EUROPEAN CENTERS OF PRODUCTION

The map of beet production in Europe shows that while its growth is scattered throughout central Europe, from northwestern Spain to Moscow, there are four centers of importance. The greatest is in the chalky soils of Holland, Belgium, and the north of France between Paris and the English Channel. This is economically one region separated only by imaginary political boundaries across which the beets are freely passed to the nearest factories without tax or duty. Another great region is in central Germany, near Magdeburg, where beets occupy from one-tenth to one-seventh of all the cultivated land. Here the beet fields spread in great expanses over the level, perfectly tilled plains; and, while the peasant children pull weeds, their mothers, even before the war, could be seen plowing the beets, using at times the family cow for a draft animal. During the winter the manufacture of the sugar occupies much of the laboring population and the by-products help to feed the animals on the farms. This district is well situated for export of sugar because it is on the navigable Elbe, which carries nine-tenths of the traffic in this territory.

Northern Bohemia, in the plains around Prague, also on the navigable Elbe, has raised much of the Austrian crop. In southwestern Russia a large part of the level plain centering in the Kief district, in the Ukraine, is a beet section where, although the yield is only about half (seven and one-half tons per acre) that of Germany (twelve tons per acre) and their sugar content lower, beets are extensively grown and the acreage of about two million, larger than that of any other country.

GOVERNMENT INFLUENCE AND THE BRUSSELS CONFERENCE

The sugar industry is one to which governments have given much attention and about which many laws for both protection and taxation have been made. In many countries the sugar industry exists only by the special privilege of government protection. Throughout central Europe sugar has generally been high in price because practically all the producing nations have a protective tariff to keep out foreign sugar and in addition an excise or local tax of several cents a pound on sugar. Thus, in 1902, the German excise tax was two cents and the French tax five and one-fourth cents per pound. The consequent high prices lowered sugar consumption. England, which has no tax on sugar and whose sugar price is therefore the cheapest in the world, had in 1902 a sugar consumption of ninety pounds per person; that of the United States with a two cent tax * was seventy-one pounds; while the Russians and Spaniards ate one-sixth as much, the French one-fourth, the Germans less than a half, and the Italians but a tenth. When the production in Germany, Austria, and other countries of Europe was greater than the consumption, sugar could not without loss be sold in foreign countries until after the excise tax had been repaid by the government. For example, the German manufacturer who paid his excise of two cents per pound, could not get more than three cents per pounds for his sugar in England, leaving him one cent for the sugar unless the government refunded the excise upon the exported sugar. This the government did, and, as an encouragement to foreign trade, the export refund or ''draw back'' was usually made larger than the excise, and, therefore, resulted in a bounty on export sugar.

The industry was further complicated by the formation of sugar trusts by the refiners in Germany and other countries. There refiners' trusts raised the price to the people of the home country, and because of large profits from this source could afford to sell the surplus abroad at exceedingly low prices. When Germany, France, Austria-Hungary, Holland, Belgium, and Russia were thus partly paying for the exported sugar, it became an expensive business for those governments, but one from which the two great importing countries, United States and England, chiefly profited. These bounties so stimulated production on the continent of Europe that surpluses of sugar accumulated and the competition with cane sugar became so keen that the British sugar-producing colonies of Jamaica, the other West Indian

* The United States has had for many years an import duty of two cents or more per pound.

Islands, and Guiana suffered great depression on account of the reduced price of sugar. To protect her colonies, England threatened to lay on all sugar imported into that country a tax that would just equal the bounty that it had received in the export country. This would benefit the British treasury at the direct expense of continental treasuries. To seek means of relief, a sugar convention was called at Brussels in 1901 and 1902, at which most of the European countries agreed to stop all export bounties whatever. As a result the world's sugar exporting went forward on a more normal basis. The removal of export bounties lowered the prices in exporting countries and raised it in importing countries. Thus England saved her colonies from the competition of sugar made cheap by export bounty and the people of beet-growing countries had for the first time cheap sugar for home consumption. The result was instant increase in consumption in beet-growing countries. In Germany this increase amounted to fifty per cent. in a year and in France consumption was nearly doubled. All this legislative tinkering had an interesting effect on the race between the two great sugar plants, the beet and the cane.

COMPETITION OF BEET AND CANE

During the fifty years before the Brussels convention, the proportion of beet sugar had increased from fourteen per cent. of the total world production to sixty-four per cent.; but the revival of the cane industry in Cuba and other tropic countries and the decrease in the planting of beets in Europe, after the Brussels convention, caused it to fall to fifty-eight per cent. in three years. By 1910 the cane was again ahead. (During the period of the Great War the cane had undisturbed opportunity, while the war ravaged the greatest beet-producing region of the world, the north of France and Belgium.) As a result the production of beet sugar has fallen off 3,500,000 tons during the war period, while the production of cane sugar has increased 1,300,000 tons. The total production of beet and cane in 1917 was about eleven per cent. below that of the pre-war period.

As a natural result of the labor and climate required, the sugar-beet industry was established late in the United States, despite great land resources for it. Production was only 3,000 tons in 1890, but, stimulated by a high-tariff-made price, it

FIG. 122.—Competition of cane and beet sugar.—World Production

reached 184,000 tons in 1900; 400,000 tons in 1906 (surpassing the cane crop); 500,000 in 1911; 800,000 in 1915. The threatened famine of the war stimulated production and increased the acreage from 480,000 in 1914 to 665,000 in 1916.* As almost all of the American seed supply had been imported from Germany, there were many interesting and romantic adventures in the getting of good beet seed out of Germany by bribery, smuggling, and long detours, including caravan journeys through central Asia. The United States is now nearly independent for a time at least of foreign-grown seed. The possible beet area of the United States is several times as large as the possible cane area, and seems to follow rather closely the July isotherm of 70°, which traverses the country in long detours, from Maine to California, giving us a widely scattered sugar-belt which skirts the northern and western edge of the corn-belt.

The sugar beet thus offers a money crop to the American farmer in those regions where the climate is a little too cool for the maximum development of corn.

The beet with its heavy labor requirements did not interest the American farmer while corn land was still to be had for the taking. The peculiar fitness of sugar for irrigation farming is shown by the great labor required, the large yield, and the concentrated and valuable product. Most of the crop is grown on irrigated soil. The relative importance in some American localities is as great as in any part of Germany. At the last census, Eddy County, New Mexico, had fifteen per cent. of the improved land in beets, while Bay County, Michigan, had thirteen per cent. and Ventura County, California, and Spokane County, Washington, had six per cent. each.

*SUGAR PRODUCTION IN UNITED STATES AND ITS POSSESSIONS
(in tons)

	Beet sugar (chiefly refined)	Louisiana	Other states	Porto Rica	Hawaii	Philippine Islands	Total
1901-02.......	184,000	360,000	4,000	103,000	355,000	75,000	1,082,000
1909-10.......	512,000	364,000	11,000	346,000	517,000	140,000	1,892,000
1910-11......	510,000	242,000	12,000	349,000	566,000	164,000	1,946,000
1911-12.......	599,000	352,000	8,000	371,000	595,000	205,000	2,131,000
1912-13.......	692,000	153,000	9,000	398,000	546,000	345,000	2,144,000
1913-14.......	733,000	292,000	7,000	351,000	612,000	408,000	2,405,000
1914-15.......	722,000	242,000	3,000	346,000	646,000	421,000	2,382,000
1915-16.......	874,000	137,000	1,000	483,000	592,000	412,000	2,501,000

It is quite common in the beet-growing districts of the United States for the hand labor to be done on contract by newly arrived immigrants. A peasant from Rumania, Hungary, or Poland, accustomed to growing beets, and to a low standard of living, contracts at so much per acre to take care of the beet

Fig. 123.—Women and children weeding a sugar-beet field, western United States. (U. S. Dept. Agr.)

fields. With the assistance of his wife and children he then takes entire charge of the crop for the American farmer.

The harvest conditions make irrigation favorable to beet growing. Irrigation insures a dry October, a month in which warm rains can do much injury to the beets. The adjustment of these factors gives more than one center of beet production to each of the four states of California, Colorado, Idaho, and Utah. The adaptation of the beet to cool climates makes it important in Michigan and to a lesser extent in Wisconsin on the glacial areas too far north for the best corn. New York and Ohio are on the southern margin of the beet region and have too many other crops for the farmers of any one locality to care to contract to produce the hundreds of acres of beets needed to keep a factory running through fall and winter season for the many years necessary if it is to be profitable to the owners.

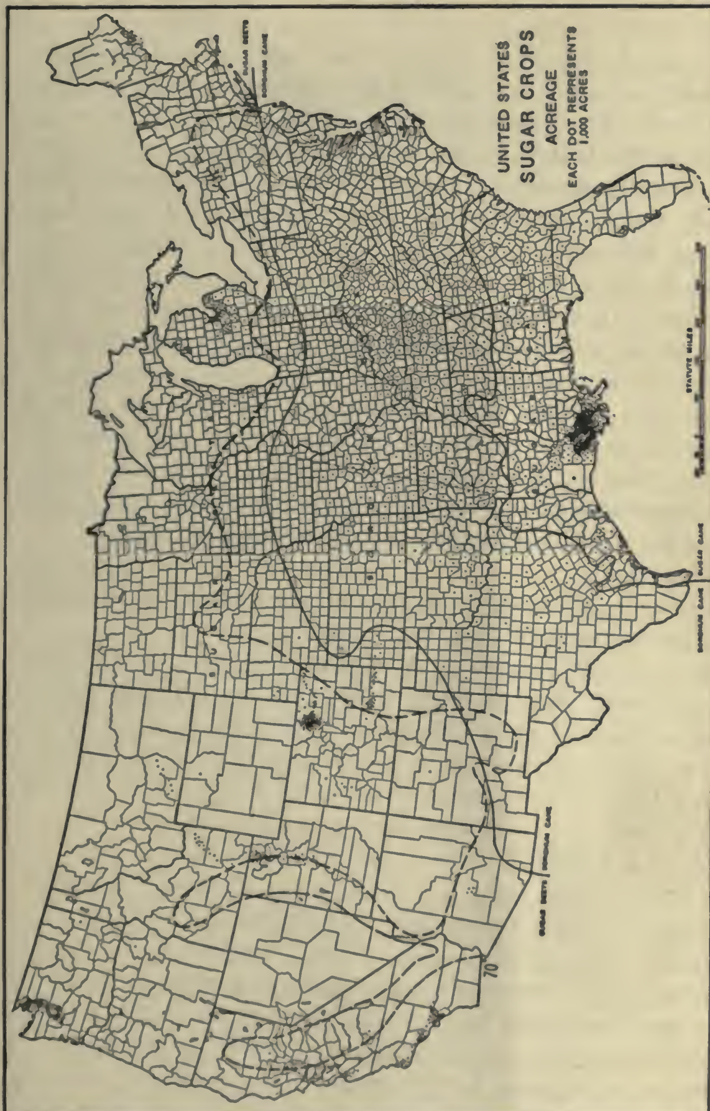

FIG. 124.—The three sugar zones of the United States—cane. sorghum, beet—and the significant summer isotherm of 70. (Finch and Baker.)

CLIMATIC REQUIREMENTS, GROWTH, AND DISTRIBUTION OF SUGAR CANE

The battle between cane and beet is carried on at long range, with far-flung sugar sacks, the plants themselves never meeting leaf to leaf. The sugar cane is as distinctly limited to warm climates as the beet is to cool ones. It will grow on the edges of the temperate zones in such districts as Louisiana, New Zealand, Natal, Cape Colony, and Argentina. It has been grown at 32° north latitude in Spain and 31° south in New Zealand, but it is at home and does its best only in regions free from frost. It invades the frost zone only where there is a long growing season, and protection, by tariffs and bounties, from tropic competition. The best crops require such conditions as exist in Cuba, Java, Brazil, and India, where there is a temperature of 75 or 80° F. the year round and a rainfall of sixty inches or its equivalent by irrigation. The cane's need of much sunshine gives irrigation a great advantage, and a large share of the world's cane crop is irrigated to some extent.

Drought hurts cane, first, by limiting its size, and second, by making the joints shorter, increasing the amount of fiber and decreasing the sugar content per pound.

Cane does not require such careful handwork as the beet. It is cultivated with plows, not hoes; by men, not by women and children; and even the steam plow may do much of the work, as has been proved in the British island of Trinidad and in Hawaii. The method of planting is by putting cuttings in the ground, or, as in Louisiana and Cuba, by laying in the bottom of a furrow a row of cane stalks, which sprout from every joint. After eight months or more of growth and cultivation the leaves are stripped off, and the stalks are cut by hand and carried away to the factory. The transport of the cane to the factory is a serious problem. A good crop amounts to fifteen or twenty tons of cane per acre and forty is sometimes reached. The fields are often muddy and the distance to the factory is increasing as factories become larger. In backward countries, cane is sometimes carried on mule back, but in the great shipping districts carts drawn by oxen or mules are used; the best-equipped sugar plantations have portable railway tracks placed in the fields and diminutive plantation locomotives to pull the cane cars. Cane sugar resembles beet sugar in the size of the factory required if the juice is to be economically extracted and the by-products disposed of. Several thousand acres of cane make a good unit. The guaranteeing of this amount of cane year after year is difficult if many independent tropic farmers must be depended upon to produce it. This difficulty tends to make the sugar company grow its own cane—an undertaking much easier than the growing of beets by a corporation on a large scale. For generations the work was done by gangs of negro slaves in the tropic colonies of European countries. Most of the world's commercial crop is now grown on plantations by gangs of negroes in Louisiana, mulattoes and Spaniards in Cuba, Malays in Java, Chinese and Japanese in Hawaii. In the Argentine province of Jujuy one of the leading plantations of that country employed (1911) 5,160 workers (of whom 4,520 were Indians at thirty cents per day for women, and forty cents per day for men, with 19 miles of permanent railway, 19 miles of temporary railway, 600 cars, and 7 locomotives. Cane growing needs far less scientific agriculture than beet growing requires. Most plantations in Cuba and even in the United States are still growing the crop year after year on the same ground without adequate crop rotation. As this state of affairs cannot continue indefinitely, crop rotation will be established, requiring even larger area and increasing the difficulty of carrying the cane to the mills.

THE DISTRIBUTION OF CANE GROWING

The adaptation of the sugar cane to practically all moist lowlands lying between Louisiana and Argentina in the New World and between southern Italy and India, Natal and New South Wales in the Old World, provides an easy source of sugar for all tropic peoples. Cane growing is a local industry in practically all these countries. The children, partly or entirely naked, walk about sucking a stick of raw cane, a substitute for our stick of candy and often more wholesome, because unadulterated. Although the crop is widely grown throughout the tropics, only a few of these many countries export sugar, because, while a crude ox-driven mill with three rolls will suffice to crush the cane for local use, it cannot compete in the world market. In India, for example, it is estimated that there is an annual production of two and one-half million acres, an area greater than that of any other country; but this crop does not enter into foreign commerce because it is all consumed locally, and the import is increasing. Much of the Indian crop is grown under irrigation in the moist valley of the Ganges and it is often eaten raw (unrefined).

Sugar cane is grown in the lowlands of Mexico and of each of the Central American countries, and also in every South American country except Chile. But throughout much of this region the process of manufacture is crude, the conditions of transportation, of labor, of capital, and of political stability are unsuitable for the development of a large cane-sugar export, although there are in tropic America large areas of excellent cane land, especially on the shores where the trade wind blows. The lowlands of the Gulf and Caribbean coast of Mexico, Central America, and northern South America are excellent examples of such lands.

The export supply of cane sugar comes only from especially rich plains near tropical shores, favored by fairly stable government, such as Cuba, Java, the Philippines, Hawaii, and Brazil. At no place is cane sugar grown for export in locations distant from the seashore and from ocean transportation. Naturally with such a wealth of opportunity man will use the best first.

SOUTH AMERICAN SUGAR

In South America three countries export sugar, each producing under distinctly different conditions.

The British colony of Guiana on the northeastern coast of South America is one of the most interesting of cane lands, showing intensive cultivation and the untouched wilderness side by side. Large areas of coast swamp have been reclaimed from the sea along the north shore by the same methods as those used by the Dutch (the original settlers of Guiana) in reclaiming Holland. This reclamation is the more unusual because most of the country remains a great forest absolutely uninhabited, save for a few uncounted savages. The explanation of this unused land is to be found in the climate, which is so ill suited to white colonists that they number but five per cent. of the total population and merely occupy positions under the government or in the management of stores, plantations, and other enterprises. In the attempt to people this fertile desert and work the productive lands, the government has permitted the recent importation of thousands of East Indian coolies accustomed to growing rice and sugar cane. The reclaimed swamp land is very fertile, has a large rainfall, and, like the flat and level dike lands, is easily irrigated. Furthermore, the drainage ditches serve as canals for the boats that carry the cane from field to factory.

In contrast to the capitalistic and highly scientific sugar industry of Guiana, Brazil has a sugar industry whose methods have not changed in a century. There is a small sugar export along eighteen hundred miles of coast in the central regions in that country, but for years it declined with the decline of price due to beet competition. During the war scarcity Brazil increased her production, probably only temporarily. Sugar can be more easily produced in the more thoroughly established export regions where the government is controlled from north of the tropic of Cancer.

Peru is the third South American sugar exporter. In that country, the sugar plantations are located in the fertile rainless coast desert from which the high Andes cut off the moisture-laden east winds from the Atlantic. A few streams fed by the Andean snows and flowing down to the Pacific save this Peruvian plain from a condition of hopeless barrenness. There is sufficient water to irrigate parts of the valleys, and to make possible a luxuriant growth of cane, which, together with alfalfa fields, orchards, and gardens, makes a strong color contrast to the brown desert beyond the last irrigation ditch. The yield per acre is good, because of the proper amount of sunshine, and water afforded by irrigation, but there is small room for the extension of Peruvian production.

Argentina has an isolated cane-sugar region in the sub-tropic province of Tucuman, latitude 28° south. The production per acre is rather low, and the total production is not sufficient for the national supply.

SUGAR IN THE WEST INDIES

The history and description of sugar growing in the West Indian Islands is an interesting chapter in economic history. In the sixteenth and seventeenth centuries, these islands were much prized by the colony-owning powers of Europe, and were the center of the world's sugar production. At the end of the eighteenth century they had a high degree of prosperity, based on plantations owned by Europeans, worked by African slaves, and largely given over to the growth of export sugar and rum, distilled, then as now, from the cane juice.

The emancipation of the slaves allowed leisure to replace labor and brought decline in the sugar crop of many of the West Indian Islands, but in none so much as Hayti, where political chaos succeeded French rule and the jungle is crowding more and more into the abandoned sugar fields. Latterly, the sugar growers of the West Indies, particularly of the British West Indies, have had to meet the severe competition of European beet sugar, which has further depressed the prosperity of the sugar colonies. Sugar is, however, an important export from Trinidad and Barbados. The discontent of British West Indian colonies, some of which desired to become possessions of the United States in order to have their sugar imported free into the United States, was one of the reasons leading up to the British action that resulted in the Brussels sugar conference of 1903.

The advantage of free admission of sugar into the United States (with high prices to growers) is well shown in Porto Rico. In ten years after its annexation to the United States the export crop of an island less than half as large as New Jersey increased from 50,000 to 250,000 tons, and the value of the export increased from $2,500,000 to $19,000,000. In the second decade of the free admission of Porto Rico sugar, the crop increased from 250,000 to 500,000 tons (1917). The sugar is grown on the coast lowlands and the increase has come about largely through the consolidation of many small plantations and the modernizing of factories by American capital. The rainfall on the windward northeastern side is sufficient for the crop, but on the drier southwestern side the cane fields are irrigated. The same process of capitalistic consolidation is in progress in the British West Indies, in some of which, as in Barbados, the industry has survived from colonial periods in a rather primitive condition.

In addition to its part in the sugar industry the island of Barbados is interesting as an example of the way man supports himself upon the earth. This island of 166 square miles has nearly 1,200 people to the square mile. Sixty per cent. of the area of the island is in sugar, which is allowed to stand three years and is then followed by cotton, corn, or potatoes. Laborers at farm work earn thirty to forty cents per day and the women half as much. "Field work is all done by hand. Sugar lands are cleared by hand labor and put in condition for the next crop with spade and fork. I saw very few, not over five plows during a forty-mile drive." *

There is a strong contrast between this small-scale, semi-Oriental industry of Barbados and the scientific and large-scale operations of Cuba and Hawaii.

CUBA

Cuba is, next to India, the greatest cane-sugar producer in the world, yielding at times one-fourth of the total produce, and leading all other lands in the amount exported. About half of all the cultivated land in Cuba is in cane fields. Normally the island was producing during the last decade of the nineteenth and first decade of the twentieth century about 1,100,000 tons per year, but the war with Spain reduced this amount in 1896 to less than one-fourth and destroyed seven-eighths of the sugar mills. Under the stable government that followed independence, Cuba recovered its normal position by 1903, and has since taken a higher position than ever in the world's sugar market, the crop of 1910-11 being 1,900,000 tons; that of 1916-17, 2,900,000.

Cuban sugar plantations, most of them owned by Europeans or Americans, are usually of large extent. The use of plantation railroads with locomotives to haul the cane to large factories is quite common. The plantations are being enlarged and improved machinery is being installed to reduce costs, since labor

* United States Commerce Report, October 3, 1911.

is scarce and its cost is rising and the price of sugar on the whole declining. The pre-war price of two and one-fourth cents per pound at plantation left some profit.

Cuba has been able to produce such great quantities of sugar because she has had a fairly stable government, a population economically superior (more nearly white) to that of most tropic countries, and an abundance of good, rich, well-drained sugar land. Only one-fourteenth of the sugar land is now in use, so that the industry can still be very unscientific. When land has been exhausted the industry has been able to move, generally to the eastward from Havana where the industry had its first center. The increasing scarcity of labor sets the limit of Cuban sugar growing.

HAWAII

The Hawaiian Islands, with a total area nearly as great as that of Massachusetts, are second only to Cuba as a source of sugar imported for the American market. The sugar yield per acre is the largest in the world, due first to the virgin fertility of the phenomenal soil, decayed lava from the great Hawaiian volcanoes. Some of it has been further prepared by nature for sugar by having once been submerged long enough to get a good admixture of coral limestone—~~soil of soils~~! ? Fine yields are further guaranteed by heavy use of commercial fertilizers and by irrigation on the leeward sides of the islands. In the absence of suitable rivers at the right elevation for stream diversion the water is gathered near the sea level from streams and wells and pumped up, sometimes hundreds of feet, through iron pipes and spread over the fertile lava slopes, making some of the most spectacular plantations in the world. The tractor is in general use for plowing the sugar lands. Hawaiian crops have averaged over nine thousand pounds of sugar to the acre, twice the harvest of West Indies, and these latter islands in turn yield better than cane fields upon the rich delta of the Mississippi, where the climate is too cool for the best growth of cane.

Hawaii has had the special privilege of receiving a higher price than any other sugar exporter except Porto Rico. This high price was due, before the islands were annexed in 1898, to the reciprocity treaty of 1876, admitting Hawaiian sugar to the United States without the payment of duty. The 11,000 tons produced in 1875 grew to 250,000 in 1899; 506,000 in 1911; 644,000 in 1917. Since annexation the export goes free of duty to the United States, which naturally gets it all.

This special privilege to the sugar growers of Hawaii has led to high profits and the suppression of other industries in the islands. These profits began when the islands had a few thrifty white people and many easy-going natives, giving an admirable opportunity for the formation of great estates which loudly called for workers. These came from China until the Chinese exclusion treaty shut them out in 1898. Then came Japanese until the Japanese Government checked their emigration to the islands. Then came laborers from the Philippines, Portugal, and Russia. to grow the sugar on a few vast estates. One company reports harvesting 6,448 acres yielding 56,865 tons of sugar, an average yield of 8.76 tons of sugar per acre. It took only 6.89 tons of cane to make a ton of sugar. This cane is exceptionally rich, and the yield phenomenally large, as were the plantation profits of $2,261,000 in a year.

THE ADVANCED DEVELOPMENT IN JAVANESE SUGAR GROWING

Java, an island about the size of New York, is very remarkable in the world's commercial geography. Forty per cent. of the land is cultivated. It supports a population of thirty million who have food products for export, and yet parts of the country are sufficiently wild to shelter the wild elephant and the rhinoceros. The cultivated areas have the great advantage of being alluvial plains made of rich volcanic mud where a fair rainfall can be improved by supplemental irrigation—agricultural conditions that are very hard to equal and cannot be surpassed. The chief export is cane sugar, of which Java furnishes about one-fifth of the world's crop, being second only to India and Cuba. In sparsely peopled countries like Cuba, sugar can often be grown on newly cleared land, and as the cane will live for many years with an annual cutting, new sugar lands are often made to give six or eight or ten crops before replanting. In Java, the larger area under cultivation makes it impossible to keep moving to new land; hence, this island has the most scientific agriculture to be found in any cane-growing region.

Since the first cutting of canes, following the plowing and planting, is always the best, a field in Java is allowed to yield only one crop; the same restriction applies in Louisiana because of frost. Sugar is followed the next year by beans, then by corn, then rice, then sugar again. Under this systematic cultivation and a complex system of governmental control which at times amounts almost to compulsory labor, the sugar output increased threefold in the twenty years following 1884. When the Cuban supply was temporarily stopped by the devastation accompanying the war of 1895-98, Java played an important part in supplying the United States, sending to her in 1899 as much as seventy-one per cent. of the crop. This meant that every second day throughout the year, a tramp steamship skirted the coast of Java, loading 600-pound bamboo baskets of sugar for the American consumer, 10,000 miles away. Just before the Great War we were using 400,000 tons of Java sugar every year, but in the spring of 1918 it was reported that 900,000 tons of Javanese sugar were piled up waiting for the ships that did not come. After the United States, China is Java's best customer in times of peace. The rest of the sugar goes to Japan, India, Australia, and other Eastern countries, practically none of it going to the mother country, Holland, nor to any other part of Europe, because of the beet supply there.

The Philippine Islands have admirable soil, temperature, and rainfall for the growth of sugar. The sugar resources are much greater than those of Java, which is but a third as large; but the population is eight million instead of thirty, there is no Dutch Government with a system of compulsory labor, the industrious Chinese are excluded, the high price of hemp and copra have given other outlets for enterprise, and the United States has taxed the sugar when it reached the United States. The result is a sugar industry only a third larger than the output when the islands were a Spanish colony, and not so large as the production in Porto Rico. The methods of extraction and manufacture have always been wasteful, but improvement is expected as a result of a campaign of agricultural education now in progress in that archipelago.

MAURITIUS, REUNION, AND EGYPT

Sugar is the predominating export from the two tropic islands of Mauritius (British, 713 square miles) and Reunion (French, 970 square miles) in the Indian Ocean near Madagascar. They have a combined population of over half a million, of whom a large part are industrious coolies brought from India and China, so that these small lands play a comparatively large rôle in sugar commerce, exporting nearly all of their quarter of a million ton crop.

Egypt has excellent resources of soil, sunshine, and irrigation water for sugar, but she plays an unimportant rôle in this commerce because her population of 930 per square mile demands rice, corn, and beans, crops whose acreage far exceeds the sugar acreage.

THE SUPPLY AND PRODUCTION OF SUGAR IN THE UNITED STATES

The United States, with a sugar consumption of over four million tons, has been growing cane sugar for a century, and beet sugar since 1890; yet the import increases year after year, despite the fact that the home product has trebled within twenty years. Despite rapid increase of production during the war, and supposed efforts to minimize consumption, the United States reached its greatest import of 3,900,000 tons in 1916, and imported only 100,000 tons less in 1917.

Home-grown cane sugar has had small chance of supplying the huge home demand because the areas suitable for cane growing are limited, and inferior to those of tropic districts. The superiority of the tropics lies in climate rather than in soil. In the frost-free climate there are records of fifty yearly cuttings from one planting, and in parts of Porto Rico cane has lived and been cut for twenty years, while on the Cuban plantations eight or ten crops are regularly cut from one planting. Louisiana must plant annually four tons to the acre. The average yield is fifteen tons per acre; the yield of Hawaii is forty-two tons, and that of Java is about forty tons. The tropic crop has twelve full months for growth, more if need be; while that of Louisiana has but eight, so that American cane yields but 120 to 150 pounds of sugar per ton, while the cane of Cuba and Java yields from 200 to 225 pounds per ton. The Louisiana crop suffers the disadvantage of expensive labor of planting, occasional injury from frost and sometimes heavy December rains which may ferment the crop and cause the loss of millions of dollars in a few days. These factors combine to make our cane-sugar industry one which, like our beet-sugar industry, could not survive without the high price produced by a protective tariff. Despite the

FIG. 125.—Planting sugar cane in Louisiana. The rows are curved to keep them horizontal and prevent washing, a lesson that the North has strangely failed to learn from the South. (U. S. Dept. Agr.)

stimulus of war conditions our cane crop remained stationary from 1913 to 1917.

Owing to these climatic limitations cane-sugar production, even with tariff aid, attains importance only in the southern third of Louisiana, a coast strip in eastern Texas, and a few localities in Florida. The sugar territory of southern Louisiana is part of the rich and swampy flood plain of the Mississippi River. The only tillable land is within a mile or two of the Mississippi, or other streams, where the deposits of the overflowing streams have built up a little land a few feet above the general swamp level. In two of the parishes (counties) of Louisiana (St. Mary and Terrebonne), over half of the cultivated area, and in seven other counties over twenty-five per cent., was recently in sugar.

The limitation on production is not set by lack of suitable land; for it is reported that we have ten million acres of good

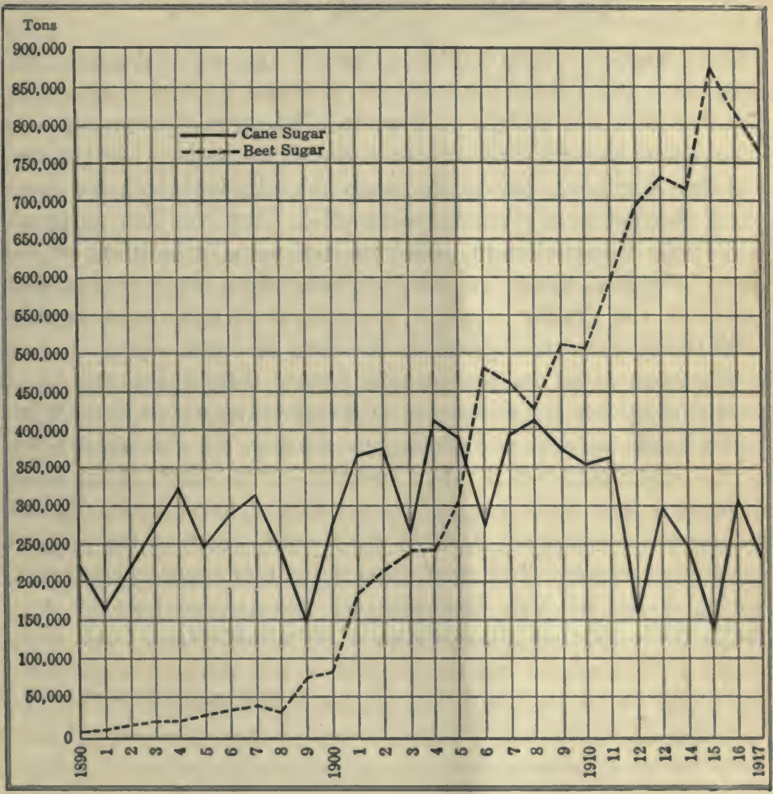

FIG. 126.—Production of cane and beet sugar in the United States.

cane land and now cultivate one-twenty-fifth of it. It should be kept in mind that this same land, when drained, is good without handicap for rice, cotton, or corn, and many forage plants for meat production. The American cane-sugar growers have always had to combat scarcity of labor as well as troubles of climate, and above all the uncertainties of the tariff.

The extraction of cane molasses for local use is a simple process rather widely distributed in the South, and a little cane is grown for this purpose as far north as Arkansas and Eastern North Carolina.

CANE SUGAR AS A LOCAL SUPPLY CROP

Beet sugar is only edible after it has been through the machinery of a great refinery. In contrast to beet sugar, cane juice is a prized article of food in all stages of manufacture, even when sucked directly from the cane itself. Living and yielding for years beside the native's palm-leaf hut, the cane patch furnishes a pleasing element in that complete support which the tropic climate yields to man with little labor on his part. Crushed by ox or man power between rude rollers and boiled in the family kettle, it provides a cheaper sugar supply than the grocery store yields in the land of frost.

The cane is an important and widely distributed source of food throughout the thousands of Polynesian islands from Australia to Singapore, and thence to Hawaii, six thousand miles to the eastward. In the Fiji Islands, as in Java, there is an important cane-sugar industry, producing here under British management about one-fifth as much cane sugar as the crop of the United States. The chief market for this sugar is the neighboring island of New Zealand. In the warmer part of Australia there is a very large area of admirable cane land, especially in Queensland, but the population is less than one a square mile, and the strenuous desire of the Australian commonwealth to remain a white man's land has caused the enactment of laws prohibiting the admission of the colored laborers (Hindoo, Negro, Chinese, or South Sea Islanders) on whom the planter depends. As white laborers will not go to the tropics, the Queensland sugar output is not increasing; that of New South Wales is small, and suffers from the same handicaps that interfere with cane growing in Louisiana.

THE BY-PRODUCTS OF SUGAR MAKING

The mill that suffices for making the sugar and molasses for local use in the interior of Venezuela, Guatemala, or India, may have two or three small rollers turned by oxen, getting fifty or at most seventy-five per cent. of the juice. This is boiled in open vats, a primitive method which leaves much of the sugar in the form of molasses; however, the molasses is one of five great staples in the nourishment of the masses in tropic America. (The others are corn cakes, cassava, bananas, and beans.) In great commercial sugar plants, however, enormous rollers with a pressure of many tons are driven by steam, ninety per cent. of the juice is extracted, and a washing of the crushed cane extracts an additional five per cent. The juice is evaporated in vacuum pans, which save more sugar and require much less skill than the primitive method, because evaporation takes place in the vacuum at so much lower temperature that there is less danger of burning the sugar. The molasses that comes from the more scientific process has so little sugar left that it is not fit for human food nor even for the distillation of rum. Thus these two classic staples of trade, which have for centuries been the great by-product of the sugar plantations of the West Indies, are now made only by a cast-off process used in the less efficient plants of small plantations or backward sugar regions.

The tasteless molasses of the modern plant is fit only for the distillation of industrial alcohol and the preparation of a cattle food which, under the name of molassquite, has of late become of increased importance. Molassquite is made by absorbing the sugar of the molasses in the spongy pulp that comes from the heart of the cane. Since only one-fourteenth of the possible sugar area of Cuba is in use and only one-thirtieth of the island is under cultivation, there is the possibility of an important trade with the countries of the temperate zone where livestock is raised. Owing to the rising price of cattle foods, wheat bran and corn are now nearly as expensive as cane sugar, which is as nutritious and as acceptable to the ruminants as to man. Ten pounds of mill (blackstrap) molasses, with the addition of two pounds of cottonseed meal, make a stock food almost the exact equivalent of ten pounds of corn.

There is no reason why we may not in the near future have a very important commerce in sugar and sugar by-products with the tropic countries, which will help to make cheaper meat, milk, and wool in the countries of the temperate zone.

A recent improvement permits the bagasse or crushed cane to pass directly from the crusher to the furnace. The labor of spreading it out to dry in the sun, as was done for a century, is thus avoided.

THE FUTURE OF CANE-SUGAR INDUSTRY

The growing of any large amounts of sugar outside the tropics has only succeeded where governments have shielded the industry from competition with the tropic cane. If the time should come when we desire the increased wealth of free trade, or when the pressure of temperate-zone population on land resources makes us need our sugar lands for other crops, an indefinite amount of tropic land is ready to grow sugar for our supply. It is in favor of cane sugar that science has not been so fully applied to it as to beet sugar. The latter industry was started in scientific Germany; the former has always been in far-away colonies of countries where science was not held in high esteem. The cane has never been an important crop in the home land of any first-rate power nor in the land of a highly educated people. Much improvement appears to be possible in cane-sugar production in suitable localities.

A striking and perhaps revolutionary example of this improvement comes from Hawaii, where there has been established a new practice in sugar-cane growing which promises greatly to reduce the cost and to put cane still further ahead of the beet. Weeds spring up in the tropic soil literally over night. To dig them out of the rows of young cane plants is laborious and expensive. Mr. F. E. Echart, an employee of a Hawaiian sugar company, observed that the cane shoots emerge tightly rolled up, and sharp pointed like a pencil. He found that this point would penetrate paper laid flat on the ground. By impregnating the paper with asphalt and holding it down with bamboo pegs, stones, dirt, etc., it was found that the young sugar shoots came through, though the soft-topped weeds could not. The paper caused an increase of from 3 to 5° F. in the temperature, and so increased the moisture that the cane grew at abnormal speed while the weed sprouts smothered in the darkness. By the time the paper had disintegrated, the cane plants were big enough to shade the ground and take care of themselves. This expedient brought a reduction of from fifty to seventy per cent. in the labor requirements and, because of the greater heat and humidity and the lessened growth of weeds, an increase of some ten tons or more of cane per acre. The plantation at once proceeded to erect as part of its equipment a paper mill to make paper out of bagasse, the refuse of the cane stalks after crushing. By this means a fifty per cent. saving in the price of paper is effected, as well as the complete utilization of the bagasse, a part of which had previously been used as fuel in the power plants of the sugar refinery.*

It is easy to imagine strips of paper, miles in length, spread out across the great valleys of the Congo or the Amazon, or many a smaller tropic river, with stalks of sugar cane shooting through them. The sugar, perhaps, may furnish alcohol to drive our motor cars and tractors after we have had all the sugar we want to eat, and gasoline has become scarce.

The present acreages of cane sugar are insignificant in comparison with the resources. Java and Cuba each have a million and a third acres, or roughly, 2,000 square miles each. Hawaii has but 250 square miles, merely a few little corners. The cane-sugar supply may be increased by other means:

1. Plant Breeding. Recently while the average sugar content of the Porto Rican crop was eleven per cent., new hybrid varieties at the Porto Rican experiment station were yielding twenty-one per cent. of sugar.

2. Fertilizer. Cane demands fertilizer, especially nitrogenous fertilizer. Our air nitrate plants are now unlocking a nitrate supply that may perhaps be limited only by our needs or the limited supplies of power, if they have any limits. (See Chapter XXVI.)

MAPLE SUGAR

Maple sugar is produced by the evaporation of the sweet sap of several varieties of maple, which grow over large areas of eastern and northern United States. The sugar was a very important factor in the life of colonial days. The process of

* *Scientific American*, April 20, 1918.

manufacture suits the frontiersman. A small hole is bored about an inch into the trunk of the tree when the sap is flowing in the first days of spring. The sap flows out through a tube into buckets, is carried to camps in the woods, boiled in large open kettles or pans until the proper degree of thickness is reached, then poured into molds and crystallized into the delicious maple sugar. Some of the product is sold in a more dilute form as maple syrup. This kind of sugar costs more than either beet or cane sugar and would have no place in the world market but for its fine flavor, for which it commands a higher price. The sap flows in quantities sufficient for satisfactory sugar making only when the days are bright and sunny and the nights are frosty. This climatic factor limits sugar orchards to the region east and north of Indiana. The industry is particularly important in the White Mountain region of Vermont and New Hampshire and the adjacent parts of Canada.

The sugar maple tree, which yields from the time it is twenty or twenty-five years old till it is seventy-five or a hundred and is then a valuable wood, is certainly a more permanent sugar producer than any other; but the yield is at present low. There is no reason why the amount of sugar contained in the sugar maple might not be greatly increased, as the productivity of the sugar beet and the sugar cane has already been improved. Of course, the process would be slow, but the results would be large and the plan is entirely feasible.

SUGAR FROM SORGHUM

Another sugar plant, sorghum, a member of the corn family (see Chapter V) resembling both kafir corn and broom corn, has long been grown in southern, central, and southwestern United States for the manufacture of syrup for local use. The juice is extracted and treated like the juice of sugar cane.

During the Civil War, when the blockade between North and South stopped shipments of sugar and especially molasses from Louisiana to the North, sorghum was grown in the corn-belt of the North, and in the form of syrup was used as a substitute for the product of the sugar cane. A century ago this plant exceeded the beet in sugar content; but progress in improving it has been slow. Experiments carried on for many years at Fort Scott, Kansas, have at last resulted in the making of satisfactory sugar from sorghum. Now that the laws of plant breeding are better known, its sugar content may be susceptible of as great improvement as that which has taken place in the beet. It is quite possible that a century hence it may rival, or even displace, the sugar beet in the United States, because like corn it can be cultivated with work animals and machines.

HONEY

The only other true sugar is the most ancient of all, one that has doubtless been available for millions of years; namely, honey.

Bee culture, with its products, honey and wax, preys upon the blind thrift of an insect. Like poultry farming it depends to an important extent on human labor; but it also must have an environment affording nectar-bearing flowers. Where rainfall permits abundant vegetation, the tropics are the best bee lands. Honey and wax are important exports from the Greater Antilles, and there seems to be plenty of room for extension of the industry.

Bees are among the most highly developed of animals. Their care is one of the most scientific and fascinating of the animal industries. The keeping of a few bees is common in nearly all the warmer parts of United States and Europe, but it is a by-product industry which, owing to its dependence upon blooming plants, cannot be intensified. It is, however, by no means fully developed, as Professor George A. Coleman, of the University of California, shows by a report to the effect that Santa Cruz County, California, could feed 10,000 more colonies of bees, 50,000,000 of the insects, that should add $200,000 a year to the wealth of that county. In emergencies, the bees, like the Danes who eat margarine and sell us butter, will feed in the winter on cane sugar and let us have their honey.

Glucose is a substance so much like sugar that it meets the same need. It is found in grapes and raisins, and is produced in large quantities by chemical manufacture from the starch of corn and sold under the commercial name of corn syrup or Karo.

"This substance is entirely wholesome and may be freely employed in the place of sugar." *

A recent Italian discovery may also have much significance for the future of the world's sugar. An expert in the national experiment station at Asti has invented a process for the making of fruit honey by extracting all the water from grape juice, leaving it in a perfectly keeping form suitable for preserving fruit, making soft drinks, and perhaps for other uses. This process may afford a valuable outlet to the European wine-growers if the demand for wine permanently declines.

* Lusk: *Food in War Time,* p. 41.

CHAPTER XXIII

TEA AND COFFEE

Coffee and tea are the aristocrats of a rather large number of substances used to satisfy a general desire for some kind of warm drink, usually with our meals. Although highly prized and costly, tea and coffee are important rather for the comfort and satisfaction that they give the palate than for their actual nutritive value. Neither is of any real use in the diet, as evidenced by the millions who with perfect ease get along without both and without any substitute. Other millions who use the one or the other know how good they are and how in time man comes to depend on them, until a meal without them seems poor. Their stimulating influence gives them a hold on our nervous systems that strongly fixes on us the habit of using them.

So general is their esteem, so thoroughly do we feel the need for them that they may properly be called staples of the world's food supply as they are of the world's trade. These two staples have been affected by the war less than almost any others, for several reasons: the lands that produce them were far from war's disturbances; both tea and coffee come from trees, so that the existing orchards of the world at the beginning of the war could almost or quite maintain production for a term of years; the high value and small bulk of tea and coffee make it possible to continue the trade in them whenever trade can exist at all. Of course, the blockade kept both coffee and tea out of Germany, and the Russians suffered from a great tea famine, along with the many other privations resulting from a diminution of trade unparalleled in the history of the commercial world.

COFFEE, THE TREE, AND THE CLIMATE

The coffee bean grows on several species of the coffee tree. One of them (Arabica) will endure rather low temperature, and has with slight protection survived the winter of Germany, but is of no commercial value where the average temperature for a season is less than 60°. If grown under tropic conditions, large shade trees must tower over it to protect it from the full heat of the sun. Another species, the Liberian, can stand the full heat of the tropic sun even at low elevations.

Coffee is grown in many countries and has become a regular article of diet in many parts of the world; but the estimated number of coffee planters in the world, fifty thousand, is less than the number of the corn growers of Illinois, and the world's coffee crop, worth about $250,000,000, is not so valuable as the corn crop of that state. Several factors combine to restrict coffee producing to limited and widely scattered areas. The plantation cannot endure any frost. This requirement limits the crop, with a few insignifiant exceptions, to the tropics, although the greatest coffee region, Brazil, is close to the edge of the temperate zone, where the groves are located on hills to insure protection from frost. The plant requires a hot climate, yet the trees must be shaded—side crops of corn, bananas, beans, or coarse varieties of peas are sometimes grown with the young trees to protect them from the full rays of the sun and to insure some income before the coffee is matured. The climate must be moist as well as hot, with a rainfall of from seventy-five to one hundred and fifty inches, yet the soil must be rich and also well drained; coffee growing is thus practically limited to hills and uplands where rapid slope of the land gives the necessary drainage. These conditions, therefore, tend to locate the best coffee districts on plateaus and hilly regions. As the coffee is usually grown for export, the plantation should in addition be reasonably near the seacoast. A rather large population is also necessary, to perform the large amount of labor required in caring for the crop.

Coffee, unlike wheat, corn, rice, apples, bananas, and beans, has not been known for ages. The plant is probably a native of Abyssinia, whence it was taken to Arabia about the eleventh century. Its spread was slow, and not until 1562 were the first coffee houses opened in London. As an important article of commerce, coffee really belongs to the nineteenth century, the quantity consumed having about doubled between 1855 and 1885 and again since that time; its use is still rapidly increasing. The chief source of commercial supply has shifted far. At first, it was Arabia, then the West Indies; then Java had the supremacy; and lastly Brazil has taken the lead with a production far outdistancing all competitors—even all competitors combined.

THE GROWTH AND PREPARATION OF COFFEE

The tree naturally grows to from twenty-five to thirty feet in height, but in the coffee orchard it is usually pruned and kept down to from five to eight feet in height to permit easy picking of the berries. The berry, which looks much like a cherry, usually incloses two coffee grains in its pulp. After being picked, the berry is put through a number of mechanical processes, the first of which takes off the outer pulp. The berry is then dried in the sun, a process requiring from six to eight days. Rather complicated machinery has been invented to cure the coffee after it has been picked and dried. It is often averred by persons in a position to know that these machines, on a Brazilian plantation, turn out Rio, Mocha, Java, and other varieties of coffee. Machines remove the two layers of inner husk, and various sortings and gradings separate the grains so that those comprising each kind of coffee are of the same appearance and size.

ARABIAN COFFEE GROWING

One of the best places to grow coffee is found on the slopes which face the lower plain along the Red Sea in Yemen, the southern part of the Arabian Peninsula, and the home of Mocha coffee, of which much is heard and little is seen. Here the shade-loving coffee tree has the advantage of a mist which rises on the lower plain almost every morning in the year and toward noon envelops the coffee-planted slopes in a haze which keeps off the full rays of the sun and also gives the proper moisture for the good development of the plant and the production of its seeds.

The fine quality of this Arabian coffee is due chiefly to the fact that it is carefully prepared, most of the crop being bought on the trees by Turkish and Egyptian merchants who personally superintend the harvest. The amount of coffee grown in Yemen is much smaller than that which is sold under that name, and it is much smaller than the demand. In Yemen, coffee is purely a money crop, and is not used by the natives, who drink a decoction of the dried hulls. Only a small portion of the Yemen land suitable for coffee is planted to that crop. Most of it is in dhurra, a grain resembling millet, which will give sixteen crops before the coffee trees are ready to bear. It is a long-time proposition for an Arab to wait for the coffee tree, especially as Yemen is rather an arid country with inadequate irrigation, poor roads, high taxes, and the bad government that has so long blighted the Turkish Empire.

INDIA AND CEYLON AND DUTCH EAST INDIES

The British Government, which has done much to encourage agriculture in its colonies, encouraged the establishment of the coffee industry in India and Ceylon. The chief Indian district is located on the eastern or interior slopes of the western Ghats Mountains in southern India, where elevation and climate are suitable for coffee. The acreage in southern India is declining slightly because of the low price of coffee for the twelve years following 1897. In Ceylon, with its moist highlands, coffee growing quickly became important, and by 1880 was the chief export of the island, $15,000,000 worth being sold abroad annually. But a fungous disease, producing leaf rust, broke out in Ceylonese coffee plantations, so injuring the trees that they could not produce much fruit, or killed them outright, and brought ruin to many coffee planters. Some substituted cinchona for coffee, but most turned to tea, which has almost replaced coffee as a crop on the Ceylonese highlands. The only way to circumvent the blight which killed coffee of the Arabian species was to introduce the more hardy Liberian coffee, a native of west Africa; but even that variety is not entirely immune to the blight. This species of coffee is now grown in Java, a name under which not only the product of this island is sold, but also the small amount of coffee produced in Sumatra, Borneo, Celebes, and some other places. The Java coffee is of good quality because it is grown at an elevation of from two to four thousand feet upon government plantations, where careful measures in harvesting the crop are rigidly enforced. The total coffee crop of Asia and the East Indies in a recent year was less than one-sixteenth that of Brazil.

COFFEE IN SPANISH AMERICA

Coffee is one of the best money crops for the tropic highland, and for this reason is well suited to Mexico, Central America, and northern South America. In all these regions the ruggedness of the country makes transportation difficult, the roads are exceedingly bad, and the trail for pack animals is often the only means of access. Only valuable products can pay for such transportation, and coffee, worth from six to twenty cents a pound, stands high above wheat, worth possibly one and one-half cents a pound, or lumber, with its low value and difficult form, or coal, sold at four or five pounds for a cent. Geographic and economic factors combine in an interesting way to influence coffee production in mountain districts. The elevation that produces the proper conditions of moisture, temperature, and slope also makes the climate endurable and has attracted the majority of the population of nearly all tropic American countries. These natural labor conditions favor the production of coffee, with its easy transportation. The traveler may see on the distant mountainside a bright green forest, which closer examination shows to be plantations of closely pruned little coffee trees clinging to the steep slopes. The high prices prevailing in 1887-96 made coffee growing very profitable, and it became one of the chief money crops of Mexico, Central America, Colombia, and Venezuela, as well as Brazil and some of the West Indies.

In Mexico, coffee thrives best in the central of the three topographic zones which comprise that varied country. The first division, the hot low plain along the seacoast, is considered too hot for coffee; the second, the high plateau inclosed between the eastern and western cordilleras, is too dry and too cool; but the outer slopes of the plateau, the so-called "warm land" of the Mexicans, with its good rainfall and its succession of fertile, warm valleys and forest-clad slopes, is a natural coffee region. Some of the plantations are as far south as the Isthmus of

Tehuantepec, which, however, is not high enough for the most successful coffee growing.

Southward the elevation increases and the plateau of Guatemala and Salvador is an almost continuous coffee plantation from the boundary of Mexico to the boundary of Honduras. These two small states produce more coffee than all Asia and the East Indies, and it comprises over two-thirds of their total export. Many of the Guatemalan plantations are owned by German capitalists and the Germans for many years imported much Guatemalan coffee. At harvest-time the coffee crop employs half of the population. In Costa Rica, the plateaus are even higher and the coffee tree upon the hillside assures the people of this cool plateau the European and American imports brought to them by the little railway that climbs up five thousand feet from the Caribbean port of Limon to San José, the capital.

Colombia and Venezuela, being in the hottest part of the torrid zone, have lowlands of such high temperature that few persons live on them except those necessary to carry on the commerce between the seaports and the interior plateaus among the northern ranges of the Andes. Here again the valuable bag of coffee, on the back of the mule as he climbs down to the seaport or the river steamboat landing, represents the best money crop that could be produced in these isolated plateau districts. Small quantities of coffee are produced on the plateaus of Ecuador and on the eastern slopes of Peru, whence it must be carried by mule and railway over the forbidding mountain chain of the Andes. These Andean countries grow about as much coffee as Central America produces, but the output is not one-tenth that of Brazil. On the eastern slopes of the Bolivian Andes is the province of Yungas, which claims to have the best coffee in the world; but there is not enough of it for export.

THE WEST INDIES

The coffee tree grows in nearly all of the West Indian Islands, but the island of Hayti, occupied by the two states of Hayti and San Domingo, is the heaviest exporter. In Jamaica the "Blue Mountain coffee," the highest priced coffee in the world, is produced. Its fine quality is due to the alternating rain and sunshine that there lasts throughout the year; but the crop amounts to only a few tons per year. It is ceasing to be a plantation crop, and is passing into the hands of the small cultivator. Porto Rico is well fitted by climate, soil, and labor supply to produce the good coffee that has for many years been an important export. Before this island was annexed by the United States, its chief market was in Spain, where the Porto Rican coffee with its peculiar flavor was in demand. When the Americans took possession, the Spanish Government imposed a tariff on Porto Rican coffee, depressing its price, and producing hard times in Porto Rico; but the United States Government has tried to improve the methods of coffee growing and to introduce varieties acceptable in the markets of the United States.

BRAZIL

Brazil is lord of the coffee world, with production greater than that of all other countries combined. Three-fourths of the world's crop is produced there, yet the coffee region occupies but a small corner of the country, which is as large as the United States and Great Britain combined. Systems of railways thread the coffee zone and come down to the two great coffee ports of Rio de Janeiro and Santos.

The large and prosperous city of São Paulo, the capital of the province of São Paulo, is the chief city of the coffee-producing district, which slopes away from the Coast Range, toward the Paraná River in the interior. On this plateau, between 600 and 2,500 feet above the sea, are thousands of square miles of a rich red volcanic soil capable of producing several times as much coffee as the world needs. The southeast trade winds bring from the south Atlantic an abundant rainfall, completing the natural conditions for coffee production.

Partly because of this abundance of land, the Brazilian coffee estates are often of enormous size. In times of prosperity their owners live luxuriously in the capitals of Europe, while the estates are cultivated by overseers who employ as laborers the incompetent negroes, who were slaves until 1892. Of late Italian immigrants have begun to replace the negroes, who are drifting to the coast settlements north of Rio de Janeiro. It is the task of one workman to take care of two thousand coffee trees, which cover about five acres. Brazilian coffee does not bear as good a name in the world's market as does that of Mocha or Java, chiefly because of the inferior care bestowed on the harvesting in a country where efficient labor is so much more difficult to obtain than in Java and Yemen. In Java, the ripe coffee berries are picked off, while the green ones are allowed to remain on the branch, but in Brazil it is not uncommon for green and ripe berries alike to be swept off the branch by a single motion of the hand, though the unripe coffee makes a product of inferior quality. Great efforts have been made in Brazil of late years to improve the quality of coffee, especially by the introduction of imported machinery. As this machinery is very expensive, large coffee cleaning and grading establishments are to be found only in the large towns, and on a few of the largest plantations. Some of the plantations are so large that private railways run through them to carry the workmen and coffee from one place to another. As the land is cheap, careless cultivation prevails, and the heavy rains do enormous damage to the resources of the country by washing away the fertile soil.

GREAT FLUCTUATIONS IN PRICE

Owing to the fact that the land suitable for coffee is so much more extensive than the land needed for coffee, the limiting factor in its production is the danger of oversupplying the market, which brings low prices and loss. The same situation prevails with coffee as with the potato and truck crops, but the coffee tree differs greatly from the potato plant in taking several years to mature and then producing for several decades thereafter. Hence the alternating cycles of riotous prosperity and ruinous depression are long. High prices prevailed in the coffee market from 1887 to 1896, and enormous numbers of coffee trees were planted in nearly all coffee-growing countries and in many new countries as well. The trees begin to bear in about six years and may yield for thirty or forty more. By 1897 the production was so large that the price fell while the yield kept on increasing until 1902. The chart of coffee prices shows most conclusively how this industry has been influenced by the planting of many trees in time of high price and the absence of planting in periods of low price, with resultant alternate booms and depressions. This tendency is apparent in many industries, but especially in that large class of agricultural products subject

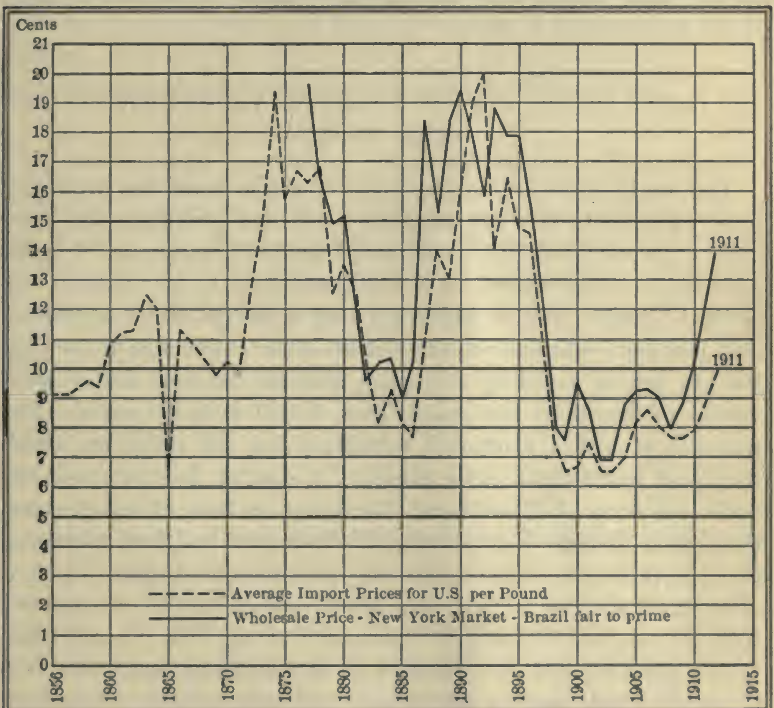

FIG. 127.—Cycles in price of coffee—a product capable of easy overproduction. (Idea from Chisholm.) High price, over 12 cents, means prosperity. The resultant heavy planting and enlarged crop makes oversupply, low price, and decline of orchards until demand catches up and makes high prices to start another cycle.

to overproduction. The hard times following the fall of prices in 1897 brought great hardship to Brazil, as to all the other regions where coffee was the chief export. These hard times were particularly acute for Brazil, because of its almost complete dependence on coffee. The coffee district is the chief center of white population in Brazil. In the leading state, São Paulo, ninety per cent. of the wealth comes from coffee plantations and coffee traffic. Sometimes this situation is called monoculture.

In an effort to restore prices, which were practically down to the cost of production, the Brazilian Government taxed new coffee plantations for several years and financed a great but unsuccessful attempt to buy up the surplus of coffee and hold it for an advance in price.

THE COFFEE SUPPLY AND THE DECLINE OF THE INDUSTRY IN NEW COFFEE REGIONS

The world-wide fall in the price of coffee from the profitable level of 1895 to the unprofitable level that prevailed for more than a decade after 1897, suddenly checked the spread of coffee growing in countries where it had been recently introduced. In British Central Africa, coffee growing upon the Shire highlands had just been established, and led all other exports in value; but the low prices, aided by droughts, reduced the area under cultivation in less than ten years from 17,000 to 5,000 acres. The planters sought a profitable substitute for the coffee on which they had based their early hopes. A similar fate overtook the coffee industry of Hawaii and Paraguay, in both of which countries, as in British East Africa, the industry was just springing up; but these countries could not compete with Brazil, which is more than able to furnish the 25,000 square miles now needed to grow the world's coffee. The price of coffee is a temptation to the grower, and the dangers of the business are well illustrated by conditions in the Malay Peninsula, where coffee growing was established in the world coffee boom between 1893 and 1899. A picul (133 pounds) cost about $15 to grow. For a time it sold for $25 and all went merrily. Then the price fell to less than $15, and the coffee growers began to plant rubber trees on their plantations. By 1905 the price of coffee had gone up to $30 a picul, and since that time it has been $45, for we are now in an era of high prices, save for the decline in trade caused by the war. Doubtless in a few years the plantings will again catch up with the demand and another slump will come.

Although coffee was early introduced into England, it has largely been replaced there by tea. The Dutch, owners of Java, are the leading coffee users, with a consumption of twenty pounds per capita per year. The Americans and Belgians use half as much as the Dutch, and the Germans and Swiss one-third as much, when they can get it. During the Great War the Germans were busy manufacturing a great variety of coffee substitutes, partly by roasting cereals and acorns. Coffee is the chief non-alcoholic beverage of France and other countries of western Europe, and Havre, with millions of sacks sometimes in her warehouses, has for years been the leading coffee market.

TEA, AND FACTORS AFFECTING THE DISTRIBUTION OF TEA CULTURE

Drinks made from decoctions of leaves are more common than those from decoctions of seeds; various plants have been used and are used for this purpose in various parts of the world. The usual tea of commerce is the dried leaf of a tree native in the hills of Assam, one of the eastern states of British India. The tree is quite hardy, standing a frosty climate, thriving in central China and the cotton-belt of the United States, and in many places were no tea is produced. The distribution of the tea-growing industry gives us one of the best examples of the working of combined geographic and economic forces. The large amount of skilful hand labor required in packing and preparing tea makes it necessary that tea be grown in regions of dense population with resultant low wage. For this reason the tea industry, despite interesting American prospectuses and high American hopes, has remained and will remain in the populous Orient. In cultivation the tea tree is usually kept down by pruning to a height of from five to six feet so that the leaves can be picked by hand; but when allowed free growth it attains considerable size. It is very hard for a plant to survive the plucking of its leaves, especially the young leaves; hence tea is successfully produced only where growth is promoted by the most favorable conditions—an abundant moisture supply and a warm temperature. Little oil cells give the leaf its flavor, while the stimulating quality comes from a substance called theine which is almost exactly the same as the caffeine of the coffee and the stimulating principle in cocoa or chocolate.

CONSUMPTION OF TEA

The cultivation of tea began rather late in Chinese history, about the ninth century A.D., and it was long the only Chinese export to the Western World. Some of the leaf was introduced into England in 1657, and commanded in that country a price of $15 per pound in 1665; but by the end of that century it was quite common, and Britain soon became the leading tea-drinking nation, a result of the seafaring habit. The distribution of the tea habit shows clearly the influence of national commerce. Britain began to use tea at the very time when she triumphed over her great sea rival, Holland, and her shipping has given her a large part of the world's tea trade as well as its tea consumption. The English-speaking peoples consume nearly three-fourths of the supply of commercial tea; Russia, with her long-used caravan routes to China, uses nearly all the rest. The consumption per capita shows it to be essentially the drink of Orientals and of the English peoples, the average per person being six pounds per year in the United Kingdom and seven pounds among the Australasians, who are thoroughly British and are even better able to buy than are the people of the United Kingdom. Canada averages 4 pounds per capita, Holland 1.75, the United States 1.4, and Russia 1.25. The Russians are usually described as great tea drinkers; the statement is true for the wealthier classes, but the vast masses of the Russian population are too poor to buy tea. The Germans consumed less than one-seventh of a pound per capita before the war, and the French (wine growers and coffee drinkers) but an ounce per year. The use of tea is very common throughout Siberia, the trans-Caspian provinces, and Persia, as for some centuries it has been a commodity in the caravan trade across the heart of Asia.

CHINESE TEA INDUSTRY

It is impossible to say how much tea is used in China. It is widely grown in that country in family gardens for home use. The tea habit of the Chinese and Japanese seems to be the result of an attempt to make pleasant the drinking of boiled water—a necessity long ago recognized by these peoples, who live on a land laden with the germs resulting from the density of population and the custom of fertilizing land with human excrements. They knew nothing about the germ theory of disease, but they did know that people who drank boiled water remained well, and that those who drank raw water fell ill. Hence they adopted the habit of drinking boiled waters and improving the flavor with tea. The entire Chinese crop is grown in the tea gardens of the small land holders, chiefly in central China; and that country was for a long time the leading producer of tea for export.

Chinese tea is usually picked three times a year, the first growth in March, the second in May, and the third in August. The choicest first pickings are so highly prized at home that they are rarely exported. The later pickings of an inferior grade are for the use of foreigners. After the picking, which is usually done by women and children, the leaves are wilted in pans over a fire. They are then rolled into balls by hand to squeeze out the sap, and are dried on screens, care being taken not to let the hot sun burn them. They are further dried by "firing" in copper pans over a fire, being stirred the while, it is said, with bare hands, although the pans are white hot. Inferior tea is stirred with sticks. After the firing, the leaves are hung up in sacks for a day, then picked over, sifted, assorted, and by aid of bare feet packed into tea chests for export. In some grades of tea, each leaf is rolled by human fingers. The difference between black and green tea is merely a difference in curing, although the two kinds are rarely grown in the same locality. Early in the curing process, if the tea is to be black, it is piled up in heaps half-cured and allowed to ferment; the fermentation drives off half the tannin, of which tea has ten to twelve per cent. This process gives a flavor much desired in many markets.

The province of Szechuen, one of the western provinces on the headwaters of the Yangtse-Kiang, has a very large population, estimated at over sixteen million, a number about equal to the population of Brazil. The people have supported themselves in that inland location for generations by household industries and agriculture. Most of their few exports go down the rapids of the Yangtse-Kiang to Hankow and Shanghai; but they also send into Tibet some of the worst tea in the world. It is made by cutting off twelve-inch twigs of a tea tree, roughly drying them in the sun, chopping them up, twigs and all, sticking them together with rice paste and then compressing the mass into hard bricks for shipment over the fearful passes of Tibet on the backs of coolies, mules, and camels. The ease with which this compressed form of tea may be carried accounts for its shipment by caravan into Russia at an early date. The chief seat of brick-tea shipment is Hankow on the Yangtse-Kiang in central China. While the tea has generally been considered to be of very poor quality, it has greatly improved of late years; some of the brick tea has for some years been made in Hankow under Russian management, and great care is exercised to see that the quality is good.

JAPAN

Tea, like coffee, requires fertile but well-drained soil and much moisture, a combination of conditions usually furnished best by hillsides. These requirements, together with the large amount of labor required, make it a crop admirably suited to Japan, where the great demand for food causes the level land to be prized for rice and grain crops; tea growing in terraces on the steep hillsides fits in admirably with the Japanese economy. Tea for home use is still prepared by hand in the old-fashioned way, but for export it is almost entirely cured by machinery; the standard Japanese teas are green teas and the United States is their principal market. Thousands of boxes are sent directly to Chicago, St. Louis, and other interior points by way of the trans-Pacific steamers which sail from Yokohama to Vancouver, Seattle, Portland, and San Francisco, where they connect with the trans-continental American railway lines.

FORMOSA

The best tea in the world is grown by the Chinese in the island of Formosa, which has belonged to Japan since the Chino-Japanese War of 1894. The eastern half of this tropic island is still possessed by head-hunting savages, and tea growing by Chinese immigrants on the west half is a comparatively recent industry. Most of the eighteen or twenty million pounds per year is cured by American and English firms for sale in their home countries.

INTRODUCTION OF TEA IN BRITISH COLONIES

The world's tea trade has been revolutionized during the last fifty years as a result of the activities of the British Government in introducing tea growing into India and Ceylon. In the year 1888 the British import of this commodity from China fell below the import from the British colonies of India and Ceylon. Between 1881 and 1900 the Chinese export fell from 300 million to 215 million pounds, and in the year 1905 a commission of Chinese experts was sent out from the tea-growing province of Nanking to study methods of tea growing in British India. China had fallen behind because her unprogressive tea growers clung to the old hand methods of their remote ancestors, while her rivals, under the British flag and the British teacher, had attacked the problem in the scientific spirit with unbiased minds and had been using many labor-saving machines. Another result of this production of tea in new regions has been a steadily decreasing price since 1885, so that at the present time tea growing is not a very prosperous industry.

The tea plantations of India cover about a half-million acres, four-fifths of which lies in the northeastern part in east Bengal and Assam, regions tributary to the port of Calcutta. The tea is grown on the hills sloping down from the great plateau of Tibet and to some extent in many other places along the southern slopes of the Himalaya Mountains, a district receiving tremendous summer rains. In southern India on the Nilgiri hills is the most important Indian tea district outside of Assam and Bengal. Because of its low latitude this district produces best at an elevation of from 4,800 to 5,600 feet above sea level, while on the slopes of the Himalayas the plantations find the temperature that best suits tea at 3,500 feet or less.

EUROPEAN TEA INDUSTRY OF CEYLON

Instead of being picked three times a year, as in China, the tea of India is gathered every ten days during the period of the monsoon rains in summer. The orchards of Assam, like those of Japan, average 450 to 500 pounds of tea per acre. The still more humid hills of Ceylon are probably the best tea-growing regions in the world. There the leaves can be plucked every two weeks throughout the year and the land has yielded 1,000 pounds of dry tea per acre, a quantity greater in actual weight than the average wheat yield of the United States.

The tea industry is new in Ceylon; it was taken up very suddenly by the coffee planters after the blights had destroyed the coffee trees. In 1867 there were 10 acres of tea on the island; in 1887, 2,700; in 1897, 170,000; in 1904, 338,000—but the prices were so low that no new tea orchards were then being set out. The Ceylonese method of growing tea is typical of the most successful method of engaging in tropical industries. More than half of the plantations are owned by corporations, and nearly all are managed by English superintendents. The average size of the plantation is three hundred acres, while in China it is probably a small fraction of an acre. The work on a Ceylon tea plantation is done by coolies (men, women, and children), many of them Tamils from southern India, who usually return to their homes across the straits after a period of work has given them a little money. So many people travel thus that a railroad has been built across the reefs in the rather wide strait that separates Ceylon from India. The intensity of the tea industry and its dependence upon a dense population is shown by the fact that less than six hundred square miles of tea plantations furnish employment for about four hundred thousand coolies, a ratio of one person to the acre. Very different is the American corn-belt farm of 160 acres, whose proprietor often has only one hired man, employed for a part of the year, to help him grow and harvest forty acres of corn, forty acres of hay, forty acres of oats, fatten forty cattle, and grow sixty hogs, besides raising enough horses for his own use with an occasional pair to sell.

THE LABOR FACTOR AND UNITED STATES TEA GROWING

The vast amount of hand labor used in pruning and caring for tea trees and picking and curing the tea shows why the tea industry has not been developed in the United States, although it has long been known that the tea tree may grow over an area one hundred times greater than all the tea plantations in India and Ceylon. A little tea of good quality has for some years been produced near Charleston, chiefly by the labor of negro children, but naturally the industry does not expand in this region of relatively high wages. It costs fifteen cents a pound to pick tea in South Carolina, and the laborers there have been unable to learn a certain dexterous movement that pulls a leaf without destroying the bud in the axis of its stem. To avoid losing the bud they pinch off the leaf, wasting about one-third of the weight of the leaf.

If high wages did not suffice to keep the tea industry from thriving in the United States, the low rainfall in the picking season would add the finishing touch. At most the rainfall is about thirty inches, enough for corn and cotton, but not nearly enough for the tea plant, which is being subjected to the fearful strain of having its leaves continually plucked. The monsoon climates of southeastern Asia, with fifty, sixty, one hundred, two hundred, and even more than two hundred inches of rain in the summer period, are beyond doubt the best places in the world to grow tea. Small tea orchards have been planted in many other places, including the Russian province of Trans-Caucasia, where the climate must be more definitely against the industry than in monsoon regions such as the Malay Pennisula, French India, and Burma, or the trade-wind regions, such as Jamaica, Madagascar, and Brazil, in all of which tea growing is being tried in a small way.

Java has the best combination of conditions to rival the four great tea countries, China, Japan, India, and Ceylon; but the low prices have caused a decline of tea acreage even there.

OTHER TEAS

The leaves of a number of other plants are locally used as tea in various places throughout the world. In southeastern United States the Cherokees and other Indians dried the leaves of a holly plant from which they made yupon, or "black drink." The plant contains real caffeine and is widely distributed over the southeastern United States from Virginia to Texas. White people learned its use from the Indians and in early times it was quite popular. Dr. R. M. Harper, of the United States Department of Agriculture, found it still growing and used in 1916 by the farmers on an island in one of the sounds just south of Norfolk. In Australia the eucalyptus leaf is used; in South Africa is a so-called Bushman tea; a grass called lemon grass is used in India; while in the Island of Bourbon or Reunion, in the Indian Ocean, the so-called "burbon tea" is made from a dry orchid.

Of all the minor teas the maté or Paraguay tea is the nearest rival of the ordinary tea of commerce. This plant, which is a member of the holly family, grows wild in southern Brazil and in Paraguay, in which latter country it is also grown in plantations. The leaf is dried, but less carefully than the tea of the Orient. It is widely used by the people of Paraguay, and several million pounds are exported to Argentina, Uruguay, and Brazil, together with smaller quantities to some other parts of South America. A little is even sent to Europe, and the amount is rapidly increasing. The total export from Paraguay was worth more than a half-million dollars in 1909. Some is now being exported from Brazil. The summer rains of the maté-belt favor the rapid leaf growth necessary for a leaf-yielding crop like tea.

It is plain that any real shortage in tea or coffee is about as unlikely as a shortage of potatoes. As to tea land—there is plenty of it, for we do not need much. All the crop of Japan is grown on less than two hundred and fifty square miles. Like the potato grower, the orange grower, and the apple grower, coffee planters and tea planters chiefly and properly fear overproduction and an unprofitable price, to which they have been from time to time subjected, and probably will be subjected for indefinite generations to come: for it is scarcely to be expected that there can be maintained an exact ratio between production and consumption while the price is profitable to the grower and plenty of land is available for the extension of plantations.

CHAPTER XXIV

CHOCOLATE AND SPICES

THE CONFUSION OF CHOCOLATE NAMES

THE chocolate and cocoa of commerce are prepared from the seeds of the cacao tree, which, because of its name, is often confused with the coco palm which gives us the large, hard-shelled coconut (usually spelled cocoanut). Further confusion is furnished by the coca tree, the leaves of which are sent to market from the east slopes of the Andes in Peru and Bolivia for the preparation of the drug cocaine. The word cacao here refers to the dried bean of the theobroma tree. From these beans we make chocolate or cocoa. While chocolate contains the stimulating element common also to tea and coffee, it differs from them in carrying large amounts of nutrition. The bean in its native form is nearly fifty per cent. fat, which remains in chocolate, but most of which is removed in the manufacture of the powder we call cocoa.

ORIGIN AND PRODUCTION

The cacao tree is a native of tropical America, growing wild in the Amazon and Orinoco River Valley forests up to an elevation of four hundred feet. There are several species of the tree, and in cultivation there are many varieties of each of several species. At the time of the discovery of America, it was grown for food from Panama to Guatemala and Yucatan, and to some extent in the lowlands of Mexico, in which country it was so prized that the dry seeds passed as money among the Aztecs of the plateau. The Spaniards carried it from Acapulco to the Philippines and the early exportation of the beans to Spain and Portugal has caused its use to become so general in these countries that no other European people eat more than one-sixth as much per capita. The use of cacao is rapidly spreading; it furnishes a table drink, a highly prized material for candy, and an acceptable, very nutritious food for travelers and explorers.

The climatic requirements of cacao are exacting. The tree, which is fifteen to thirty feet high with a trunk eight to ten inches in diameter, requires more heat than coffee and yet cannot stand the full blaze of the tropic sun, and so is grown under the shade of taller trees, the young plantation being sometimes shaded by bananas. It requires much moisture, with soil rich and deep, so that it is almost always grown upon low plains. The valuable seeds or beans are produced to the number of thirty to sixty in a greenish or reddish pod, two to six inches in diameter and six to fifteen inches long. Since this heavy, melon-like fruit is attached in clusters to the trunk and larger branches of the tree, and since a strong wind beats the immature pods about until they fall useless to the earth, the area over which cacao can be a profitable crop is greatly limited by the mere existence of wind. Where strong winds blow, as occasionally in the Philippines when the furious tropic typhoons (hurricanes) come, the cacao tree cannot be depended on as a source of income, although it has long been grown in all parts of these islands. The same trouble affects most of the West Indies, where cacao can be grown only in sheltered valleys protected from the wind, as in rugged parts of Trinidad, Jamaica, Grenada, St. Lucia, and Dominica. A level island, like Barbados, exposed to the steady trade winds, cannot produce it. The trees begin to bear at the age of three years, but do not reach maturity until they are ten or twelve years old; they may then bear for thirty or forty years more. They are usually planted about two hundred trees to the acre, and careful records from a number of plantations in Dutch Guiana show that the yield over a period of several years was 477 pounds of beans per acre per year.

IMPORTANCE OF THE DOLDRUMS OR EQUATORIAL CALMS

Near the equator in all continents is a zone of calms, called Doldrums, lying between the two trade-wind zones and drenched with frequent and heavy rains. In this belt, nowhere more than

Fig. 128.—The heavy fruits of the cacao tree cannot mature in a windy location. They are so close to the stiff stems that they twist off instead of swinging with the swaying branches as do peaches and apples. (Photo Walter Baker & Co.)

13° north or south of the equator, are the most important cacao districts.

Ecuador, whose name means equator, was long the leading cacao-shipping country, with its doldrum rains and evergreen forests. The trees here find every condition suited to them and the modified jungle easily becomes the cacao orchard. Cacao is the chief money crop of this part of the country. As with the banana, plowing is not necessary; the only care needed is enough chopping to prevent the smothering of the young trees.

In the year 1900 it was estimated that six hundred square miles of land yielded all the sixty-seven thousand tons of cacao grown in the world, yet Ecuador alone boasts several thousand square miles of good cacao land. But this in turn is as nothing in comparison to the hundreds of thousands of square miles of equally good cacao land in the Amazon Valley of Brazil and neighboring countries. However, cacao growing is not a comfortable business, and it takes large profits to tempt men to engage in it. The Ecuadorean growers all desire to live elsewhere. The climate suited to the cacao forest is unwholesome to the white man, and the jungles swarm with dangerous animals, poisonous serpents, and pestiferous insects. Fevers are common, and labor naturally is scarce. Although sparsely settled, the low plain of Ecuador is populous in comparison with the empty jungles of the Amazon Valley, of which Ecuador, Peru, Colombia, and Bolivia each own an area greater than the Pacific Plain of Ecuador. However, the scattered settlements along the Amazon have recently produced as much cacao as Ecuador and have even surpassed her. In the Amazon Valley the cacao export is second to the great forest product of rubber.

The British colony of Trinidad, below the hurricane-belt and with many protected hollows, is the third American cacao-exporting country, while Venezuela and San Domingo are close rivals.

A little cacao is grown in many West Indian Islands and throughout Central America, chiefly for local use, although Guatemala and the adjacent parts of Mexico claim to produce the best cacao in the world. Throughout most of the lands where cacao is grown, it is ground in the homes in a very crude way, for family use.

OLD WORLD CACAO GROWING

Cacao, being a native of America and only recently of importance in commerce, has not long been grown in the Old World; but the greater labor supply of the Old World tropics bids fair to make those regions outstrip America in the export of the precious beans. The tropic islands of São Thome (or St. Thomas) and Principe (or Prince's Island) lie under the equator in the Gulf of Guinea, and though they have less than forty-five thousand people (of whom ninety-six per cent. are negroes), and have an area of but three hundred and sixty square miles, they have the cacao climate and a fertile volcanic soil. In the year 1905, this tiny Portuguese colony outstripped Ecuador and all other cacao-producing countries. This output is not a measure of superiority of resources; for slavery still exists there and the taskmaster can make the native work.

The recent introduction of cacao into Ceylon has been followed by rapid increase of production there. The cacao industry may possibly run the same course as did the tea industry, which succeeded coffee, and itself became unprofitable, after the island had taken first place among tea exporters. In Java and in the island of Reunion also the climate and the labor supply are favorable, and cacao has been cultivated on a small scale. Samoa and other Pacific Isles have begun to produce cacao, but the population is insufficient for the production of a large surplus.

METHOD OF PREPARATION AND USE AS FOOD

When the cacao pods have been gathered, they are cut open, and the seeds, which are covered with a slimy pulp, are put in piles to ferment, a process which in the course of a week disposes of the pulpy covering of the seeds and cures them ready for drying and shipment. When carefully fermented the seeds are twice as valuable as when carelessly done.

Cacao differs from tea and coffee in the manner of its use. The latter are used as decoctions, made by steeping or boiling the tea leaf or coffee berry in water; afterwards the leaf or berry is thrown away. All processes of cacao manufacture merely grind up the beans, which we eat as solid chocolate, as candy, or drink in suspension in a thick, brown liquid made by mixing with milk or water. The Chinese cooks in the Philippines pound the beans in mortars and flavor them with spices to suit individual tastes. In the Western World the beans are taken to the great factories of Holland, England, France, Germany, Switzerland, or the United States, where expensive machinery pulverizes the beans to great fineness, and mixes the powder with sugar and sometimes with milk also. This need of milk makes it necessary for chocolate factories to be near dairy centers; and it has even caused the removal of some plants to country towns in dairy districts, as in eastern United States and Switzerland. Switzerland has thirty chocolate factories and exports thousands of tons, amounting to five or six dollars per capita for the Swiss population. The manufacture of chocolate is one of the ways in which Switzerland utilizes her mountain pastures through her dairy industry to the fullest extent.

Breakfast cocoa, made by removing the nutritious fat of the bean, is for some people more easily digestible than is chocolate. The fat is valuable in medicine and has the peculiarity of never becoming rancid no matter how long it is kept. Examination of the table of food values and the comparison of chocolate with our staple articles of diet will show its great value as food. It is several times as nutritious as eggs and about two and one-half times as nutritious as beef. These are significant facts when taken in connection with the relatively declining quantity of beef, the increasing quantity of cacao (fifty per cent. in five years) and the indefinite room for expansion in its production. As the cost of cacao production in Ecuador is estimated at four cents a pound, and the selling price is several times that figure, there is good reason to expect the production to increase in response to demand. Chocolate is so new in world commerce that its cultivation has not been reduced to a scientific basis. Most of the orchards are only seedlings, which are much less productive than grafted trees of selected varieties; the latter are only now coming into general use in some of the most progressive cacao regions—Trinidad, for example, where the British give tropic agriculture the benefit of science.

Before the war the great cacao markets were: first, Hamburg (Germany is a great cocoa user); second, Havre; third, London;

and fourth, New York; from these cities it is distributed over the Western World.

SPICES

Spices have no nutritive value whatever, but they render very great service to food. One of the requirements for food is that it shall taste good. A moment's thought will show us that most of our foods are composed of ingredients which in themselves we do not like—flour and water, potatoes unseasoned, rice unseasoned—all these and many others are of such poor natural flavor that, though they are very nutritious, we would almost famish before we could force down enough of the unseasoned stuff to nourish our bodies. Therefore we resort to a great variety of seasonings: soy-bean sauce among the Orientals, meat among Americans, mustard among the British, and spices in varying quantities and number throughout almost all parts of the world, especially the tropics. Despite their lack of nutritive value, spices are so generally prized as an article of diet that they have nearly world-wide distribution. In the history of commerce they are especially interesting, because the trade in spices long dominated the commerce between the East and the West. They were for centuries almost the only food products that could be transported far. They were of greater relative importance in ancient and mediæval than in modern times, because the limited variety and poor taste of the food made necessary something to improve its flavor. It was the spice trade that Columbus sought, and spice trees were among the trees early introduced into the New World.

SPICES THE PRODUCT OF TROPIC GARDEN SPOTS AND HIVES OF POPULATION

Nearly all the spices with the exception of mustard and red pepper grow only in the tropics. The trees and fruits from which they are produced have been widely disseminated throughout the hot countries, where the local consumption of spice is common. However, the commercial production of the spice rarely follows the mere introduction of the plant for local use:

for nearly all the spices are like tea in requiring tedious and painstaking labor in their production. As a result their export is limited to centers having dense population and abundant supply of labor. All Old World crops came to the New, but the export of spices from the New World remains insignificant. Yet these regions dominate in the export of grain and cattle, products suited to regions of sparse population.

PEPPER

This is the most important of all spices. It is prized by rich and poor in both tropic and temperate latitudes. In quantity it equals all other spices combined. Singapore is the leading port for the shipment of black and white pepper. Most of this export is assembled from Malacca, Sumatra, Borneo, and Siam, but much is also grown about Singapore. It is significant in this connection that this island of 206 square miles supports 348,000 people, a large proportion of whom are Chinese coolies, the best laborers in all the tropical world. With them are many Europeans—a combination providing both workers and supervisors. In Siam also are at least two hundred thousand Chinese, in the vicinity of Bangkok. The Chinese coolies are also responsible for most of the pepper and other exports of Sumatra. The Malabar coast of India is another pepper country; a little is also produced in the West Indies.

Black pepper is the dried, unripe seed of a climbing vine, sometimes twenty feet high; the white pepper is the same seed when riper and peeled. The common method of growing this plant is to sow the seeds in fields of rice, castor beans, and other temporary crops. At the same time the seeds of rapidly growing trees are sown. In two years these trees are cut and stuck in the ground as poles, making a permanent support for the climbing pepper vine, which yields its crop in about two years.

Cayenne pepper or chillies is an entirely different plant, yielding a small fruit somewhat like the peppers commonly seen in markets of the temperate zone. It is widely grown for local use throughout tropic Asia, Africa, and South America, and takes its name from the city in French Guiana.

GINGER

This, the second spice in the order of demand in the market, is the underground stem of a reed-like plant growing wild in the warm parts of Asia. It is one of the most widely cultivated spices. It is planted like any common crop, dug in ten months, and, like most spices, dried in the sun. The best preserved ginger is exported from South America, West Africa, Bengal, Cochin-China, and, in small amounts, from northern Queensland.

CINNAMON AND CASSIA

Cinnamon is the bark from the young shoots of a small evergreen tree native to Ceylon and the adjacent coasts of India. The cinnamon industry was a government monopoly in Ceylon until 1883. Since that time it has been introduced into Java, Cape Verde, Brazil, West Indies, and eastern Africa. It also grows in Florida and Mexico, but almost the entire supply is still produced in certain districts of southeastern Ceylon, where forty thousand acres of it are under cultivation. This island has the necessary warmth, moisture, and light sandy soil, and over most of its territory the population ranges in density from two to six hundred per square mile, thus furnishing the labor supply necessary to keep the cinnamon trees trimmed to a low bush-like form, to gather the long shoots, peel the bark from them and to dry it for market. The flavor of cinnamon, like that of most spices, is due to an essential oil. Cassia, the bark of a somewhat similar plant, is much like cinnamon and is gathered in the same way; but it is of inferior quality, and is largely used to adulterate the Ceylon article. Most of the cassia is produced in the tropic part of south China, and the exports, amounting to a million dollars a year, are all sent out through Hong-Kong.

NUTMEGS AND MACE

Mace is the husk that encloses the nutmeg, the fruit of a tree growing wild in the Banda Islands in the Dutch East Indies. It requires a hot, moist, fully tropical climate and a fertile, well-drained soil. This spice tree, with the clove, was long a monopoly of the Dutch Government in the Moluccas or Spice Islands, where the Dutch traders in the days of their commercial supremacy preserved their spice monopoly by sailing the eastern archipelagoes and cutting down nutmeg trees wherever they found them. Nutmegs are now chiefly grown for export in Singapore, the islands of Penang, British East Indies (107 square miles, 906 people per square mile), and Grenada, West Indies (270 square miles, 500 people per square mile). The population of Penang is largely Chinese, which conduces to the production of nutmegs. In addition to nutmegs, the little West Indian isle of Grenada exports cacao and some minor spices. The nutmeg trees do not produce complete blossoms, some being male and some female. They do not bloom until they are six or seven years old, and as about three-fourths of the trees are males, there is great waste in producing them. Recent experiments, however, show that they can be grafted like apple trees and all thus made productive. Connecticut has long had a fame (but scarcely credit) for nutmegs made of simple home-grown wood and sold to the unwary.

CLOVES

The clove is the dried, unopened flower bud of a tree grown to some extent in Penang but most largely in the island of Zanzibar (640 square miles) on the eastern coast of Africa, where the population of 270 per square mile has a considerable sprinkling of East Indians, Europeans, and Arabs, who are the employers of labor. The oil of cloves is often extracted from the spice and sold as a separate product.

VANILLA

Vanilla differs from the other important spices in being a native of America and Mexico. It is the only orchid out of many thousands that produces an edible product. It is cultivated to a small extent on the eastern coast of Mexico, but it is cultivated chiefly by Oriental labor in the Indian Ocean islands of Reunion, Mauritius, and Seychelles. These islands resemble other spice districts in population. Reunion (200 people per square mile) has a considerable sprinkling of Hindoos, while Mauritius (500 per square mile) has an important element of Chinese. The cultivation of vanilla is very exacting. It is a climbing vine and must grow in the shady and humid forests. Owing to a peculiarity of the blossom, each one must be fertilized by means of a small splinter of wood in the hand of the attendant. After the beans are ripe they must be most carefully dried to develop a perfect flavor. The manufacture of vanillin, a substitute produced from sugar by electrolysis, threatens this industry, which is one of the most unhealthful of occupations.

PIMENTO OR ALLSPICE

This fragrant spice is the small dried and wrinkled fruit of a beautiful tree which grows to a height of about thirty feet. It is a native of tropical America and is cultivated chiefly in the island of Jamaica (population over 150 per square mile in a mountainous territory). The pimento trees commonly grow in pastures, and at picking time small black boys climb the tree and break off the fruiting twigs. Women pick them up from the ground and attend to the work of drying and preparing the fruits for market.

MUSTARD

Mustard is the most popular and extensively used spice in Great Britain, where it is a great substitute for good cookery, as meat is in America and pepper is in Mexico. It is also quite generally used in many other countries. It is the finely powdered seed of a plant belonging to the same family as the turnip and beet. The production of this seed is quite widely scattered and seems to be centered in localities possessing the necessary foggy climate that favors its best development; thus certain foggy districts in Russian Poland have developed a relatively large mustard industry, the product being exported through the adjacent German port of Königsberg. In Essex and Cambridgeshire, England, and in Holland are other mustard-growing districts. The United States has one successful mustard district near Lompoc, in Santa Barbara County, California, in a valley opening directly to the Pacific, whence come the necessary fogs at the ripening time. The attempt to develop mustard production in sunny districts east of the California Coast Range resulted in failure, although the crop was promising up to within two weeks of harvest. Then came the sunshiny days that made the mustard too strong to use.

Mustard of an inferior quality is exported from Bombay, India, where the climate renders the seed too pungent to be generally acceptable.

The amount of land required for the growth of the world's supply of spices is so small that the danger of an inadequate supply due to land shortage is about as remote as is the danger of a scarcity of salt.

CHAPTER XXV

THE ULTIMATE FOOD SUPPLY

It has been shown in connection with nearly every article of diet save meat that we can easily and greatly increase the supply in the Western World. Nevertheless, it is perhaps worth while to consider the general question of the future food supply, because it is so generally believed that the chances of making a living are growing fewer, that the resources of the world for each man are less than they were a few years ago. This belief is not founded on geographic or scientific fact; it belongs in the same class with the idea in the mind of the horse when he sees a bar in front of him and thinks he is fenced in, although he could easily tear down the fence with his soft nose. If resources appear to be growing scarce, the scarcity is due to the shortcomings of our suddenly grown financial and industrial system, and from our quite unscientific method of distributing goods and wealth and holding property. It is true that the world has a fixed area, and that the number of mankind, despite the temporary destruction wrought by the Great War, is increasing very rapidly; but while the area is stationary and the material in the world is constant in quantity, the usable resources are also rapidly increasing. A resource is something which may be turned into or made to produce a useful commodity. Science every day enables us to have some new commodity, where before there was waste. Because of this creation, there is good reason for the belief that the available resources of the world are increasing quite as rapidly as the population, and that they will continue to do so for a number of generations, if man devotes himself to science and industry rather than to war.

The complaint of lack of opportunity is old. At various times in the world's history industry has apparently caught up with resources, so that there actually were few opportunities available under existent conditions. Such a period was the warlike and piratical seventeenth century. As commerce, industry, and the desirable and available world then existed, there was little room for enterprise for the worker or investment for the capitalist. Foreign peoples were positively or potentially hostile and, therefore, their lands were unsafe. The sea was unsafe for merchantmen; there were no railroads; highways were bad; and idle hands could often find no employment. Foreign resources were to men of that day as the interior of Alaska, or the forest along the coast of Hudson Bay, or the copper deposits of central Africa are to us today. The people of Holland, then the greatest financial country and the chief money lender in the world, found themselves in a land of small opportunity, as a result of the great scarcity of resources to develop. There were few new enterprises in which they could invest their surplus; hence, when interest rates had sunk to a very low point, they speculated wildly in tulip bulbs. For the last half-century, on the other hand, railroads and steamships and the security of peace have opened almost the whole world to commerce, to investment, and to settlement by industrial people. From 1885 to 1914 the rapid progress of science, showing us new ways to utilize raw material, brought the world into a period of really rapidly increasing resources or opportunities for industry—resources that needed developing and offered employment to the capital and labor of all nations.

The Dutch investor of this period owned railroads in the United States, plantations in Java, nitrate works in Chile; moreover the rate of income is several times as great as it was in the seventeenth century, when his ancestors gave way to the tulip mania. An example of the internationalism of industry is this typical enterprise in progress in Spain—an English corporation financed largely by French and Belgian stockholders, with its work directed chiefly by American engineers, who utilized Spanish workers in building reservoirs in the defiles along the southern slopes of the Pyrenees; the impounded waters were being used for irrigation and for the manufacture of hydro-electric current, the one to make dry valleys rich with crops, and the other to turn the wheels and light the streets in Spanish towns. The war stopped this work for a time almost as suddenly as it stopped the import trade of

Germany; but the development of the enterprise resulted in more jobs in Spain, more people and more homes in Spain, more crops in Spain, more factory products, and a surplus to go to America to pay the engineers, to England to pay the managers, and to France and Belgium to pay the stockholders.

THE DEGREE OF UTILIZATION OF RESOURCES

The question naturally arises: When are resources fully utilized, and when is a country fully occupied? It is difficult to say when a country is full because of the present practice of living by manufacturing and consuming the products of other localities. The standard of living is a second factor making it difficult to say when resources are fully utilized. If the people are content to live in small houses rather than large, to eat grains, vegetables, and beans rather than meat and other products requiring much land, then the population can be large. Under the system of household industry many localities in Europe and Asia are populated up to the food-limit, the non-flesh food-limit, and the record of famine in India shows that country to be far beyond the food-limit in years of crop failure. Millions there have starved beside the railway, which could have brought them food if they had had goods or money with which to buy it. Yet worse, within this century human bones have been taken to the Indian fertilizer factories by the trainload, because whole populations had perished, and not even the most distant kin of the dead remained on earth to bury them. But this devastation was due rather to misplaced effort and unorganized commerce than to shortage of the earth's food supply. Pigs fattened in some lands while people starved in India by the million. Belgium, the most densely peopled of Western lands, has, more than India, passed the point where she can under present standards feed her people from her own lands; but she was getting along very well until the war disturbed her commerce, because she had successfully reached the stage of buying raw material, selling manufactured goods, and importing food with the proceeds. This nation, like other nations, and other localities in Europe and America, has become like a city in its economic life and was steadily increasing in population; with the steady increase of commercial facilities, it showed evidence of continued growth in manufacture, population, and dependence on the foreign markets and on foreign raw materials. To a large number of people in Belgium, their land, at least in part, had become a home space, their sustenance space being in other lands.

The best example of a country with fully developed resources is Japan, with meager mineral wealth, a steep and hilly land, a small proportion of arable land, and a population of about four persons per acre of tilled land. Until the recent sudden shift to commerce, this population supported itself almost entirely by agriculture, with an average area of 2.6 acres per farm family. On this slim resource, the nation had maintained its physical and intellectual vigor and a high civilization; but it was engaged almost exclusively in the ultimate phase of agriculture, namely, gardening by hand labor, and using only the non-flesh diet with the addition of fish.

Before the war Japan was reclaiming each year an area large enough to feed over two hundred thousand people and new lands to be reclaimed will provide for over thirty million increase of population at the present rate of four people per acre.

The mystery of China's support of their millions is explained in a skilled American agricultural observer's account of a visit to the farms of the densely peopled province of Shantung.* Every scrap of vegetable matter and excrement is saved and returned to the fields, which yield a harvest of wheat or barley in June and then, with the aid of midsummer monsoon rains, a second crop of millet, corn, sweet potatoes, peanuts, or soy beans. The last two are nitrogenous meat substitutes and help to explain the observer's statement that "One of the farmers in this province with whom we talked had a family of twelve people which he was maintaining on 2.5 acres of good farm land, keeping besides one milk cow (also used as a work animal), one donkey, and two pigs. The crops raised were wheat or barley, millet, soy beans, and sweet potatoes." At this astonishing rate one square mile could maintain 3,072 persons, 256 cows, 256 donkeys, and 512 pigs. It would be impossible to find an American square mile that could feed, under American methods, the

* King, F. H.: *Farmers of Forty Centuries.*

animals alone, to say nothing of the people. Japan, and apparently China, are now entering upon the second stage of development, in which there will be (as now in Europe) a large manufacturing population added to the agricultural population.

Not all of China is so densely peopled. These conditions prevail in *spots,* especially on alluvial soils. Unused land is indicated by the reports that wild boars are regularly hunted within five miles of the Yangtse-Kiang at Ching Kiang, the first port up from Shanghai; that, within the same distance of the port of Fu Chow, the leopard is hunted and deer skins are regularly exported from Yangtse ports; that large wild hares are so common along the Yangtse that the European resident is surfeited with them.

In the light of these achievements and tendencies of the yellow race it is plain that even they have by no means caught up with the resources at their disposal. Japan, with an average population of 350 per square mile, probably most nearly approaches the limit; in Europe, Italy, with an average population of 326 per square mile, is probably the nearest Western counterpart of Japan. A part of Italian agriculture has reached the ultimate garden stage, with the terracing of hillsides, yet work animals are still used in most parts of the country. As in Japan, there is in Italy great scarcity of mineral resources and there was, until a recent date, only a little manufacturing. Unlike Japan, Italy has a dry summer, which greatly restricts the production of food for the support of a large agricultural population, so that Italy's high per cent. of usable land has not served to prevent great poverty, especially in the southern provinces. As a consequence of this approach to the agricultural limit, many Italians have emigrated and the country is rapidly entering on the second or manufacturing stage, having increased the power used in manufacturing from one million to three million horsepower within the five-year period from 1899 to 1904. Much of this power is derived from the streams that rise in the glaciers, on the southern slopes of the Alps. The Italians use the suggestive name of "white coal" for this stream energy, which, in that country without coal, serves to locate most of the Italian manufactures in the north. Emigration is chiefly from the non-manufacturing south. Italians have now begun to utilize to some extent volcanic heat as a source of power; this development may give a new outlook to southern Italy, where in the past the volcanoes have been merely terrors desolating fields with lava and shaking down houses with their earthquakes.

UNUSED AGRICULTURAL RESOURCES OF THE TEMPERATE ZONES

It is evident that there are two standards for the estimation of resources: the *Oriental standard,* based on hand labor and largely non-flesh diet, and the *Western standard,* based on work animals, dairying and other animal industries, and a meat diet. The descriptions of the crowding of population in Japan, Italy, and Belgium, may lead one to think that after all the world is getting filled up. But examination of a map of the world will show that these countries occupy a very small fraction of the earth's surface. Judged even by Western standards, the temperate zones have large unused agricultural resources. Unused resources should be classified into the two distinct types: resources unused under present conditions, and resources that science may develop by inventing better methods than those now in common practice. North America, the south temperate zone, and even parts of Asia are relatively unoccupied lands when compared with Italy, China, and Japan. So little is farm land utilized and sought in the United States that in large areas east of the Alleghenies it is a common saying based upon fact, that when a man sells a farm he gives away either the value of the building or the value of the land, for the price obtained is often less than would be required to replace the buildings. Very little land in the United States is intensively cultivated; moreover the United States enjoys an advantage unique in the Western World —a vast area on which to cultivate the great gift of corn. Over one million square miles of the country can produce this king of forage crops, one of the most productive and easily grown of all the grains. Furthermore, this grain lends itself to double cropping, the recourse of crowded peoples. In Japan and China, and wherever possible in Italy, the land is made to yield two crops per year, winter grain between October and June, and rice or some other summer crop between June and September. Similar double cropping, now almost unknown in the United

States, can be practised, if need be, in most of the corn-belt. For example, as far north as New Jersey a good crop of peas can be harvested in May and June, and a full crop of young corn, or cotton farther south, sown between the rows, will ripen before frost. Even a third crop can be grown and agriculture yet maintain its Western standard through machine work and large area per man. Cowpeas, clover, and several other

Fig. 129.—Man standing in a cornfield in which velvet beans have almost completely covered the corn. This bean has nitrogen-gathering nodules as big as the end of your finger. Its beans and leaves are both edible by hogs, cattle, and horses. The cutting of the corn crop in the usual way is impossible, but some of the ears may be snapped off and the animals turned in to eat all they can and trample the rest underfoot to the great enrichment of the soil. The rapid increase in the growth of this bean in the Southern States has caused its acreage in the United States to exceed that of the potato. (U. S. Dept. Agr.)

leguminous plants will thrive with the corn or cotton, enriching the soil with their roots, feeding animals with their tops and making possible a wealth of agricultural production now undreamed of in most of the United States and impossible in sunny Italy, with its rainless summer. Yet even there, over three hundred people per square mile, most of them farmers, succeed in extracting a living from the hilly and rocky earth. The American cotton-belt, with its summer rain, with an area six times the size of Italy, and now supporting only from twenty to fifty people per square mile, has easily twice the ability of Italy to produce food, raiment, and timber, per square mile and is many fold richer in minerals and waterpower.

In the United States are one hundred thousand square miles of swamp land, scattered among the old glacial lake beds in the northeast, in tidal marshes along the Atlantic Coast, in cane brakes south of the Chesapeake, and in the alluvial lands along the Mississippi and other rivers. These swamps when drained have a triple advantage: they are fertile, they have a good moisture supply, and they do not wash in heavy rains. They are twice as productive as uplands, and are at the present time almost untouched. Moreover, there are in the West sixty thousand square miles which irrigation can make almost or quite as productive as the reclaimed marshes. The proposition to drain these marshlands of the South systematically immediately after the Great War is one of the most sensible projects brought before the American public since President Roosevelt and Gifford Pinchot initiated the movement for the conservation of natural resources. It is generally expected that thousands of soldiers, for years freed from the restrictions of city life, will insist upon the freedom of out-of-doors. This unused south land is the greatest American reserve of cheap unused land, and the drainage of swamps if done systematically and properly has the double advantage of making new land and of removing the mosquito, carrier of malaria, perhaps man's most powerful enemy on the face of this earth. Hitherto, not man, but the insect, has dominated this world, square mile by square mile. Man has used the little corners where the mosquito and other disease-bearing insects do not thrive. Where they do thrive, the malaria, the sleeping sickness, the yellow fever, the typhoid fever, and the other insect-borne diseases have kept man in the background. The place to begin the attack upon this enemy which has been more potent than even the Germans ever threatened to be, is the swamp lands of the United States, from which can be made millions of farms producing indefinite quantities of food—if we want the food.

Canada, with a population about equal to that of Belgium, has in the east a large area as little used as is the adjacent part of the United States; and the vast plains west of Winnipeg contain several hundred million acres of fertile lands which would support scores, if not hundreds, of millions of people if tilled like similar plains in Germany, Denmark, or northern Japan.

Alaska, to the surprise of Americans, has been found capable of producing luxuriant grasses and ripened grain, and if need be, can easily be made another Finland, which supports several million agriculturists with millions of farm animals and exports a vast amount of lumber.

The trans-Siberian railway has opened up the heart of a country larger than Europe, with a wide belt of at present unused grain lands, almost another Canada, which may possibly permit the Russian realms to double their population with ease. Manchuria and Korea, for which Japan and Russia fought, have unused lands several times greater in area than those which support the fifty million Japanese, but these lands are probably not so productive as those of Japan, because of the large amount of irrigation in Japan. China, with a population that taxes the present food-producing resources of her empire, has a huge labor supply, and untouched mineral resources second only to those of the United States, with the result that the manufacturing possibilities are more stupendous there than in the United States. It is also probably true that China herself has extensive unused agricultural resources.*

In western Asia the era of railroad building has been barely begun in what was once the seat of empires and kingdoms—Asia Minor, Syria, Mesopotamia, and Persia. The richest part of Asia west of India is Mesopotamia, the valley of the Tigris and Euphrates rivers, the seat of most ancient empire and most recent war. The irrigated soil supported dense populations of Assyrian and Babylonian farmers and townsmen from before the days of Abraham until after the fall of Rome. For centuries, cursed by Turkish misrule, it lay unused, with abandoned irrigation ditches reaching through several million acres of alluvial

* In spite of the popular impression that China is overcrowded the country can support twice its present population, and there is plenty of room in China for the business men of every nation with no necessity for old-fashioned competition in which energy is wasted in trying to keep the other fellow out, according to Dr. Paul S. Reinsch, American minister to China, who recently attended a luncheon given in his honor by the Commercial Club of San Francisco.—From *Oriental News and Comment*, 1918.

soil. But there is every prospect that, with the incalculable stimulus of order, and under development by European and American engineers and capitalists, it will again become the seat of great agricultural production and a large population. The British took possession of Bagdad in March, 1917, and immediately set the natives to work on canal digging. In the spring of 1918, the American consul at Bagdad reported that the area planted in that region was eight times that of the preceding year and four times that of the best recent previous year.

In Argentina and Uruguay in South America, in South Africa, in Australia, and in New Zealand, the south temperate zone has millions of square miles of land, with a total population less than twice that of Holland and Belgium. These large territories, while greatly handicapped by aridity, have a wholesome and moderately invigorating climate, and resources that will permit a many-fold increase in the population based on a many-fold increase in the production of grain, meat, dairy products, and fruits. Moreover, as in most of the world, their mineral resources are but slightly developed.

THE DESIRE FOR IMMIGRANTS

It is true that in China, Japan, and India, the people lament that their numbers are so great—a state of mind strikingly different from that of the innumerable booster clubs organized in many states, provinces, and countries of the New World for the sole purpose of attracting more people to come and settle in their localities. Aware of the numerous unused resources of the temperate zones, we are in a position to understand the great efforts that have been made by many countries with unoccupied and undeveloped lands to induce immigration from the densely populated countries. For decades the United States gave away one hundred and sixty acres of land to any man of any color or nation who would come and live on it. At the present time many American states, especially those in the West and South, but also those in the Northeast, are making an organized and persistent effort to spread knowledge of their unused lands and to attract settlers. For years Canada has been expensively advertising in many countries the fact that she, too, has good farms to give away to all settlers. Australia, Chile, and Argentina have actually lent immigrants money and assisted in their transportation to the free lands which were to be their new homes. While much of this effort has been due to the desire for increase of wealth, which the immigrant would give with his capital and produce by his labor, there has been another good reason. In many localities, covering large areas of the Western World, the population has been too sparse to support a good, well-organized, well-financed society with the necessary schools, churches, and other institutions.

SCIENCE CREATES RESOURCES

Supplementing all these resources, usable with our present knowledge, but unused, comes the development of science. She is yet young and fecund. Many are the new creations men of science have wrought since their wits have been cudgeled by the pressing needs of the war: the submarine, the flying machine, the tank, great discoveries in medicine, and industrial substitutions without number. All these represent the work of a comparatively small number of our population in a few short years. There is nothing unusual about it. It is but the beginning. The war has shown us the importance of science. Now that the war is over we must seriously consider the problem of education and the helping of men to make a living and to live. More than two blades of grass will grow where one grew before, and clusters of grass will grow where there was none. Our new knowledge, applicable alike to agriculture, manufacture, mining, and transportation, gives us many new facilities for utilizing resources hitherto unavailable. Science, therefore, may be said to create resources of great benefit to every land from empty Australia to the teeming Orient, which still depends on human muscle for bearing burdens and running the loom.

One of these great creators of resource is chemistry. Man's economic possibilities have already been increased by its discoveries, and doubtless great economic powers are yet to come from the laboratory. Suggestive of progress due to this agency is the synthetic method of making indigo, which is now almost entirely produced from retorts distilling coal tar instead of from the vats in which the people of India and Central America ferment the stalks of the indigo plant. The indigo fields are now free to produce food. After the existence of large areas of unused land has been demonstrated, the question arises: What will this land yield? How many people will it feed? This question is bound up with that of fertility and artificial fertilizer. By studying this subject the chemist has done much and will do much more to increase the food supply and thereby the numbers of men who may inhabit this earth. One of the war-time improvements that will have a very far-reaching effect on the world's food supply is the manufacture of nitrogenous fertilizers. A few years ago, the supply seemed to be quite definitely limited, with famine not far away. In the middle of the nineteenth century commercial fertilizer began with guano, the accumulated dried droppings of birds which lived upon almost rainless islands off the coast of Chile and Peru. In a few decades this surface deposit of centuries was exhausted. Then we discovered the nitrate fields of Chile, which will last us for a few decades. But before this product was nearly exhausted, man's possible alarm was postponed by the chemists, who discovered a way to make sulphate of ammonia out of coal tar. A ton of coal, distilled in a modern by-product coke oven, makes a good many gallons of ammonia. From this rival source of nitrogen were produced 210,000 tons of sulphate of ammonia in 1890; 500,000 tons in 1900; 1,300,000 tons in 1912. However, the supply depends upon coal, which is itself quite definitely limited in amount. This limitation does not apply to the most recent supply of nitrogen that the scientists have opened to us—air nitrates.

Mechanical power in the form of electric current sending its white-hot spark through a little box containing limestone and a few other cheap materials unites them with the unlimited nitrogen of the ever-abundant air. We now know that so long as sources of power remain and ledges of limestone exist, that is, for millions of years, man can have all the nitrogenous fertilizer he wants. One of the important means of doubling yields, particularly yields of breadstuffs, is thus at his command.

Plants need many substances, especially carbon, oxygen, nitrogen, phosphorus, potash, and lime. Some of these are secured abundantly from the air, or are to be found in the soil so commonly and plentifully that they rarely need to be applied. But three main substances are so scarce that they are the chief constituents of artificial fertilizer: namely, phosphorus, potash, and nitrogen. When a few hundred pounds of these substances have been applied to an acre of the poorest ground, if the climate is favorable, magnificent crops of sturdy and productive plants promptly arise.

In the latter half of the nineteenth century the commercial fertilizer industry was firmly established. It has continued to spread rapidly since 1900 and is now an accepted feature of the agriculture of the Western World. Without it man had fared poorly in times past. Undoubtedly one of the reasons for the fall of many ancient empires was the exhaustion of the soil because of the continuous growth of crops and the carrying away of plant food faster than it was produced by nature, until the land became so unproductive that it was not worth the farmer's time to cultivate it. This condition is to be found in areas around the Mediterranean basin at this day. Dense population has been maintained in a few spots of great richness, especially on alluvial soil. A good example is Egypt, where the River Nile has continually enriched its valley for thousands of years with layers of flood mud. China and Japan have maintained their great populations by scientifically and laboriously putting back upon the soil everything taken from it. In some parts of the Western World careful systems of animal agriculture have approximated this method. These systems have provided for the return of the excrements of the animals, which, with the slow release of plant food from the mineral earth, has sufficed to maintain fertility at a fair degree of productivity. But the new opportunity to go to the railroad station and bring home a few sacks of phosphate, potash, and nitrogen, has given man a new hold upon the earth—as long as the supply of fertilizer holds out. Hence arises an important question as to our ultimate resources of fertilizer.

PHOSPHATE

Phosphorus is perhaps the least abundant of the fertilizing substances. At present it is the cheapest element of our supply of fertilizer, because it is temporarily abundant and is easy to procure while the supply lasts. For thirty years the chief source has been the fossil deposits near the surface in South Carolina, Florida, Tennessee, parts of Tunis, and elsewhere. The phosphorus famine which seemed imminent a decade ago has been postponed for several centuries by the discovery of very large deposits in the Rocky Mountain region, especially of those near Yellowstone Park. Probably many more will be found when the world has been thoroughly investigated; and it is reasonable to hope that before this supply, sufficient for several centuries, has been exhausted, man will know enough to extract phosphorus from the sea, where the very small percentage in solution makes a total quantity inexhaustible, as far as man's needs are concerned.

POTASH

The scientist is similarly challenged to increase the supply of potash; the need became very acute in all Allied countries between 1915 and 1918. The world's commercial supply hitherto has been drawn almost exclusively from Germany, where at Strassfurt on the Elbe 2,000 tons were produced in 1881, and 11,000,000 in 1912. Thence it was distributed by the hundreds of thousands of tons among the leading countries. A very diligent search in the United States has revealed no abundant supply of potash equal to that of Germany, although some is found in lakes in California and Nebraska and the kelp beds on the Pacific Coast contain a supply from which we could get enough to use (at a high price) if we were permanently compelled to depend upon it. However, industry hesitated for a time to embark largely on such an enterprise because of the reasonable certainty that at the end of the war the old cheap sources in Germany would again be opened and the more expensive hothouse industry would perish. As the war scarcity increased and the price of commercial potash rose from $45 to $600 a ton, numerous attempts were made to secure it—from Searles Lake in the California desert, from many small lakes in the Sand Hills of Nebraska, from the green sands of New Jersey, from shale rocks in Georgia, from the dust of blast furnaces and cement mills, from alunite in Utah, from ancient lava in Wyoming. There are whole mountains of rock containing about 8 per cent. of potash. Heat will release it. America could make its own potash if necessary, but it would cost much more than digging it in Germany, Alsace, or Spain where large deposits are recently reported. Italy has vast stores of it in her lavas, but it would take coal (at present) to get it.

NITROGEN

Nitrogen has for many years been the most expensive and the most generally needed of the artificial fertilizers, although in nature it is so abundant, composing about four-fifths of the air.

OUR RESOURCES FOR MECHANICAL POWER

The possibility of producing food indirectly by the manufacture of air nitrates by means of the whirling wheels of the dynamo, gives added importance to artificial power, that great primal necessity of manufacture, trade, and transport. Beyond any doubt the most important single resource for the maintenance of existing civilization is the power to drive machinery. At the present time we are depending largely on coal, which, being a mineral, is one of our surely perishable resources. Unlike the field, which may yield thousands of crops, or the forests, which may perpetually yield timber, or the waterfall, which will run on for ages, coal, once used, is gone forever. This most important mineral has recently had its economic value doubled by the discovery of the means of making gas by a method which utilizes inferior coal or peat itself, for the making of gas to run gas engines—a very efficient means of getting power from fuel. The production of one horsepower in one hour from one pound of coal is a common achievement.

The new turbine water wheel and rapidly developing skill in transmitting power by electricity are introducing a water-power era in places where coal is costly. The full utilization of a power that now flows uselessly to the sea, might enable many now sparsely peopled parts of the world to maintain large manufacturing populations—provided food supply is available and the falls can help make the fertilizer needed to produce food for the manufacturing populations. An example of distant unused water-power is the Congo River of west Africa, which rivals Niagara by tumbling down to the sea in many cataracts. Engineers have already been seriously discussing the carrying of power seven hundred miles from the falls of Zambezi to the mines of Johannesburg in the Transvaal, and to the diamond mines of Kimberley. The plateaus of Brazil and the slopes of the Andes also have enormous unused water power.

Moreover, in many parts of the world the wind blows with great force and regularity. Wind has long been used as a source of industrial power in Holland; and modern windmills, if we choose to use them, may be made much more efficient than those of the picturesque Dutch pattern.

The success of the Italian engineer, Ginori Conti, in developing during the period of the Great War no less than 13,500 horse-power of electric energy from steam engines driven by the heat from the boiling volcanic springs of Tuscany is very suggestive of vast power developments that may take place in the widely scattered regions of geysers, hot springs, and volcanoes. Equally suggestive is the plan recently put forward * by engineers to utilize several million square miles of tropic sea, which has a surface temperature of about 80°, and a half-mile down a temperature of 40°. The surface is kept at 80° by the continuous rays of the tropic sun, and the bottom is kept at 40° by the continuous inflow of water from the region of roaring polar winds. The engineers find that ether in an engine will boil and turn into vapor (like steam), if the boiler tubes are in the sea-water having a temperature of 80°, and will condense at the other end of the engine if the condenser tubes are in the cold water having a temperature of 40°; this cold water can easily be brought up from the sea a half-mile below the surface. We may picture power-plants floating in the warm Atlantic—great floating islands of reinforced concrete which will have a permanency that will put to shame the coal mine and almost Niagara itself, for they have but to pump up a stream from the inexhaustible cold sea beneath them in order to keep their boilers

* *Engineering News*, August, 1913.

stoked. Concrete ships with storage batteries may possibly tie up at such a plant to be loaded with energy, part of which will carry them to the wharves of New Orleans, Philadelphia, or Stockholm; there, when they have been attached to the transmission wires of the city distributing system, they will run the city's wheels and lights, cook its food, and perhaps heat its rooms.

There is a place on the shore of St. Croix, one of the Virgin Islands, recently purchased by the United States, where the shore falls away so steeply (45°) that power plants erected on the shore could probably get both warm and cold water with ease.

There exists a possible source of power which is available anywhere and which can be utilized whenever the art of developing power from a low-temperature drop is sufficiently developed. We refer to the heat of the earth's interior. It is already practicable to sink bore-holes and mine-shafts to a depth of two miles or more. By circulating water down such shafts and back to the surface, the heat of the deep strata can be brought to the surface. It may be said that by the constant circulation of cool water down the shaft and back the deep strata would eventually have their temperature reduced so that the deposit of heat would eventually be "worked out" like a coal-mine.

The enormous bulk and weight of the deep-lying strata, however, which would slowly conduct their heat to the flowing stream, would probably make the life of such a source of heat very long.

It is interesting to draw a parallel between the development of the natural resources of the earth in minerals and in power. As is well known, in the development of the mineral industry it has been the rich, high-grade deposits which first attracted attention and have first been commercially worked. It was not until the best of these were exhausted, and the product became increasingly valuable, that means were found to work the vastly larger deposits of low-grade ores which were formerly considered wholly worthless. So in the art of power development Man has hitherto only made use for power development by heat-engines of the high-grade drops in temperature produced by the combustion of coal, oils, and other fuel.*

One more power source is already feasible in some places. All other sources of power are insignificant by comparison with the great source—the direct rays of the sun, which hurl into nine thousand square miles of Egypt enough power to replace all the engines and waterwheels in the world. Three different types of mechanism have already utilized this power to a small extent,

* "Low-grade Power-Sources," *Engineering News*, August 6, 1913.

and we may some day find the sun to be the most accessible of all sources of power. The possibility of making sun power more available than the already existing forms rouses interesting speculation as to where would be the natural seats of empire, if the best sources of power were within two or four hundred miles of cloudless desert.

Altogether there is good reason to think that man is coming into an inheritance of an abundance of power to run his wheels, to make nitrogen for his fields, and develop for the future an agriculture of which we in the present know but little.

It therefore appears that in the twentieth century the human race is looking out on a new world—a newer world in the economic sense than the one Columbus showed to the sixteenth century—the world created by scientific industry, speedy transportation, and rapidly improving mechanism. Old standards for measuring the value of land to man have been replaced; the new scientific discoveries are bringing about changes by a series of improvements more rapid than any that we have ever before experienced; and the end is not in sight, if we can only restrain the lust of war, and devote our talents to the utilization of the earth rather than to the destruction of the handiwork of God and man.

An abundance of nitrogenous fertilizer is by no means the only contribution that power may make to man's food supply. Electric current has been used to stimulate plant growth, and experiments carried on in England have had results little short of marvelous. Adjacent plots in a Liverpool park in 1917 were treated alike in every respect except that over one came a current of electricity from the air, somewhat after the fashion of a shower of rain. In comparison with the produce of the plot which was not so treated, onions in this plot increased 633 per cent., sugar beets 467 per cent., peas 29 per cent., barley 30 per cent., oats 39 per cent, potatoes (one variety) 63 per cent. It is too early to make any prophecy on the basis of these astonishing results, but if cheap power can first make plant food and then make plants eat it and increase several times in size, it is easy to see that we may have several-fold increase of the total food supply.

Power may also be used to run farm machinery in the near future, when we may reasonably expect good country districts to be wired with power lines as they now are with telephone lines. Every farm might then have its own power, and it would be the rule rather than the exception for the electric current to milk the cows. It is by no means impossible that we may invent some form of electric transmission that will enable the plowing and harrowing as well as the heavy hauling to be done by electricity rather than by gasoline, kerosene, or coal gas.

NEW RESOURCES IN INDUSTRY

Agriculture is the mother of industry. By the creation of new resources in agriculture, science can make it possible for the earth to support larger numbers of men. Population is limited by the supply of food. Increase of the food supply alone will permit the number of men to increase by the billion. For this reason agriculture outranks all other industries in importance.

In the utilization of the earth for agriculture, we have, down to the latter part of the nineteenth century, used a haphazard method. Our concern for the supply of the future resembled the attitude of the Indian who, from a herd of buffaloes, killed a hundred and carried off only their tongues. Science is now beginning to examine all parts of the earth with reference to their usefulness, as the savers of by-products in a modern slaughter-house examine and use every part of an ox.

The essential feature of soil, for purposes of agriculture, is fertility. How to unlock the resources of the earth is man's problem. The key is vegetation, and vegetation requires first, heat; second, light; and third, moisture. Agriculture has thus far been little practised where the land can not be plowed. The insistence in the past on arability as a fourth requirement has caused vast resources of fertility, heat, and moisture to be practically unused, and, by leading to erosion, plowing has caused soil sufficient for kingdoms to be barbarously wasted and destroyed, to the permanent and profound injury of the earth as a home for man.

The barriers that have prevented men, especially in the temperate zones, from utilizing fertility have been: first, cold; second, aridity; third, steep and rocky surface; fourth, excess of moisture; and fifth, unwholesome climate. All of these barriers are now giving way.

Until the latter part of the nineteenth century, man's progress in increasing his powers and combating difficulties was almost entirely the result of the unscientific effort of untrained workers and the enthusiasm of the individuals who tamed the wild animals of the forest, cultivated and improved by selection those plants that seemed most useful, and, by accident, made inventions and discoveries. We have now entered a new epoch.

1. Thousands of men are now being definitely trained in most of the fields of human endeavor by the most careful study of the sciences fundamental to existing knowledge and future discoveries.

2. Institutions are supporting the constructive work of these men. Edison and Burbank were compelled personally to raise money for the support of their profoundly important work.

The war has doubtless resulted in giving the development of science a much firmer basis of financial support: for it has clearly shown that national protection, industrial development, and human life are dependent on science to a greater degree than we had ever thought. We may, therefore, expect science to be promoted much more effectively in the coming decades.

An example of revolutionary discovery is the recent unraveling of the laws of heredity, which permits us to make an art of breeding and thus of improving the plants which furnish us most of our food, clothing, and raw materials. These plants become machines and man the mechanic, a manufacturer of food machines. We now understand the effect of environment in fitting plants to survive particular conditions. The climate of Arizona is dry; but we now know that every desert in the world has been developing plants that will thrive in Arizona; for example, in the Old World, the olive illustrates adaptation to a dry environment. We need no longer depend on the chance introduction of plants by immigrants and independent botanists. The search for suitable plants has been definitely organized by governments and corporations. The alfalfa from Siberia, or the peach from Mongolia, is hardy as a result of natural selection during ten thousand or ten million raging winters, followed by the same number of blazing summers. These plants may be well adapted to conditions in some parts of the United States. It is also raw material for the plant breeder of the Agricultural Experiment Stations. Because of the work of the explorer and the plant breeder, we can raise new cold-resistant or quick-growing plants that push the farm line north, or new drought-resistant plants that push the farm line into the arid regions, or better yielding plants in the fields now under cultivation. The several-fold increase of sugar in the beet within a century is indicative of further changes that may be wrought in any plant and are now actually in progress in many. Surprising results have been obtained in producing kinds of corn which are (a) more vigorous and productive, (b) more oily, (c) more starchy, (d) more highly charged with protein than are the ordinary varieties. As a result of the search for the plants of the world's cold and arid deserts and the improvements of plants there found, new crops are already being produced and harvested in lands previously considered too arid or too cold for any use save as scanty pastures. One of these quick-growing plants is the kafir corn, now grown near the one hundredth meridian in the United States, where, for every mile it pushes the farm line westward, it opens to cultivation sixteen hundred square miles of farms, which will, under existing American conditions, easily support seventy-five thousand people, and in some countries would support several times that number. The thornless cactus may make good pasturage in what is now the dead desert. The wet lands may receive almost equal benefit from new crops.

THE DOMESTICATION OF NEW PLANTS

Vast additions to wealth, comfort, and industry are to come from the domestication of plants now unused or produced only by unaided nature. A suggestive example of this policy with its revolutionary results is the history of the cinchona industry. The bark of this tree produces quinine, so highly prized as a remedy for certain fevers and malaria that the British Government orders it to be kept on sale in every post-office in India. For more than two centuries after its discovery in 1638, cinchona bark was produced only on the remote eastern slopes of the Andean Mountains in Peru, Bolivia, Ecuador, and

Colombia. It was gathered from trees growing wild in the forest, and no one thought of questioning the right of this mountain range to a permanent world monopoly of this precious product, until, in 1852, the Dutch Government introduced it into Java, and, in 1860, Clements Markham, an Englishman, introduced it into India. It is now cultivated on the southern slopes of the Himalayas and on the mountains of southern India. It was cultivated on a commercial scale in Ceylon with such success that between 1881 and 1886 the export to London increased from 350 tons to over 5,000 tons. The Ceylon supply was so much larger than the South American that the industry became unprofitable even to the Ceylonese, and has declined in that country from 64,000 acres in 1883 to 9 acres in 1912; but it has steadily increased in Java, with its populous valleys and humid mountain slopes, until the export from its cinchona groves reached over 10,000 tons in 1911. The price is one-thirtieth that which prevailed in 1870, when it was gathered wild on the Andean slopes. The export from South America has practically ceased, for the hunter in the sparsely peopled forest is unable to compete with the myriad villagers on the plantations of Java.

Within two decades cultivation of rubber has passed from a dream of the visionary to an established industry which promises in a very few years to render unnecessary the unpleasant jobs of thousands of rubber hunters who now scour some millions of square miles of tropic forest in Asia, Africa, South America, Central America, and Mexico for the scattered wild rubber trees. In 1911 wild rubber sold in New York for $3.00 a pound. A better product is now raised in the plantations of Ceylon and Malaysia for about twenty cents a pound and its price has gone down to so low a figure that the growers are wondering if they can limit the output.

Every decade of the twentieth century should witness one or more (probably several) such important transfers of the derivation of an important product from the forest to the field or orchard, from the hunter to the cultivator, with great increase in supply and reduction in cost. An interesting example of change of source is the recent discovery that the hevea (Brazilian) rubber tree of the Malayan plantations produces seeds, containing forty-two per cent. of an oil closely resembling linseed oil. This discovery will probably release ground for wheat in Argentina, Dakota, and Manitoba, where now the fields are taken up by the very exhausting crop of flax for linseed oil.

ANIMAL BREEDING

The breeding of animals is another example of the success of science in affecting agriculture. Animal breeding follows the same laws as plant breeding and has been longer understood. We can estimate the value of the work already done by comparing the useful cow with the wild buffalo. By the application of science to animal breeding, the efficiency of our domestic animals in many respects can be approximately doubled. (See chapter on Dairy Industry for improvements in the dairy cow. See chapter on Poultry for improvements in the hen.)

ULTIMATE USES OF THE SEA

It has already been pointed out in this chapter that the sea contains, through the difference of its upper and lower temperatures, a resource of power probably usable even under present conditions, and in quantities beyond all computation in terms of man's need.

The food supply that the sea may give us is perhaps, on the side of flesh foods, almost as limitless as the possible resources of power. It may completely overshadow the land in its possible production of edible flesh, and that, too, with almost no labor for production. As factors pointing to such a conclusion, we have its area of 150,000,000 square miles in comparison to the land area of 50,000,000. We know that much of the land area is of very low productivity because of the varying limitations of drought, cold, rocks, low fertility, and perhaps diseases. In contrast to this, the sea teems with life and fertility. All of the sea contains plant food, the leachings of all continents for geologic epochs, and while the trees of a land forest are spectacular, they may not of necessity represent a greater annual growth per unit of area than the product of a similar area of open sea where no plant, save perhaps a little floating seaweed, is visible, but where microscopic plant forms in great quantity grow not only on the surface of the sea but far beneath it, and microscopic animals and small animals a fraction of an inch long exist here in great quantities.

The chapter on fish showed how little we have touched this resource. We have not begun to catch even the herring in the North Pacific. We are still throwing away, according to one estimate, fifteen to twenty thousand whales a year in the Antarctic Ocean alone. Each of these whales is the equivalent of about a hundred beef cattle. Each of these in turn is, according to the table in Chapter VIII, equal to the product of about six acres of good Illinois land. Thus the fifteen thousand whales equal 1,500,000 cattle, or the product of ninety thousand acres of the best farm land anywhere occupied by white men.

When we start out scientifically to search the sea for food, we may easily find that a single species of the smaller floating mollusks, such as the pteropod mentioned in the chapter on fish, will equal in total bulk of edible food all the meat animals now possessed by man. Thus a few decades or centuries hence, the fishing ships of Britain might bring back from the Arctic, the Antarctic or the tropic sea, one hundred or two hundred pounds per capita per year of pteropods—fresh frozen, dried, or canned. Furthermore, it may be as easy to do this for a population of two hundred million as for a population of fifty million. The same is of course true for New England, for France, for Japan, or any other industrious nation that applies science and energy rather than chance and prejudice to the problem of securing a food supply from the sea. Such a change would merely be the adoption by the Western World of the already well-proven Japanese dietary of fish, cereals, vegetables, and very small quantities of meat.

Doubtless this may sound fantastic to many persons of a so-called practical turn of mind, but I wish to call attention to the fact that there has been no systematic economic survey of the sea. Most of the scientific work that has been done in the past has been done for the systematic, classifying scientists. At great expense we have dropped a little dredge down twenty-five thousand feet, brought up all the traces of life we could, and classified every species we could identify, giving them two Latin names in a learned monograph for the bookshelf of the zoologic or geologic specialist. Meanwhile edible pteropods, (merely one of many species) float about in unnumbered billions waiting for some constructive servant of humanity to tell us just where they may be found, how they may be caught, how they may be prepared for food, and then to actually come teach us conservative landsmen how good they are and how to use them. It would be difficult to find a more useful piece of work than the effective introduction of hungry man to the food resources of the sea. A relatively small amount of work as man's efforts go, would in a few decades easily achieve such a result, and do much to put hunger out of the list of troubles of any people willing to work.

CHAPTER XXVI

TREE CROPS AND OUR ULTIMATE FOOD SUPPLY

Possibly the greatest of all agricultural benefits resulting from applied heredity will be the breeding of new crop-yielding trees—a piece of relatively slow scientific work for which we are now ready. It promises to be so exceedingly useful because (1) it will give us new foods, (2) it will enable us to use now useless land, and (3) it will save the greatest of resources by furnishing crops for hilly regions which can then be productive without the destruction of soil that now accompanies the attempt to plow them and put them in the grain crops ill suited to such lands.

Man (or more properly woman) began agriculture at the wrong end of the plant kingdom. The grains on which we feed are all weaklings. The harvest is often but a small handful in comparison with the bushels yielded by trees—the engines of nature which have for ages been giving man the most astonishing object lessons of production, and inviting him to improve them rather than the feeble grains at their feet. But the grains are annuals—a great advantage to the primitive woman from whom we learned most of our agriculture. The time has now come for a systematic scientific utilization of our agricultural resources, including trees. Centuries of actual experience in various parts of the world tend to prove that we may have a whole new agriculture, which at all stages will be perfectly adapted to the natural resources of the earth.

Land naturally tree-covered may be classified according to intensity of cultivation and value of output somewhat as follows: first, the forest yielding game, furs, and gums; second, the forest yielding lumber; third, pasturage; fourth, tilled land and grain fields; fifth, orchards yielding tree crops. Whenever we find an agriculture that has substituted the perennial tree crops for the annual grains, we find an agriculture with an output rivaled only by that of the market garden. The yield of wheat, corn, and oats is scanty in comparison with the heavy harvest and large income furnished by the apple, peach, orange, date, olive, and Persian (so-called English) walnut. Yet we have hitherto depended almost entirely on the chance for the development of useful varieties, produced by accidental crossing.

Now, however, science has taken a hand. We need no longer depend on chance, the resource of the ancient nomad. We know the laws of plant breeding, and as a result tree crops, with their great yield, will no longer occupy an inconspicuous place in agriculture. Probably the cultivated fruit trees of all sorts do not cover over two per cent. as much ground in America and England as is given over to the less productive grains. As agriculture adjusts itself to resource, tree crops with their great superiority should eventually far outstrip the grain crops.

Plant breeding, scientific, not accidental, plant breeding, is a force that will transform agriculture as the steam engine has transformed transportation and the factory. It will enable us to harness the trees, the great productive engines of the plant kingdom. The plant breeder, the constructive botanist, now tells us, for example, that it takes only time and patience to make, by repeated crosses, a good crop-yielding hickory tree, almost an ideal hickory tree. Its nut can have the delicious sweet flavor of the shagbark, the thin shell of the bitternut, and a sufficiently near approach to the size of the Indian giant to put it in the same class with the English walnuts for food value, accessibility, and desirability. It will, however, differ from the English walnut in being thoroughly acclimated by thousands of years' adjustment to our changeable climate, whereas the English walnut is a Mediterranean exotic, thoroughly at home in the United States only on the Pacific Coast, where Mediterranean conditions prevail.

For two centuries the white man has been felling the forests of America to make room for fields. Many an Eastern field, now of low fertility and scanty harvest, has, or has had, on it the acorn-bearing oak, the nut-bearing walnut, chestnut, and hickory (shagbark or shellbark), the seedling apple, the seedling peach, the red-heart and black-heart cherry (wild mazzard), and the fruitful persimmon and pawpaw. Yet this year, as for generations, all these astounding sources of crops have been negligently brushed aside, cut down, rolled in piles, burned up to make room for wheat and corn.

Science, backed by money and patience, offers to make some good tree crops for a million square miles of American hills, and for other millions of square miles in other continents as well. But science is as yet doing little to bestow this inestimable gift upon us, because the work depends on appropriations by far-

FIG. 130.—Evergreen oak in Portugal with an average annual record of 750 quarts of acorns. This acorn is nearly as good for stock food as some grains, and its record as human food is undoubtedly much older than human history as we know it.

seeing legislators, and such legislators are not often picked out by the voters—as yet. Is it too much to hope for economic intelligence here?

Tree crops may render different services to man's attempt to utilize the earth and increase the food supply: (1) they permit us to grow crops in land too rocky to be plowed; (2) they produce crops on land too steep to be plowed; (3) they thrive on land too dry for grain (for the tree is the most drought resistant of plants); (4) they permit a two-story agriculture, trees above and tilled crops beneath; (5) they offer valuable substitutes for meat as well as for bread and butter; (6) they are well adapted to plans for the conservation of natural resources.

1, 2. TREE CROPS IN STEEP AND ROCKY LAND. THE APPALACHIAN MOUNTAINS OF EASTERN AMERICA OFFER AN INTERESTING EXAMPLE

The Anglo-Saxon, with the level-land plow agriculture, brought from England, a land of gentle rain, entered the mountains, felled the fine trees of the rich forest, scratched the sloping earth with a plow and planted corn—corn, the great king crop of the level country,—the poorest crop of the hills. Before this mountain corn crop can ripen, it must be subjected to many rains. Unfortunately, the typical summer rain of the mountains is a tearing, pouring thunder-storm which lets loose on an acre of ground, one, two, three, and even four hundred tons of rushing water in a single hour. It is therefore natural that the earth should be washed away. After the earth has been deprived of its protection of forest and roots, the gashing and loosening by the plow and hoe seem to be a further special preparation for its complete removal by the rushing waters. The light, loamy soil which, if properly cared for, might nourish a thousand or ten thousand crops, is gone in a few seasons, and merely serves to choke the meadows below and to hinder navigation of the valley streams.

This hideous, frightful, bootless waste does not have even the excuse of enriching one generation of men. The process of corn-growing is so laborious on this steep, stumpy, and often rocky new ground that the poor mountaineer gets only a meager crop. In the effort to get much money for little corn, he turns to the distillery to make corn whiskey. This expedient has always seemed a natural right to the hard-pressed mountaineer; hence the century-long conflict between the moonshiners and the United States collectors of internal revenue. The illicit still yet runs in Appalachia, and in many localities the man who has shot a Federal revenue officer is a local hero.

Great is the contrast between these poor, uncomfortable, whiskey-cursed, law-breaking mountaineers of Appalachia and the comfortable, prosperous inhabitants of similar but less favored slopes in Corsica. I have traversed miles of mountain slopes in Corsica having the angle of a house-roof. The slope was steep, but a good road wound in and out along its face. At intervals we passed through villages of substantial stone houses, with well-built churches, well-stocked stores, and often comfortable inns. The people were farmers who made their living from these slopes despite the house-roof steepness. A genuine mountain agriculture has been developed there, a tree agriculture which prospers without the plow and its attendant erosion. The tree can utilize the heat, light, moisture, and fertility of the mountain without imposing upon man the fearful and destructive task of plowing a place that was never meant for the plow. If, perchance, the mountain is so rocky that plowing is impossible, it makes no difference to the tree. It sticks its roots between the rocks and thrives, perhaps even the better, as rocks on the surface check evaporation and keep the moisture in the earth.

I recall a region in northeastern Corsica where, except for a few breaks not over 100 yards each, I passed for fifteen miles through an open forest of chestnut trees, and *every tree* was grafted to a heavy yielding variety. These forests are really orchards, the sustenance of the people in the many villages. The chestnut is to them what corn is

FIG. 131.—Corsican mountain side as steep as a house roof. No free goods as in America. Every tree is a grafted chestnut and the crop makes the land worth $200 per acre. Note the prosperous-looking gateway of the chestnut land owner.

to the Appalachian mountaineer, and more, for does not a chestnut tree once established outlast two or three generations of men? There is always, so I was told, a crop, a large crop succeeding a smaller one, as is the case with many crop-yielding trees. Time and again I was told in Corsica and in France, by growers, merchants, and government officials, that the average annual yield of a good mature chestnut orchard was from 2,000 to 3,000 pounds of nuts per acre.

This nut is food for man and beast. It is also the money crop to pay for purchases from the outside world. The Corsican mountaineer eats his chestnuts fresh, boiled, roasted, made into mush, baked on the griddle, fried in oil, baked into a loaf, and also in a few other ways.

After the human harvesters have picked up the best of the nuts, the pigs are turned in to finish the crop. A good pig will add unto himself two pounds of weight per day for a couple of months; he is then, at the beginning of winter, salted down for future reference.

Furthermore, there is pasture beneath the chestnut trees, for they

FIG. 132.—Pecans, exact size, grown in the climate of Philadelphia from a tree grafted four years before with twigs from a fine parent tree in Illinois. Parent tree had a good crop on it when the white man first found it in 1817 and has not missed more than three crops since.

are not allowed to make a dense shade. They produce better if the sunshine can fall on all of the branches. Pigs, cows, mules, and goats, especially goats, browse beneath the trees. Goats'-milk cheese is an export of Corsica, and it is worthy of note that a balanced ration is furnished by the starchy chestnut bread and the cheese from the goat that browses beneath the tree. It is a standard and by no means bad-tasting meal in many Mediterranean mountain districts. The goat, which, in proportion to size and food consumed, is the greatest milk-giver in captivity, thus plays an important part in adjusting agriculture to the environment.

So far as I know there is not one ungrafted chestnut tree among many thousands in Corsica. The seedling nut tree is nearly always a scrub, but the grafted trees are all aristocrats, *i.e.,* lineal descendants of the Napoleons and George Washingtons among trees.

It is easy to see that high value should attach to a tree that lives for a century or two, produces regularly of valuable crops without labor and sells for much good money when it is finally felled. I was repeatedly told by reliable Corsicans in 1913 that while unplanted land has practically no value, these orchards are worth from $150 to $250 per acre. That figure puts Appalachia to shame, and compares well with Illinois corn-land values. One of the methods of calculating the value of the orchards pays a curious compliment to the tree. The bearing capacity of the tree is estimated by an expert. This is multiplied by five centimes per kilogram of bearing capacity. This result is reduced by one-third for the cost of picking up, and this result, the earning power of the tree, is multiplied by twenty to give the value of the tree. The land is thrown in for nothing. Thus a tree yielding 200 kilograms (220 lbs.) is worth 133.4 francs, and ten such trees would make an acre of land worth 1334 francs, or more than $250. As the trees grow old and must be cut out, they are worth their cost. Hence the high rate (twenty-fold) of capitalizing the earning power of the tree. It is salable and non-depreciating property.*

The chestnut is typical. There are many more crop trees, and equally effective examples of utilization of some of them might be given if space permitted.

The tree-crop agriculture that puts hilly and rocky land on a par with plowed land becomes more significant when one remembers that the most of New England has never been plowed; that in some New England States the greater part of the land that has been plowed has been abandoned because of the rocks; and that perhaps a million square miles of the United States with

* See "Farming Appalachia," by J. Russell Smith, *Review of Reviews,* March, 1916.

good climate, good rain, good soil, cannot be permanently plowed because its steepness will cause its absolute ruin through erosion.

For New England, as for other rough and rather humid regions, the significance of the crop-yielding trees such as the mulberry, the walnut, hickory, acorn-bearing oak, and many others is this—these trees, these engines of production, do not depend upon the plow. They are indifferent to rocks. They can wedge their trunks in between the rocks, send their roots far down into the moist glacial subsoil which is richer than the subsoil of Indiana, rear their heads into the abundant sunshine, and *produce*. What care they for rocks? If there is earth among them, the tree roots will find it.

What New England and all hilly countries most need is the application of science, to give them an agriculture that is adjusted to their unplowable soils. The present agriculture of New England is a misfit imported from the lands suited to the plow.

Everywhere east of the Mississippi trees will grow where there is earth standing above the water level. With properly improved varieties of tree crops there is no reason why Massachusetts might not, square mile for square mile, produce as many fat pigs or fat sheep or fat turkeys as Kansas does now—possibly more. The proper succession of fruiting mulberries, persimmons, chestnuts, walnuts, pecans, hickories, shagbarks, filberts, and many other tree crops that might be introduced from this and other countries would give us an abundance of good food from a continuous succession of workless harvests which the pigs, sheep, and turkeys could eat if man himself did not want them.

Thus may the production of the eastern part of the country be doubled. The one-third that is now too hilly for good cultivation will, with tree crops, double and more than double its present meager output. The roughest third, which cannot be tilled, can with tree crops match in productivity the best third, which should be kept for cultivation by the plow, to which it is by nature adjusted.

3. TREE CROPS FOR ARID LAND

The benefits that tree crops can render the arid and semiarid lands are equal to if not greater than those that they may confer on the hilly lands. The grasses, grains, and ordinary forage plants are ill equipped to fight for life against the rigors and vicissitudes of aridity. Corn, for example, must have water within a certain two weeks or it is blasted, but trees can prepare for a siege. In the first place, their roots can go down to a great depth. These roots can store up energy, and when the times comes they can often support the growth that makes fruit. Furthermore, many of the trees of the arid lands are legumes, with the legume's power of gathering nitrogen from the air, leaving a part of it on their roots to enrich the soil, and using the rest to make seeds that are rich in nitrogen and, therefore, meat substitutes and tissue builders.

FIG. 133.—Fruiting branch of the wild persimmon in Georgia. The persimmon is very nutritious and grows wild over nearly a million square miles. It probably will become a great forage crop, as domestic animals like it and the tree is very hardy, growing on the poorest soil. Part of the crop had already fallen from this branch when photographed.

A claimant for supremacy in the possible desert harvest of several continents is the wide-pod thorny honey locust, a leguminous tree with a big fleshy pod easily picked and full of rich beans, which often contain over fifty per cent. of sugars and starches and also have a high percentage of protein. This tree will grow on many plains now considered almost worthless, and its seed is one of the richest of all stock foods. It nearly duplicates in quality the carob bean, the "locusts" of John the Baptist's desert sojourn. That leguminous tree is now a crop grown in all Mediterranean countries, and many beans are exported from Cyprus to England for stock food. In Spain this food is the oats of the cavalry horse. A little of it also comes to the United States to be manufactured into a substitute for milk for calves.

This honey locust is but one of nature's many desert plants. One of the botanists of the Department of Agriculture has found six species of woolly-fruited wild almonds growing on the desolate shores of Pyramid Lake in the so-called Nevada Desert. The desert may yet bloom with almonds, for these six varieties bear nutritious though small and bitter fruit, and Mr. Frank Meyer, plant explorer of the Department of Agriculture, brought back from central Asia the seeds of wild almonds producing good fruit and good edible oil in a climate with an estimated rainfall of eight inches per year.

Foreign lands have great numbers of promising trees to offer us when once we set out in earnest to breed tree crops. If we will, we may easily breed the crop-yielding trees and convert hundreds of thousands of square miles of almost vacant Western range into fruitful orchards for the fattening of beasts or the feeding of men.

One of the greatest and most triumphant agricultural booms in the world is to be found in Africa—the dry-land farming of central Tunis, where the rainfall is less than ten inches. This success is astonishing in the face of the uncertainty, dread, and failure that harass our own as yet unadjusted dry-land agriculture. As an evidence of local failure I would cite the observations of an agricultural scientist on a recent ninety-mile journey in the southern part of the American Great Plains, where the rainfall averages twenty inches. In the ninety miles traversed there was but one surviving settler and not even a cattle-ranch. The dry farmers had pushed out the cattlemen, and the recent droughts had pushed out the dry farmers—all but one—in a strip as long as from New York to Philadelphia. Our uncertainties arise under a rainfall of ten to twenty inches. The African's complacency is assured by less than ten inches. Subscriptions have recently been taken up for American people living in a region where the rainfall averages sixteen to eighteen inches. Yet the successful dry farming of Tunis is in the vicinity of Sfax, where in seven consecutive years the total rainfall amounted to forty-one inches—five and eight-tenths per year.

The Tunisian rain is a winter rain, which is the best kind for dry farming, but except for that advantage there are not many extenuating circumstances in the climate. Tunis is so near to Sahara that it is a thorny camel-pasture, and the frequent siroccos of the summer season are fearfully dry. There are no permanent streams. The Tunisian success depends upon the fact that the Arabs long ago worked out to a finish the dust-mulch practice (which we recently "discovered" with

FIG. 134.—Olive trees planted by the Romans in central Tunis more than 1,200 years ago, still bearing good fruit without cultivation and with only 10 inches of rainfall per year. The tree is the most enduring productive device within the reach of man.

such a hurrah), and, further, they and their French copyists have applied it to a crop that suits the environment: olives—a tree crop.

The summer here as in Palestine is one unmitigated drought from spring until autumn. The grass withers and assumes the dead brown of our deepest winter. Dust covers the parched landscape, but under it all, the olive, with its leaf hairy on one side and glazed on the other, scorns drought and brings its fat fruit through to autumn harvest. If the men of Africa and the Scripture lands have by the poverty of their environment been forced to employ better devices than we now possess, may we not, by the application of our brains, imitate them and apply at home the agricultural as well as the spiritual lessons they have taught us?

I rode out of Sfax in three directions—twelve miles, seventeen miles, and eighteen miles, respectively, and always through olive orchards, which lined the road on both sides. Near the town they were from forty to eighty years old. Farther out the trees were younger, and the new plantations are still spreading. I rode one hundred miles to the south, and at the end of the journey the gray-green of the olive-tree was still to be seen. Although most of the intervening distance was bare of olives, there were enough plantations *en route* to show that the whole district was suitable olive ground. I passed groups of tenting Arabs on their camels, saw their camps set back a safe distance from the good French road, and their invaluable "ships of the desert" browsing on the scattered thorn-bushes. Here was the life that had for ages prevailed on the edge of the Old World deserts. The nomad with his tents of camel's hair pauses awhile where the browsing is good, then, packing his chattels, his children, and his wives on the camels, he follows his flock where fancy (and browsing) dictate. When one had passed these ancient scenes, it was almost uncanny to come suddenly upon a two-thousand-acre plantation of healthy young olive-trees stretching away across the well-tilled plain as far as the eye could see.

In one direction, I was told, the plantings extend almost solidly for one hundred miles. The seven years with a total rainfall of forty-one inches seemed to have had no bad effect on the boom nor on the trees. The plantings would be much more extensive than they are if it were not for the fact that the government fears that the supply of labor will run short, and therefore will not, at present, release any more of the camel-range for olive-planting. . . .

This land has almost no value as pasture, and when the government releases it, it is virtually given away; but at twenty-five years of age the seven or ten olive-trees on an acre increase its value to $100 or $150. If well cared for, the average yield is from 800 to 1,100 pounds of olives, worth, at 1914 price, from fourteen to twenty dollars to the grower. The gathering of the crop requires from four to six days' (Arab days') work per acre. The oil yield is thirty or thirty-three per cent. of the weight of the olives. Compare table of acre food yields, page 175.

Among intelligent Tunisians there is no discussion as to which is more certain, a tree crop or a grain crop. They *know* that they cannot depend on grain. It is authoritatively stated that in one locality even more arid than Sfax barley gives in ten years two good crops, three mediocre crops, and five failures, while the olive gives in three years one good crop, one mediocre crop, and one failure—a sixty-per-cent. advantage in favor of the olive, which also requires less work. On the very edge of the Sahara, the natives have been growing olives for countless centuries—probably for two thousand years, and it may be much longer than that. . . .

The lesson for the American lands of scanty rainfall is clear: To develop at once a list of crop-yielding trees, so that every dry farmer can increase his chances by trying at least two kinds.*

* "The Real Dry-Farmer," by J. Russell Smith, *Harper's Magazine*, May, 1914.

Most suggestive is the experience of Hawaii with the algaroba, a species of the mesquite (a point in dispute by the botanists) which will grow extensively in the United States. Hawaii, overcoming many difficulties of a mechanical nature, has learned to grind up the beans and pods of the algaroba bean, and thereby has initiated an industry of great promise. The ground meal was worth $25.00 a ton as a stock food before the war, and was the mainstay of the dairy industry of the islands. The Hawaii experiment station issues the statement that an algaroba forest yields four tons of the beans and one ton of wood to the acre per year. The labor of production consists of picking up the big beans, which grow on a leguminous tree introduced about the middle of the last century from Peru. This great yield would be reduced in other lands, since it is due to the phenomenal fertility of the volcanic soils of Hawaii, and the tropic growing season. Mesquite grows wild from Texas to the Pacific.

Man has thought of himself as depending on a *field* in which to grow his food, but there seems abundant reason to believe that science can, through tree crops, now give him food from any land that grows a forest, and from much land that now grows almost nothing. Moreover the tree crop has a valuable by-product of wood, a material of which there is now a painful and increasing scarcity.

Owing to the long time involved and the consequent impossibility of full financial return to the individual breeder, the breeding of these tree crops must depend largely upon governments, and governments will act only in response to the pressure of intelligence. The time for far-seeing constructive scientific work has come, for we are beginning to need new sources of food.

4. TWO-STORY AGRICULTURE

Crop trees are so effective that we have already begun in this country, as in some foreign countries, to use them on good level land and to develop a two-story agriculture.

Approximately nine-tenths of the arable area of Majorca, one of the Spanish islands in the Mediterranean, is planted out to crop-yielding trees. That makes one-story agriculture. Then beneath the trees grain is grown. That makes the second story. For miles and miles in every direction that beautiful island is covered with continuous orchards of almonds, olive, figs, and carobs, with occasional grafted oak-trees, the sweet acorns of which are prized as highly as the chestnut. This tree agriculture is nothing new, for many of these orchards are of unknown age, and some of them give evidence of having seen generations of men rise, dig awhile, and die before Columbus sailed past on his way from Genoa to Gibraltar; and throughout all the years that the white man has striven in America, these same old olive- and carob-trees have been standing there, handing down their harvests of fruit and beans to the men who raised other crops at their feet—crops of wheat, oats, barley, beans, and peas.

In the average cases it works out that the grain crops pay the cost of the operation, and the tree crops come along and make the profits. The failure of the almonds, or the off years with the carobs or olives, therefore leave no deficits, and the years of good tree harvests are the years of profit. If, as is at times the case in the best-regulated lands, there is a shortage in the grain crop, it has more than an even chance of being equalized that same season by the tree harvest.

No one should be deceived into thinking that he may get a hundred per cent. grain crop and also a hundred per cent. tree crop. That would be too good to be true, too much like eating your cake and having it. The situation is much more like that of the ship that is loaded with pig-iron, and the ship that is loaded with chairs. The iron cargo is so heavy that the ship still has most of her space empty. The chair cargo is so light that the ship still has most of her buoyancy unemployed, and her owners must scurry around and get iron or other heavy stuff to ballast her down so that she will ride safely. By properly mixing iron to take care of the weight and chairs to take care of the space, the ship can actually stow away three-fourths of the iron and three-fourths of the chairs, and thus take one hundred and fifty per cent. of cargo.

It is thus with the trees and the grain. The trees send their roots down into the subsoil, and their tops into the upper air. The small grain attends to the surface, and does most of its growing in the winter, when the rains come and the trees are resting. The two stories of agriculture make more income than either story could have done by itself. Moreover the cultivation and fertilization of the grain is an unquestioned benefit to the trees, which thus become in a sense a by-product of the grain crop.

The Spaniards and the Portuguese apply the same philosophy by letting oaks grow in their grain-fields and then, when the crop of acorns gathers itself upon the ground, bringing their porkers along for a picnic, fattening them upon the harvest that is spread beneath the trees. If I were a pig, I'm sure I should elect to spend that orgy of my last fattening beneath an Iberian oak-tree rather than in an American pig-pen. And if I owned a pig, I would find it more agreeable to my inherent laziness to have the pig pick up his food than to gather it and wait upon him after the style in America.

The farmers of southwestern France annually send to the United States millions of pounds of choice Persian (so-called English) walnuts, and yet there are not ten orchards in the whole region. A French farmer gave me this explanation:

"If we planted the trees in regular rows, close together, we could grow nothing beneath them, for they cast a dense shade; but if we

FIG. 135.—French roadside. No free goods. Wheat comes clear to the gutter. The trees along the road are grafted English (Persian) walnuts. A good tree rents for as much as an acre of land, and produces more human food than an acre of pasture when eaten by a meat animal. In the distance at the left grafted chestnut trees line the fence rows.

scatter them about the fields, there is plenty of light, and wheat will grow close to the trees."

One exceedingly intelligent French proprietor whose place I visited had applied this theory by planting all his fields with walnut-trees ninety feet apart. Thirty years hence it will look like a great park that has been planted to grain, and as they approach maturity, every one of his walnut-trees will be making more human food than will be furnished by the meat from an acre of pasture. For years (before the war) the selling price of this French walnut-tree's harvest was more than the value of the meat produced by the acre of pasture, but no one can predict what prices will be during the one or two centuries that elapse while those walnut-trees still continue to shed their autumn nuggets of nutrition. . . .

A few decades hence we should and will have millions of acres set to fruit trees that we do not now regard as crops, with, at their feet, rich harvests of crops economically produced by machinery. I feel confident in this prediction, because every element involved has been tried and found good, and the process of combination has already begun.

The combination that leads the way in the two-story agriculture of America is that of the pecan and the pastured pig. The efficiency of which we have been hearing much of late pertains to the farm as well as to the factory. In the factory it has been discovered that much of the work is only half effective, and that, owing to lack of system, much time is spent in loafing instead of in work. On the farm the very same conditions exist, and one of the important discoveries of farm-efficiency experts is the fact that a pig is good for something besides eating and being eaten. He can work. For the last hundred years we have been regarding the pig as a star boarder when we should have been regarding him as a harvest-hand. The days of porcine luxury are passing, and on a steadily increasing number of farms the pig may be classified among those having gainful occupation. The point is this: instead of laboriously feeding the pig in small inclosures, where he eats what we with human labor bring him, we turn him into the fields to gather for himself crops that we previously harvested by our own hard labor.

The really new feature is the working out of successions of quick-growing crops like oats and vetch, barley and vetch, cowpeas, soy beans, sorghum, sweet potatoes, peanuts, Japanese cane, crimson clover, red clover, and the old stand-by of corn, so that the farmer does little more than to plow and plant, and drive his pigs from field to field to harvest the crops as they ripen. As soon as the pigs leave a field, the farmer plows it up and plants the next crop. When the pig goes from the fourth or fifth field, he goes to market, and the farmer puts a big deposit in the bank, for his bill for labor has been small. He has used no reaper. He has not had the work of making hay; he has known no harvest rush. The pigs harvested for him, and thought it quite a lark at that.

From Missouri to the Delaware and from Kansas to the Gulf, this system of pork production has been tried and found good. . . . When some kind of large, hardy, crop-yielding trees such as pecans, walnuts, honey-locusts, oaks, or persimmons have been added, the trick is turned. There is nothing un-American about the method, for the best kind of American machinery can be used without interference wherever it is wanted. Will the tree interfere with the harvest? The cumbersome reaping machinery does not enter into the problem, because the pig does the work. Plows and cultivators for orchard tillage have already been brought to a high degree of perfection. Indeed, no untried experiment is involved, for the plan is being carried out with success on Georgia pecan plantations that I have visited. . . .

American conditions offer great incentives to this two-story combination of nuts, fruit, and pork. All the nut-trees of the East and the South, like the pecan, the Persian walnut, the black walnut, the shagbark, and the chestnut, start late in the spring. The sun shines in on the first floor for a relatively long time; conditions are therefore favorable to cold-weather plants. Fortunately we have such plants. The clover of our fathers blooms in early June at Philadelphia, but the crimson clover, a recent importation from cool Germany, works so busily in late autumn and early spring that it blooms in April, and has virtually done its work before any nut-tree begins to cast the shadow of its leaves. The vetches are good companions for the crimson clover in working while the nut-trees sleep.

FIG. 136.—Two-story farming. Georgia porkers rooting up the remnants of a sweet potato crop in a young pecan orchard. The pecan is a coming substitute for meat.

This factor is of great and increasing importance in the southern Atlantic and Gulf regions, where the deciduous trees are bare a long time, but the hardier herbaceous plants grow virtually throughout the winter. It is in that region that the two-story agriculture of the pig and the pecan has already been worked out, and from this region it should be extended northward far into the land of frost and snow.*

5. STAPLE FOODS FROM TREE CROPS

We may get both bread and meat, that is, proteins and carbohydrates, from trees, though we have not been doing so in America thus far.

The trouble is that we have not taken tree crops seriously. In the autumn we go forth with our children and gather a few nuts as an outing, which is little more important in our eyes than the collecting of pretty pebbles, and has no appreciable influence on the family budget or the family's nutrition. We pay some rather high prices at times for fruits, which are tree crops, it is true; but what is their nutritive value compared with that of the trees of the Mediterranean garden? †

It has been pointed out by Mr. O. F. Cooke, economic botanist of the United States Department of Agriculture, that agriculture in the Mediterranean basin began with tree crops and that at least twenty kinds of trees there have still some importance as crops producing staples of nutrition.

Our tree crops, our apples, peaches, pears, and grapes, our grape-fruit, oranges, and lemons, are delightful and wholesome and needed, but they meet no major nutritive need. These needs of the body are protein for tissue, and fat and carbohydrates for energy. Except for a small amount of sugar (and sugar is already one of the cheapest of our foods), our popular fruits may properly be compared to a refreshing drink or a succulent salad. The Mediterranean garden of trees produces major foods. The almond contains much protein. The walnut contains both protein and fat; the oil of the olive is more nutritious than butter and far more nutritious than the flesh of animals. The fig is a real food, containing some protein and much carbohydrate, and giving a greater amount of nutriment per pound than bread furnishes.

So great is the service of the Mediterranean trees to man that the definition of a garden in Syria is a place where trees are grown; such was the Garden of Eden. The Syrian garden is full of trees,—walnut, almond, olive, carob, fig, apple, peach, pear, cherry, apricot, orange,

* Smith, Russell J.: "Two-Story Farming," *The Century*, July, 1914.

† "The Agriculture of the Garden of Eden," by J. Russell Smith, *Atlantic Monthly*, August, 1914.

pomegranate, and mulberry. Beneath and between the trees the vegetables and grains are grown.

The trees in this Syrian garden furnish an important and practically necessary part of the nutrition of the people. Combined with grain in the form of coarse bread, the tree-products make a balanced and wholesome ration. For large numbers of the population, at least one meal a day is commonly composed of bread and walnuts. The walnut is rich in both protein and fat, so that this combination virtually duplicates in nutritive value our occidental sandwich of bread, butter, and meat. . . . When the workman on the Mediterranean goes from home for a day's labor, he often takes a pocketful of olives and a piece of bread for his lunch.*

Emphasis should be laid on the fact that all of the nuts except the chestnut are rich in protein, and therefore are meat, milk, and egg substitutes; most of them are rich also in fat. (See table of food values.) The chestnut, though it contains little protein, is rich in starch and therefore is a real bread substitute; it is so used by millions of people in south Europe.

With a proper development of varieties of the chestnut, we shall be able to have chestnut orchards on thousands of miles of hills in the temperate zones of every continent.

Even more promising as an eventual substitute for grain is the acorn. We do not think of eating acorns, but there is only one reason why we do not: namely, that most of them possess a little bitter tannin, although not so much but that our jovial friend the pig gladly and successfully fattens himself upon them. On some parts of the Mediterranean coast occasional specimens of oak trees produce acorns as edible and nutritious as chestnuts, and they are grown in grafted orchards for sale as human food, especially in the Spanish island of Majorca and adjacent parts of the mainland. In parts of Spain and Italy it is reported that sometimes as much as twenty per cent. of the food of the poor people consists of sweet acorns. I have myself seen the acorn basket passed around the family group as we sat by the fire in a Portuguese farmhouse.

When he cannot have grain, man is quite willing to eat acorns, and it is possible that in the whole history of the race man has eaten more acorns than wheat, for they may have been an im-

* "The Agriculture of the Garden of Eden," by J. Russell Smith, *Atlantic Monthly*, August, 1914.

portant starch food for hundreds of thousands of years when man lived in the woods. The Nevada Indians a few years ago were still continuing their ancient practice of crossing the Sierras in the autumn, gathering sacks of acorns, drying them and carrying them over the mountain into Nevada to their winter homes. Acorns were the breadstuff of the tribe. The squaws crushed them between stones, soaked them in water to take away the tannin, baked the meal into bread or boiled it as a cereal that, save for a little shortage of protein, was a close rival in nutrition to the porridge of Scotland and the breakfast food of America, provided there was plenty of cream on the white man's cereal, for the acorn meal analyzes high in oil, a cream, butter, and bacon substitute.

	Corn meal	Wheat flour	Leached acorn flour [1]	Unleached acorn meal [2]
Water	12.5	11.5	11.34	8.7
Ash	1.	.5	.29	2.
Fat	1.9	1.	19.81	18.6
Protein	9.2	11.4	4.48	5.7
Carbohydrates	74.4	75.4	62.02	65.
Fiber	1.0	.2	2.06	6.63

[1] Of California black oak that had been kept twelve years and lost some of its protein

[2] "California Valley White Oak," from *National Geographic Magazine*, August, 1918.

There is no reason to doubt that there has been many, many times more acorn flour than wheat flour eaten by man in California. Acorn bread and mush was the staff of life from the Oregon boundary to Mexico, save in deserts, and in California alone there were three hundred thousand Indians (estimated) at the time of the coming of the white man. In an astonishing article in the *National Geographic Magazine* for August, 1918, Mr. C. Hart Merriam, ex-chief of the United States Biological Survey, says that one part acorn to four parts corn or wheat "makes palatable bread and muffins, adding to the cereal value the value of a fat nut product. John Muir, during his arduous tramps in the mountains of California, often carried the hard dry acorn bread of the Indians and deemed it the most compact and strength-giving food he ever used."

Acorns of several species (there are fifty in the United States alone) were eaten by various Eastern tribes from Canada to the Gulf of Mexico. Buried in the cold mud beside a spring, the Indian cache of acorns has been known to keep sweet for thirty years. When we consider that some oak trees have a record of a ton of acorns at a crop, we realize that we have here a great source of starch food. Though the statement cannot be proved, or disproved, I venture the prediction that on several hundred thousand square miles of the United States more carbohydrate can be produced from the oak tree than from corn. I refer to the hilly regions where corn-growing means erosion, and in a few generations the destruction of the soil, whereas properly selected and grafted acorn-bearing oaks would yield for an indefinite period, and would then be magnificent timber. Although there is no immediate prospect that man will need the acorn for bread, it is comforting to know that it is waiting for us when we choose to utilize it, and improve it as we have improved the apple, the peach, and the orange. In the meantime it is, like corn, good pig feed, and well worth growing for forage. An acorn diet need be no hardship to man. There is little reason to doubt that the factory, by properly combining acorns with wheat flour and other cereals and nuts, could make excellent bread which might have just the right proportions of fat and protein to be perfect food. The extracted tannin might easily be sold to the leather manufacturers, furnishing a further source of profit.

6. TREE CROPS AND CONSERVATION

The proper development of tree crops will help to conserve the soil, our greatest and irreplaceable resource. The saying, "After man the desert," is all too true, as the frightful desolation of the site of most ancient empires attests. This desolation is almost entirely due to erosion, which tree crops with their earth-gripping roots will stop: for the tree is nature's means of holding earth on the rocky framework revealed by erosion so near the surface of our hills and mountains.

The planting of our hillsides with crop trees will help us to utilize the distant flood plains: for it affords a new method of controlling rivers, checking floods, and also of increasing navigation, water supply, and water-power. At the present time man is fighting floods by the building of artificial lakes in mountain defiles. More effective is a device worked out by the Arabs of Tunis, and by a Pennsylvania farmer in his apple orchard. This Pennsylvanian made small holes, called water-pockets, small reservoirs each holding a few barrels of water, at the base of each tree. Every rain fills them; and the water soaks gradually into

FIG 137.—Water-pockets which effectually stop erosion and run-off of water on a 20-degree slope in a Pennsylvania apple orchard. Basins or temporary ponds above the trees hold many barrels of water each, and permit it to soak into the earth. Invention of J. H. Meyer.

the ground, thus entirely stopping run-off and greatly increasing the crop on the trees. The influence on nearby springs and wells, and consequently on the flow of streams needs no explanation. These water-pockets also annihilate the gully—one of the greatest enemies of mankind.

The preparation of hill lands for these tree crops may require a great amount of work in the digging of water-pockets, the making of roadways, and in some cases the removal of stones. A short time ago these tasks required brute muscle. Now science has placed new tools in man's hands. Explosives, with which we have become so familiar in war, have for a few decades been working revolutions in quarrying, mining, tunneling, road-making, and agriculture. Tractors may also be of service in some of this work.

Some such scientific utilization of resources will be necessary in order to provide land for the returned soldier. It was easy after the Civil War, because half the continent lay untouched,

FIG. 138.—The mangum terrace—a great discovery in agriculture. It is a ridge going across the face of a slope so that water will follow it to the edge of the field instead of running down the field and carrying away the soil. While it retards erosion in plowed fields it does not prevent the use of farm machinery, and can itself be easily made with a plow. Ten-degree slope is its limit. (U. S. Dept. Agr.)

level, and ready for the plow. Now the most of it has passed into private hands. Whereas the amount of land used for farms increased at an average rate of twenty-seven per cent. per decade between 1870 and 1900, it increased only five per cent. between 1900 and 1910, although population increased twenty per cent.

We can no longer simply go and take land; we must now reclaim it from water, drought, rock, and hill.

THE ULTIMATE USES OF LAND

The crop trees have an important place in our ultimate food supply. Their place may be indicated somewhat as follows, in the classification of the final uses of land for maximum return with conservation of the soil:

(a) Where heat, moisture, and fertility abound.
  1. Level or gently rolling lands will be tilled as at present but planted to more productive varieties of plants.
  2. Sloping lands will be terraced with the mangum or similar terrace to prevent erosion and permit cultivation.
  3. Hilly, steep, and rocky lands will be put to tree crops, with extensive use of water-pockets.

(b) Lands that we now call arid or semi-arid can in many cases also be planted to more drought-resisting plants of which the best are tree crops, which here also may be aided by water-pockets.

(c) Cold lands where the cost of keeping warm is great, also possibly lands that are too hot, will be left to produce timber forests.

(d) Beyond the tree crop and forest zones, in lands of cold and drought, will come cactus deserts and moss-covered tundra to be used as pasture ranges by animals suited to the conditions.

(e) The bare desert, the bare rock, and the snow field will then as now remain without harvest, save for
  1. the possible discovery of minerals where the earth is visible, and
  2. the possible utilization of deserts for sun-power generators, and
  3. the use of snow fields as sources of water-power.

CHAPTER XXVII

THE DISTRIBUTION OF FOOD AND OF MEN

"One-half of all the fruits and vegetables raised in the United States never reach a consumer," says a high official in the United States Food Administration. As was shown in a previous chapter, probably not one per cent. of the fruits and vegetables that might easily be raised in the United States are actually produced. The high prices at which we grumble are due not to scarcity of resource but to the stupidity and knavery that persists in a system of food distribution that should have been left behind when Noah went into the Ark.

The almost unbelievable waste of fifty per cent. shows that vast improvements can be made in the cheapness, abundance, and quality of the food that civilized man may have if he will apply half as much effort to the problem as he has recently applied to war, and will improve conditions in the following respects:

1. The organization of the local market.
2. The organization of the distant market.
3. The distribution of residence with reference to resources and climate.

I. ORGANIZING THE LOCAL MARKET

The railroad, the steamship, the telephone, and the telegraph have opened to us a world market and world commerce. The novelty of these opportunities has caused them to be used to excess. Man may be said to have gone on a transportation spree, a very orgy of transportation. We have unduly separated man's home space from his sustenance space, to the detriment of both sustenance and home. In the United States, a country with unused resources and idle land on all sides, an increasing number of people cannot afford to buy enough food to nourish themselves well. We have let the railroad paralyze the local market. The waste of fruit and vegetables characteristic of the

United States goes on also to a lesser extent in other parts of the world and is accompanied by dissatisfaction on the part of producers. Mr. Henry W. Collingwood, editor of the *Rural New Yorker,* one of the leading agricultural papers, has for years stoutly maintained * that, in the eastern United States, thirty-five cents of the consumer's dollar goes to the farmer who produces the food while the rest is spent (mostly wasted) in unproductive expense between the farmer and consumer.

Evidence to support this claim comes from Altoona, Pennsylvania. A few years ago, the markets of this manufacturing city of sixty-five thousand people in a beautiful and little used valley were ill supplied with poor and wilted vegetables at a high price. Mr. A. B. Ross, then engaged in agricultural extension work, organized a survey of the food supply of the city with surprising results. A typical case was that of a barrel of apples which a farmer in Bedford County, Pennsylvania, hauled to his station, and shipped by train forty miles to Altoona. There it was put on a dray and hauled to a commission merchant. After keeping it for a few days the commission merchant sold it to a man who hauled it to the station and shipped it one hundred and fourteen miles over the Allegheny Plateau to Pittsburg. There it was again put in a dray, taken to a commission house, again sold and again hauled back to the station, put on a train and shipped back to Altoona, carted to a commission merchant's store, and sold to a retail grocer, who hauled it to his store, broke it open, and delivered its contents in many small lots to his customers. This one barrel of apples underwent four sales, six cartings, and three railroad journeys.

We cannot afford such methods when the railroads are overcrowded. All that work was wasted on the barrel of apples because the marketing of food was unorganized. Each man was

* "I know that thus far no one has ever been able to disprove the following facts:

1. As an average of the country's farm business the farmer receives a thirty-five-cent dollar—that is, thirty-five cents of the dollar which the final consumer pays.

2. The present system of distribution and sale is so costly, cumbersome, and complicated that it is little short of robbery of both producer and consumer.

3. Just as soon as the farmer is convinced that the price paid him is fair he will increase his crops with his present equipment—without further advice."—*Rural New Yorker,* October, 1916.

working by himself in the dark. Marketing must be so organized that we shall know where best to send produce with a minimum of hauling.

The Altoona survey showed that the sixty-five thousand people there were spending over $4,000,000 a year for perishable farm supplies shipped more than fifty miles by rail, most of them indeed from Baltimore, nearly two hundred miles away, although there were within a few miles of Altoona large areas of relatively unused farm land with great variety of soils, a good climate, and plenty of farmers bewailing the sadness of their plight. Mr. Ross worked out a plan which should some day be applied to every community in every civilized country if modern society improves as we have reason to expect it to do. The plan is to study the local food needs and the possibilities of local food production, and so far as is feasible to make the locality feed itself. The attempt to supply local markets with local produce was made during the Great War by the United States Food Administration, as well as by the food administrations of many other countries. The great rise in prices was a contributory factor, supplemented in some cases by the absolute impossibility of getting food from the old sources of supply. Some of the results were little short of revolutionary.

From Hawaii comes the statement that the owners of sugar plantations where a few years ago sugar alone grew and almost everything else was bought, have made it a point to supply the hundreds of workers with food from the land and have almost completely succeeded. The campaign to "grow your own food" has resulted in a material reduction of Hawaii's imports. "It has shown that much of the food sold in tin cans by stores for high prices may be grown by the people in their own back yards or on their unused lands and around their schoolhouses with little or no trouble." *

Even more suggestive is the following astonishing statement by the American consul in Trinidad, writing in April, 1918:

The Director of Agriculture in Trinidad has called attention to the possibility of great economy as regards the importation of foodstuffs

* *World's Market*, July, 1918.

into this colony, as shown by the example set by the Diego Martin Boys' Reformatory, in this island. During the past four months this institution has made use of no imported food, except corn meal, and the authorities at the reformatory state that never again will imported foods be used to the same extent as in the past if ground provisions (garden produce) are obtainable. It has been found that the native vegetables, when properly cooked and served, are more appreciated than the former diet.

At present at least 50 per cent. of the expense of feeding the inmates of the institution (approximately 220) is being saved by the use of locally grown food, such as sweet potatoes, dasheens, tannias, yams, eddoes, pumpkins, salad, beans, pigeon peas, ochroes, melongenes, cassava, and farine. For two meals a day boiled vegetables, together with salt fish or meat, are served. The other meal consists of vegetable soup. Breadfruit forms an important article in the diet, and it is important to note that bread is no longer used.

The authorities of the reformatory find that cassava farine forms an excellent article of food, and have now in order a plant made on the premises, capable of grinding 2,000 pounds of cassava per week and of extracting the by-products of starch and farine.

It should be especially noted that since the Anglo-Saxons have applied themselves to the task of feeding this institution from the local supply, *they have declared their independence of bread from the temperate zone.* This statement should be pondered long by persons who have been alarmed by Sir William Crookes's insular fear of famine because of wheat shortage. The experiences of Hawaii, of Trinidad, and of hundreds of other localities during the war gave added weight to the conclusions set forth by Mr. Ross as a result of his food survey in Altoona. His plan is to have in every small country town a food standardizing plant to serve as a kind of food clearing house, with resultant improvement in quality, reduction in price to local consumers; increase in profit to the producer, and great increase in supply both for home use and for shipment to other places. These results would be secured by the following means:

I. Establishing Standard Varieties of Market Vegetables Grown in the Neighborhood and put up in Standard Packages.—The Danish standardized pig and the standard piece of bacon which the English consumer can safely buy with his eyes shut are instances in point. The standardizing plant recommended by Mr. Ross should be able to pack the products of a hundred gardens on a hundred nearby farms or back yards, freely commingling them, but making standard packages of vegetables of the same variety, picked at the same stage of ripeness and thus equally acceptable in any market to which they could be easily sent. This standardizing house with its standard package merely copies what has been the practice for years in California, Oregon, and Washington, augmenting the success of orange and apple growers and greatly increasing the consumption of those wholesome fruits.

II. Supplying the Home Market and Developing Export.—From this standardized packing plant all the stores and households of the town would be supplied with the freshest of good produce. If a surplus remained it could be shipped to nearby markets. If other markets were not available, as at times they are not, the standardizing plant should have as an adjunct, canning equipment and dehydrating equipment, so that no food need be wasted. The people of the town, without paying freight, could then eat throughout the winter their own good produce, prepared in their own local plant by the most scientific and hygienic methods. Any surplus in excess of local needs could be marketed at leisure. Ten years from now there should be many thousand little towns using good fresh, home-made vegetable food from its own local plant. This arrangement would eliminate the waste of vegetables so common in farmers' gardens, since the farmer is not in a position to handle a small surplus. It would stop the waste of labor by greatly reducing railroad transportation. It would reduce waste of work and of lumber by saving the making of thousands of packages. It would reduce waste of labor and money by eliminating the middlemen's work and profits. These men could then enrich society by producing something, whereas some of them now live only by doing what might be avoided. It would reduce the price and need of meat, because people would have more abundant and satisfying supplies of substitute foods. By giving to the farmers near every center of population the local market for twelve months in the year, it would aid greatly in the intensification of our agriculture and in its adjustment to need. It would furnish a way out of the difficulties caused by shortage of freight cars. Such a plant would give the small town its natural and proper advantage of a lower cost of good living than that prevailing in any great city.*

II. ORGANIZING THE DISTANT MARKET

This development of the local food supply with the primary object of supplying local needs, would satisfactorily end the thirty-five-cent dollar situation, at least in the town and small city. The securing of perishable food from nearby fields and local plants would bring the consumer's dollar down to seventy-five or eighty cents, and put the farmer's share of it up to fifty or fifty-five cents. But what about the surplus, the large surplus, that the small town cannot use? Shall it be sent in every direction, conflicting with similar supplies from other towns, as is now the practice in the United States, where the apples of Missouri go to New York, and the apples of New York go to Iowa?

The second feature of this plan for organizing the market is the establishment of an efficient and honest information service which will enable both shippers and purchasers to know the supplies and demands, so that food may move most directly to places where it is needed. At present both information concerning markets, and the supply for the markets is unreliable; consequently one market is glutted, disappointing the farmers, while another nearby market is nearly empty, disappointing the would-be purchasers. For example, in 1917, good peaches sold at from forty to sixty cents a basket near Bordentown, New Jersey, twenty miles up the river from Philadelphia, while at the same time similar fruit was bringing $2.00 a basket in the New Jersey towns suburban to New York. With proper information service the cheap peaches would have been sent to the high-priced market, with the result that prices would have been somewhat higher for producers and somewhat lower for purchasers; all parties would have benefited. Consumption as well as production would have been increased. An attempt to establish such an information system in one of our largest Eastern States was frustrated by commission men, who feared that this great service would interfere with their personal profits.

* For further consideration, see *Annals of the American Academy of Political and Social Science*, November, 1917.

The movement of food a minimum distance would be an enormous relief to railway congestion and should bring material reduction in cost of food, as well as improvement in quality.

The adoption of such plans would make a recognizable difference in the cost of living both in those towns that depend chiefly upon the local supply and in those that depend chiefly upon railroad supplies. Pressure brought to bear on the locality to produce its own supplies would help to put an end to the amazing conditions to be seen in and near almost any large city in the United States, and to some extent in other parts of the world. New York City imports every day hundreds of carloads of supplies, most of which have crossed the north Jersey marshes, thousands of acres of rich, black muck soil, with a riotous growth of cattails, shoulder high. This land is ideal truck land, much easier to reclaim than the lands of Holland. It is literally in sight and even within sound of the city where reside millions of people who would eat every ounce of any kind of edible produce that these thousands of acres of waste land might produce. A similar situation prevails near Philadelphia and Washington, and is really typical of the Western World during its present orgy of transportation and unorganized individualism.

Our use of railroads is typical of our method of developing a social problem out of almost every new invention. The new invention is good. It makes money for the user, displaces his old rival, and creates industrial and commercial change. This in a few years we discover has injured somebody or some group of persons, whose injury can be remedied only by the action of society. But society is hard to move, whereas the individual acting for profit moves quickly and easily. Thus the railroad has been used to make profits for its owners. Rate competitions, rate wars, railroad compromises, have given competitive points cheaper rates than points along the line, with the result that men of the Western World live in great masses, in cities of hundreds of thousands and millions, while hundreds of miles of railroad track reach out through almost empty land and we have the contradictory problems of abandoned farms, overcrowded cities, and insufficient food. If we apply to these problems the same quality of brains and the same degree of organization that we used in feeding the armies in France, the cost of living will come tumbling down as prosperity increases.

III. CHANGING THE DISTRIBUTION OF MANKIND WITH REFERENCE TO RESOURCES AND CLIMATE

1. *The Making over of Our Cities.*—Now that the Great War is over, we may expect scientific study of markets and resources. The increased attention to human welfare that we may also expect should now cause us to act on three important discoveries with regard to the modern city.

a. The present big city is too big to furnish good food supply at a reasonable price.
b. It is too big to maintain good living conditions.
c. It provides no social advantage to offset the greater cost of food and the poorer living conditions.

The present big city on the one hand, and the unused distant lands on the other, are results of a period when individualism ran unchecked and society was organized on the basis of individual profit rather than of service. If this war will teach us anything, it will teach us to draw the contrast between profits and service, business and living. Business is not a life, certainly not a family life, although when a man becomes engrossed in it, it may fill life for him. The young men of America have gone out by the millions to die, if need be, that the world might be free rather than subject to the orders of a despot. Their sacrifice surely implies that in the city, the country, the earth, all mankind should have opportunity to live rather than that a few should have opportunity to profit at the expense of all the others.

This idea involves an entirely new point of view from which to regard the utilization of the earth. If man must fight to keep it free politically, so he must use brains and fight with ideas and votes to keep it free industrially, that men, and above all boys and girls, may live rather than exist, may be healthy and strong instead of sickly and weak.

What does the scientific utilization of the earth as the home of man demand? Shall we continue to allow, on the one hand, slums and hopelessly crowded cities, and, on the other, empty country from which man flees because of loneliness? Shall we continue to let cities grow up helter-skelter to be economic cancers, or shall we demand the scientifically planned city community, the scientifically planned country community, just as we have scientifically planned factories and scientifically planned ships and scientifically planned armies?

When an architect designs a factory, he lays down on the table before him a list of the various functions of the factory and then proceeds from these known needs to plan the structure which will best meet them. It is strange that, despite our thousands of years of experience with cities, there have been few attempts to apply large-scale planning to the city as a functioning unit. Is it any more desirable that a city should grow indefinitely large than that a man should grow indefinitely large? Perhaps most of us as children have wished that we were as big as giants so that we might pick up certain undesirable persons between our fingers and place them where they belonged. Is the world-wide desire of cities to grow big, big, big, any more sensible? A city exists in order to perform certain functions, and, when it is big enough to perform them, additional size is of no more value than an additional one hundred pounds to a man who already weighs one hundred and eighty.

Mr. Ebenezer Howard, an Englishman, the world's greatest planner of towns, drew up the plans of an ideal city. He first analyzed the situation. The city affords to its inhabitants, social opportunity, to the factory, the labor market, but it tends inevitably to become congested. On the other hand, the advantages of the country are cheap sites and room for plants in the yard and garden, room to play, fresh air, and nearness to food supplies, but lack of social opportunity and opportunity for employment. Having listed these considerations, Mr. Howard proceeded to plan a city in which the inhabitants would be (1) so near to the factories that they could walk to their jobs, (2) so near to the shops that they could walk and carry their purchases if they chose, (3) so near to open space that they could easily walk to the farms, fields, and playgrounds, yet (4) sufficiently numerous to furnish the labor supply for factories, which, after all, is the economic object of the city. These ends could only be attained by having a definite size and plan for the city, with limitation of the population.

It is most encouraging to know that we can accomplish all this without any more gigantic reform than the use of common sense. We need only apply our well-established principles of building restrictions, and prevent crowding by limiting the size of lots to a certain minimum and then limiting the proportion of a lot that may be covered by a house. Thus Mr. Howard maintained that the city would be full grown with a population of about thirty-two thousand. After this city was full, further needs for residence could be met by building another city nearby, just as we build suburban stations on the railroad. In Mr. Howard's ideal plan about six thousand acres are required for the city, of which about half are left for farms, and the rest are laid out in streets and lots.

This story is not the record of a plan, a hope, a vision. It is already an achievement: for the city has been built. After much hard work, Mr. Howard succeeded in forming a Garden City Association. About fifteen years ago the association bought about four thousand acres of farm land forty miles north of London in Hertfordshire on one of the great railroads and proceeded to lay out the central part as a factory town. The plan has succeeded. In the nine years between 1904 and 1913 about thirty factories moved to the place, which had a population of eight thousand in 1913 and was steadily growing. The crucial test, however, of its success is the balance sheet. It was financed by a group of individuals who were willing to put up some money, buy the land, and get their five per cent. cumulative dividends eventually if the plan succeeded. According to the English custom, long leases were given to land, which the tenants were to improve. The company bought at farm values and rented at low town values. Thus the cottager who bought the lease of a plot paid perhaps $10 a year for the lot; but as there were seven or eight such lots per acre, the income on the original purchase price of $200 was ample. The leases which had been sold when the town was one-quarter grown, caused the balance sheet for the year 1912 to show a profit. The financial plan provides that the promoters shall get five per cent., and that further profits shall revert to the city for improvements and reduction of taxes. One of the manufacturers told me that he could foresee the time when the town would be without taxes, and that then "the manufactures will come here in droves."

It is the most beautiful factory town I have ever seen, because every house-lot has room enough for flowers in front and vegetables in the rear. There are never more than twelve lots to the acre, so that lots can be practically 20 x 200 feet, even in sections given over to the artisan. There is room for a small front yard, cottage site, and little back yard, with 100 x 20 feet left for garden. A labor agitator with whom I had a long interview told me that he could estimate how long a man had lived there by looking at his garden: in the first year after arriving from London, he does not do much; then summer comes, and the neighbors begin to hand vegetables across the line; the next year he makes a start; and by the third year his garden begins to be of some real value.

Inasmuch as the town is definitely planned, it has ample factory districts on railroad sidings, and, on each side of these, a large district given over to cottages for factory workers. This region is reserved for factory workers by building restrictions, which fix a minimum and a maximum cost for houses. Beyond this district in both directions are larger lots for the middle class with higher rent and different building restrictions. On the highest ground still farther away from the factories are yet larger and more expensive lots where factory owners and persons of wealth have their beautiful homes. Near the station is the shopping district, and immediately across from it is a seventy-acre playground. Several smaller playgrounds of twelve, five, three, and one-half acres are scattered about. This city is, so far as I know, the only town of its size in the world which makes public provision for the play of any large percentage of its population. As the limitation of population is insured by building restrictions, accessibility and play space are permanent features.

Just beyond the factory district are the farm holdings. Perhaps Mr. Howard's dream of a town that combines the advantages of both city and country will come true. It had certainly made a good start before the Great War, and the war has given it an impetus by focusing attention on man-power.

The people of this town have almost unique opportunities to develop health, muscle, character, and wealth through by-industry. They have a chance to duplicate the conditions of the artisan's life before the factories came. The boys and girls can dig the gardens, since the age for beginning factory labor is being postponed by legislation. This opportunity to cultivate a garden, and to raise poultry and rabbits, also brings health,

FIG. 139.—A vacant lot near the Wallach School, Washington, D. C., that was converted into a good vegetable garden by seventeen schoolboys. It was 105 feet by 32 feet, and produced vegetables in 1917 worth $125. (U. S. Dept. Agr.)

wealth, and solace to the old. Back of a beautifully embowered yard lives a retired engine driver. Behind his cottage is one of the most productive bits of garden, 50 x 40 feet, that I have ever seen. The old man had driven locomotives in England and in India until he had saved enough money to retire. Then he settled down in garden city to see folks and obey Jehovah's mandate to dig—when he felt like it. If a garden city family wishes to engage in market gardening on the side, small holdings can be rented just beyond the town limit. It is not necessary to pay city lot rent. The land is not suburban, it is *farm land,* so denominated in the contract.

The definite plan of this garden city saves it from the endless turmoil of reconstruction which a planless, indefinitely growing city encounters, when each section has a different use with every generation. Under prevailing conditions, each generation tears down what the previous generation built to last for many decades. Thus in Philadelphia, New York, London, Paris, and Tokyo, the business section is invading the residence section, either using awkward but substantial old residences, or tearing down good structures and building anew. The unscientific city has swamped itself. A succession of suburbs of a growing city are given over to new uses. Because the owners expect in a short time to sell for building purposes, land is held for high prices; and the chief function of American land that should be in crops and playgrounds is the support of "for sale" signs. Around garden city is a belt of farms and playgrounds, which, since it is definitely set apart for these uses, has and can have no sale value; in this respect it resembles our parks.

The most significant feature of the whole project is that it has been carried out by the application of existing practices, existing laws, and existing human science. Most attempts at social reconstruction have to await a conversion of the majority to a new point of view; and if the dreams of the constructive socialist are to come true, we must develop also an entirely new system and type of business administration. But a garden city like Letchworth, England, can be built now in any well-chosen location. There is plenty of room along the Delaware River for all the industrial population now near it (and much more) to avail themselves of the principles of the garden city, and to have good instead of poor access to the harbor.

Such a city would beyond a doubt reduce the cost of living by means of lower rents and better and cheaper food; increase wealth by means of by-industry; increase pleasure by promoting recreation; increase efficiency as a result of increased health. The land speculator alone would be the loser—he would lose his present much too wide-spread opportunity to take something and give nothing in return.

Letchworth was built chiefly because the English nation was alarmed by the discoveries of the officers who tried to recruit an army to fight the Boer War (1899-1902). They were shocked to find that the average recruit who came out of the mill towns was physically unfit, narrow-chested, undersized, underweight, with bad teeth. He belonged to the second or third generation of city workers who had grown up in little two-story houses, practically without garden, play space, or access to the country.

The social prophets saw that such conditions must be remedied. If they succeeded with one garden city in the first decade of the twentieth century, what may we expect in the next two decades after the Great War, when man with the return of peace realizes the importance of man-power and health and the value of a home where a boy can have play space, garden and pets, where the whole family can have a garden and access to the earth and green things?

2. *Garden Cities and the Food Supply.*—The problem of food alone should be sufficient incentive to the whole world to build garden cities rather than to enlarge the pavement cities of the present. In Letchworth every boy and girl may have a garden. The family garden, which was undertaken for the first time by thousands of families during the war, has there a chance to become a permanent asset. In addition to its promotion of health, morals, and the pleasure it gives those who love the earth and growing things, it affords substantial increase of income. A study of cotton mill towns in the American South (United States Department of Agriculture, Bulletin 602) shows that, of the cases studied, thirty-five out of one hundred and forty-four families with gardens averaging four hundred square feet raised supplies about equal to the rent they paid for their homes. In Letchworth the gardens with the smallest houses had from sixteen hundred to two thousand square feet. In Bulletin 936 of the United States Department of Agriculture are cited boys' and girls' home club gardens: a group of twelve with gardens of less than five hundred square feet produced two and one-fourth cents income per square foot. This income was calculated on fixed and very reasonable prices, of which the following are typical:

String Beans	30c a peck
Beets	50c a peck
Greens	25c a peck
Potatoes	30c a peck

In Philadelphia, the Vacant Lots Association, which has aided school children and others to cultivate very small plots, found that a youngster could sometimes make as much as ten cents a

FIG. 140.—Distribution of city workers of Liège to village homes. Figures represent number going from each station to Liège, June 1–5, 1906. Small agriculture is added to factory wages. By trades: miners 1,832, factory men 2,871, building trades 1,440, unskilled 1,493, dress-makers and milliners 360, apprentices 242, other trades 1,167, railway workmen 520, total 9,925, of whom 5,830 went daily and 4,095 weekly. (From *Land and Labor*, by B. S. Rowntree.) In 1914, Belgium was ahead of any other Western nation in the scientific utilization of her resources. Her factory workers live upon the land to a degree unknown elsewhere. With his plot of ground there is room for production by the aid of women and children, old persons, and the spare time of the artisan himself. This garden product, the poultry, hares, and possibly the cows, are great additions to a low wage and they conduce to the intensity of culture that gives large return per unit of land. It also gives a love of home that made the people hard to trample underfoot when Germany tried it.

square foot at pre-war prices. This was done, however, by growing several crops in a season, of which the yield is large and the family need is small; and sales were made at retail prices.

3. *Distance Classification of Foods.*—The proposed scientific distribution of man on the land in a garden city and its tributary farms indicates that there are several classes of food, based on the distance which it may, to best advantage, be transported without deterioration or excessive cost.

a. The first class is food produced in the immediate vicinity and transported by the farmer's wagon or motor truck. The immediate vicinity includes the farm zone two to five, or even ten miles wide, around the garden city. It is an area sufficient to produce all the garden stuff needed by the city in season and a considerable surplus for canning and drying. Facilities for drying may be provided so that a basket of pears or tomatoes can be put on a shelf of a drier and exposed to currents of warm air driven by an electric fan. With such facilities a single caretaker can look after hundreds of drying shelves for an indefinite number of patrons who may have such shelves as they have lockboxes in the post-office. This immediate vicinity can also produce some of the milk, all of the small fruits in season, some tree fruits, and most of the eggs, poultry, and potatoes (if the climate is suitable).

It is suggestive that twenty-five or thirty community dehydrators worked in Nebraska in the summer of 1918. Mr. Lou Sweet of the United States Food Administration says they made better product than common drying, better than canned goods, and excellent for home use, but cannot compete with large thoroughly organized plant for general commercial work.

We cannot claim to be sole discoverers of the art of drying food. Dr. Joseph Beech, Methodist Missionary, president of West China University, at Chengtu, in the province of Szechuan, recently returned to this country, says of a strange people he recently visited near the boundary of Tibet, "They have huge smokestacks in their communities which gave them the appearance of thriving industrial cities. When we arrived we found they were employed solely for the purpose of drying and curing vegetables, meat, and fish, which were suspended tier upon tier the entire height of the chimney."

b. The second class is food produced from ten to fifty miles away and transported by motor express or farmer's truck. It is very difficult for us to appreciate the social and agricultural results that are to come from the use of the motor truck in city food supply. It is said that the Allies won the war with the motor truck. The period of the war has shown us that woman may become a teamster when she tries and drive twenty horses rather than two. Within this motor-truck zone should be produced the rest of the milk (although the cows come from distant ranges when they are grown and ready to enter the dairy), most of the tree fruits such as apples and peaches (if climate permits),

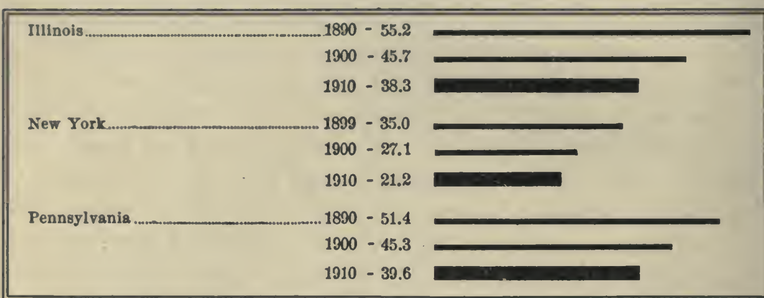

FIG. 141.—Rural population: per cent. of totals. The supply of machine-made agricultural products has combined with the factory lure to cause a steady decline in the proportion of our population that lives on farms. This shows a part of the process of development of certain regions as food-producing regions, while others become manufacturing regions.

the remainder of the potatoes, most of the eggs and poultry, and perhaps small quantities of grain and red meat, especially pork.

c. The third class is food produced in localities from fifty to fifteen thousand miles distant and transported by train and ships. These long distances and the greater cost of transportation are no bar to the carriage of goods having good keeping quality and small bulk per dollar's worth. This list includes meat, fish, butter, cheese, breadstuffs, dried legumes, dried fruits, canned goods, nuts and vegetable fats, exotic products such as oranges, lemons, bananas, and a whole host of tropic fruits that we may get whenever we are ready to enlarge our bill of fare and establish new industries.

No part of the world is too far away to help supply the well located garden city with these staples.

4. *The Location of Man's Home with Regard to Accessibility and Inaccessibility.*—The foregoing discussion of food carriage implies that some localities should become garden cities because water transport makes it easy to bring in food and raw material and to take away factory products to distant markets. Other localities should consist of farms, whole states and kingdoms of them, producing staples for distant consumption. The economies of transportation seem to promise such a distribution of population if we are to live with least waste of effort. The manufacturing city must import raw materials and staple foods. It should therefore have the best locality for import, namely, access to the sea. A manufacturing city in the heart of a riverless plain must have the same imports as the city by the sea, but these must come long distances over land, and land transport is more costly than water transport. This seems to indicate that the water-front locations (sea, river, and canal), especially those having soil and climate suitable for the production of truck, small fruits, and milk, should become almost one continuous series of garden cities, while the continental interiors, such as the plains of central Russia, Siberia, Australia, Argentina, western United States, and Canada should carry on an intensive-extensive agriculture with only enough manufacturing to meet some local needs and to keep busy that part of the population that is dependent upon agriculture but not directly engaged in it. This is nothing more than the continuation of a process that has already begun. The last twenty years have seen the population remain almost absolutely static in Iowa, a matchless interior agricultural region, while New England, with its many harbors, has rapidly increased its population because it is engaged in manufacturing in a good commercial location. The significance of the advantage in transport afforded by waterway is well proved by the fact observed by some students of marketing that ten per cent. decrease in price of a commodity will double its consumption.

The easy distribution of electric power to every home in whole communities gives to even interior localities the possibility of restoring the epoch of home industry, but this time on a power-driven rather than muscle-driven basis. There is no reason why the housewife in Iowa, Saskatchewan, or upper

Volga may not turn the electric power from the washing machine to the knitting machine, and do a half-dozen pairs of socks before John or Ivan comes in to supper on his motor plow. Material for socks is easily carried, but too much of it makes a city, and the land-freight city is at a permanent disadvantage while wheels and keels compete.

Thus the accessibility of the seacoast regions promises to make them eventually the great hives of population, whereas the level interior will consist of farms with towns and small cities.

Inland waterways of the first class will, of course, go far to emancipate any interior locations which they reach, such as the banks of the Mississippi, the Ohio, the Great Lakes, the Rhine, the Danube, the Elbe, the Columbia, the Yangtse-Kiang.

5. *Locating Our Homes with Regard to Classes of Climate.*—Climate is another factor that promises to help distribute man's city areas and his farm areas. There are some climates which stimulate man to do all he can. There are others in which he tends to do as little as he can. The one will develop cities producing highly fabricated products, the other will develop farms producing raw materials.

a. Climates in Which Man Does All He Can.—Professor Ellsworth Huntington, of Yale, has written several books giving elaborate evidence that man uses his mind best at a temperature of about 40°; that he works with his body most and most pleasurably when the temperature is about 64°; and that he is much more energetic, more healthful, longer lived in places where the climate has frequent small changes of temperature from day to day, such as accompany the weather cycle prevalent in northern and northeastern United States and northwestern Europe. In these regions the movement of the cyclonic storm brings today gentle south winds, tomorrow clouds, the next day rain or snow, the following day northwest winds, followed by moderating sunshiny days; then comes the south wind and the repetition of this cycle, which, according to Dr. Huntington, is the magneto by which nature starts up man and makes an engine of him. In lands that are constantly warm, man does not want to work and he does not work so much as in the changeable climate. Much more surprising to most of us is Huntington's conclusion that man also slows down in lands that are constantly cold, as

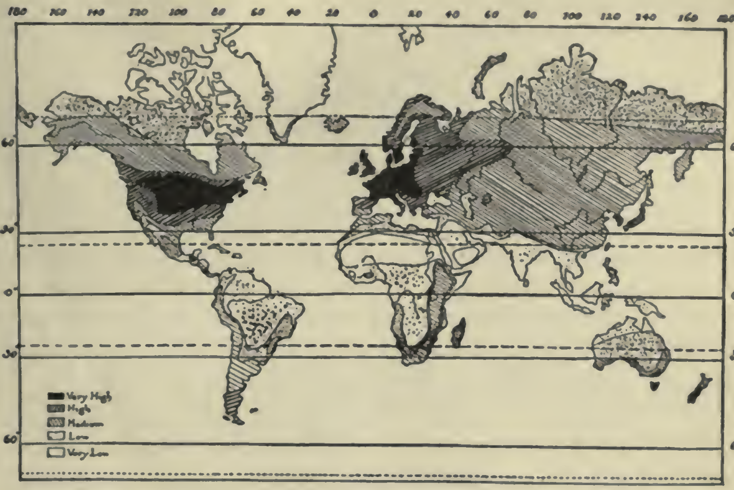

FIG. 142.—Distribution of human energy as produced by climatic influence, and measured by Dr. Huntington's experiments and observations. (From *Climate and Civilization*, by Ellsworth Huntington)

FIG. 143.—Distribution of civilization according to the opinion of a large number of men of wide knowledge, as held before the outbreak of the Great War. (From *Climate and Civilization*, by Ellsworth Huntington.)

the winter of mid-Russia and Siberia and the land of the Eskimos. It is only in the lands of moderate climate and changes that man becomes a dynamo with the strength and desire to work and the great love of achievement that builds great cities, elaborate civilizations, and far-reaching empires.

After all it can scarcely be said that this is mere theory. It but explains what men have known for generations and what history has shown for ages. The face of the conquering king on the coinage of dead kingdoms from India to Portugal is the face of a man of the north who has flung himself with energy on southern people who have been unable to resist him; but his line in turn succumbed to some other northern conqueror. A student of history can find five cases of northern people conquering southern people to one in which the situation is reversed. The delightful people of southern United States chide the Yankee of the North for his restless energy and too great devotion to work, and frankly tell him when he comes into their midst that he will learn in time to move more slowly in their climate—and he does. I have been in no country as much as three hundred miles long from north, south in which there was not the general admission that the men of the north had more energy and were better workers than the men of the south. I found this true between Rome and Sicily, and to my great surprise even in so small and good a country as England.

What is the significance of all this for the food supply? It means that the land of moderate, changeable climate in the middle of the temperate zones, as shown by the accompanying map (see Fig. 142), is the place where man will locate the industries that require the most labor; the place where most of the world's manufacturing will be done, where manufacturing cities will cluster along the harbors, the rivers, and great artificial waterways yet to be built. Much of northwestern Europe had already gone far toward that condition when the war put a temporary check upon it. If man settles down to industry and living rather than profit-making and war, we may expect such regions to become almost one vast suburb, for that is what a land of garden cities is. If man prefers the country life to the city life, as many men do, his country life may here as elsewhere partake of the suburban character through the development of co-operation, which permits farm life and at the same time social opportunity, as so graphically described by Mr. Alvin Johnson:

> Let us not think of the individual returned soldier exiled to a tongue of green land between the stony breasts of western mountains, or marooned on a dry square in the midst of the Dismal Swamp, but of organic communities of one or two hundred farms, with competent agricultural advisers to brace up the technique of those who are willing to learn, and an organ of administration to expel from the community those who persist in making an eyesore of their privilege and a center of demoralization for the community. In such a community the man who loves the soil would not need to be deprived of agreeable social intercourse, as is so often the case in the existing agrarian system. With a whole community of men who are live and efficient, co-operative institutions would not be slow in developing. This sounds Utopian. It is not in the least Utopian. Such communities have been in successful operation in Australia for years.*

California has some very interesting experiments with such communities now in progress. Such development of cities and manufacturing and farming means that there must be large raw material and food-producing regions in less stimulating climates and less accessible locations. Inasmuch as we have already skimmed the cream off the Great Plains and prairies of the United States, and are skimming the cream from similar plains in Canada, Argentina, Australia, Russia, and Siberia, we are naturally looking around for fresh lands. This brings the tropics to our view.

b. The Tropics and the Future Food Supply.—Here in the frostless realm is the great land reserve of the future, the land with the possibilities of sending us endless shiploads of food and raw materials for the garden cities on the estuaries and canals of the north. It is a treasure as yet all but untouched. It contains more land suitable for the heavy growth of vegetation than does all the rest of the world.

The temperate zones are dwarfed into insignificance when compared with the tropics in respect to the possible expansions of industry and human support. Considerable areas of the temperate zone, in Europe, China, and Japan, have approached the food-limit, but unfortunately a great part of the remainder

* "Land for the Returned Soldier," *The New Republic*, September 21, 1918.

of the temperate zones lies under the withering limitations of aridity and of low temperatures. In contrast to this, the torrid zone, which includes about half of the land surface of the globe, has far more than half of the area of abundant rainfall. Add to this its greater heat with absence of winter, and we behold possibilities of the growth of food plants and, therefore, possibilities of the support of population several times as great as those of the temperate zone. These regions are quite the equal of the winter lands, as a field for the creation of new resources by science. While the tropics have great possibilities in the new era of scientific industry, they have for ages lain practically unused, and ninety per cent. of the tropic forest stands virtually as undisturbed as in the day of our arboreal ancestors.

A passage from United States Consular Report, December 9, 1911, gives an interesting example of tropic emptiness.

> British North Borneo (area 31,000 square miles) is owned and governed by an incorporated company under a charter from the British Government. The population of the colony is estimated at 180,000 and consists mainly of aborigines with about 15,000 Chinese and not more than 400 Europeans.
>
> The natives clear small patches of the valleys and hillsides, where they plant rice and vegetables for food. For other foodstuffs they depend upon hunting and fishing. The manner of farming is decidedly primitive. The hoe is the main instrument, and there is no demand for agricultural implements or any kind of hardware except the hoe, and a long knife used in war and in cutting the underbrush. In all Borneo, there is not a cultivated tract of ground worthy of being called a farm. The greater part of the land is yet covered with large trees.

British North Borneo is about one-seventh of the whole island, which is as large as France and naturally several times as productive because the unending heat and moisture of the equatorial-belt permit the continuous growth of crops.

With the exception of certain tiny island colonies which have become peopled under the white man's influence and a few minor exceptions chiefly in southeast Asia, the tropic forest in its full force has baffled man, and he has developed only the less productive corners, where nature goaded him with difficulties, stung him into action, made him work or starve, and then often starved him despite his pathetic efforts.*

Man is inclined to take his ease where he can, and it seems to require intermittency in supplies to make him work. Thus civilization has, except under Caucasian influence, advanced in the tropics only on its arid edges and in southeastern Asia where the monsoon rains of summer make a season of growth alternating with the dry season of the winter monsoon. Under this stimulus and this limitation, India and south China alone in the tropics have become populous, and the occasional failure of the summer rains produces crop failures and famines—catastrophes inconceivable to us of the well-fed West. It is a curious commentary on man's relations with tropic nature that population should have become numerous where the famine comes to slay him, and that the equatorial-belt with its abundant and regular rains should have remained idle save for scattered tribes until the Dutch showed us by their wonderful object-lesson in Java that this is the world's natural belt of heavy populations.

Since 1798, the Dutch, leaving the forms of native government alone, have kept peace in Java and, to a considerable extent, directed and compelled the industry of the people to provide food for home use and export. This is done through a white "adviser" who tells the ornate and resplendently extravagant sultan what to do in all matters governmental. If the sultan doesn't take advice there is another sultan dashing

* Famine Deaths in India

(From William Digby: *Prosperous British India*, pp. 130-131)

1800-25	5 famines;—deaths	1,000,000
1826-50	2 " "	500,000
1851-75	6 " "	5,000,000
1876-1900	18 " "	26,000,000
Total since 1800		32,500,000

These famines are due to the fact that in this region, as in parts of China, the monsoon winds with their summer rains occasionally fail, bringing complete crop failure. Man can only live in such regions under one of two conditions,—occasional famine with its sweeping loss of life, or highly organized trade, transportation, finance, and relief, like that of Belgium, to bring in food from the lands of more regular climate The latter has not yet taken place, hence the famines of India and China.

about in bejeweled automobiles in his stead. As a result there has been peace, and the population has increased more than five-fold in a little more than a century. In Java and Madura (the population is mostly in Java) there are fifty thousand square miles with thirty-six million people, over seven hundred to the square mile on the average, and it is far from being fully populated. Only forty per cent. of the land is under cultivation. There are many wild forest districts, in which the elephant and rhinoceros roam at large; and a recent European scientist has (for good reasons, I believe) estimated that Java may easily support three times as many people as it now possesses. This would bring its density up to over two thousand per square mile. By applying this figure to the whole Dutch East Indies, of which Java and Madura are a sample comprising less than one-fourteenth, we would have a population as large as that of Europe, and nearly four times as great as that of North America. The significant thing about Java for the world's food supply is the fact that these people are able to export to the West hundreds of thousands of tons each year of sugar, along with large quantities of tobacco, coffee, tea, rice, indigo, copra, cinchona (quinine), rubber, and other tropical products. Population of such density over the suitable parts of the tropics would permit that zone alone to contain six or eight times as many people as the entire world now contains, and they would be far less liable to famine than are those in India today. If they followed the example of Java, they would also have enormous quantities of food and raw materials to export to manufacturing lands.

Evidence of the correctness of the high estimate of possible population for Java and for other tropic localities is found in the fact that Barbados, in the Lesser Antilles, has 1,170 people per square mile; that Porto Rico has over 300 people per square mile, supporting themselves by a primitive agriculture in hilly country that is still far from being fully populated; that Cuba, the size of Virginia, with but three per cent. of the land under cultivation maintains a population of two and one-quarter million people—forty-seven to the square mile. Cuba has over two persons to the cultivated acre and the methods of culture are very unscientific. There is nothing exceptional about Barbados or Porto Rico or Cuba, except that by the accidents of location and history they are more used than the rest of tropic America. If Brazil were as populous as Porto Rico, its population would exceed that of the four continents touching the Atlantic, and there is every reason to think that Brazil could easily support that number of people if they chose to dispossess the monkeys, the parrots, the serpents, and the other wild life that is now in undisturbed possession of hundreds of thousands of square miles of forest in the earth's most productive belt. The whole of Brazil and the rest of tropical South America have a population less than that of the little island of Java. This part of South America possesses, as do similar latitudes in Africa, large areas of absolutely unexplored territory. It is, therefore, perfectly natural that the few commercial products of the equatorial-belt, except those from Java, should still be the wild products of the forest, namely, rubber and gums, palm oil and ivory, with a little cocoa, which grows in orchards little better than a modified jungle. The jungle is an almost untouched resource teeming with possibilities of crops and food. In connection with the tropics, it is significant to recall that this region is the seat of production of the banana, our cheapest ready-to-use starch food, and has many rival claimants for the title, among them the sweet potato, cassava, and dasheen; the peanut, one of the cheapest proteins; coconut, one of the cheapest sources of fat, with many rivals; cane sugar, the cheapest carbohydrate; rubber, indispensable to our cheapest form of highway transport.

THE INHABITANTS OF THE TROPICS

If the tropic jungle becomes a field, who will labor in it? If three centuries of colonization have shown us anything they have shown that it will not be the white man. The white man has settled all these tropic shores—the Spanish Main, the Indies East and West, Africa, South America, and Asia. He settled them before the United States was settled and he has settled them since. He has repeatedly settled them and the settlements have always melted away. The white man is a product of the temperate zone. Caucasians do not like heat. They fly from it as it shows itself in the summer of Washington, New York, Boston, and London, and the unending heat of the tropic lowland is one of the persistent forces of nature that the Caucasians have been unable to withstand. In three centuries of trial on every tropic shore, there has been no single case of a group of Europeans who have physically thriven, or increased from generation to generation, or maintained the culture of the founders. It is instructive to analyze the population of Jamaica after three centuries of repeated colonization by strange races from Europe, Africa, and Asia—from the temperate and from the tropic lands. That island has had the incomparable advantages of 250 years of British rule and a large amount of mountain with its cooler climate. Adjustment of all these forces has produced a population of nearly 200 per square mile, 2.3 per cent. white, 76 per cent. negro, 19 per cent. "colored," 1.8 per cent East Indian. Within twenty years the increase of the colored races has been over 200,000; the white population is now about 15,000. Such races as the Malays, the Negroes, the Hindoos, and the south Chinese, have through many generations become better adjusted to this climate of which they are a product than have the whites. They can live and work and increase on the tropic lowland—witness Java and Jamaica. The white man can only come in as the ruler, the capitalist, the plantation manager, the engineer, the sanitarian, the expert, and the professional man, but in these capacities he can make the framework and uphold the structure of tropical society—industrially, commercially, and politically.

The distribution of population in tropic America affords an excellent illustration of the influence of climate on the white man and on the location of his home. These countries are all under the dominance of the Spanish and Portuguese, races which are supposed to be more resistant to tropic conditions than are other white races. Yet in all tropic America, with the single exception of Rio de Janeiro, these races have placed their capital city inland on the plateau to get away from the tropic low plain. This was done, too, with great effort, as shown by the labors incident to carrying on trade in the pre-railroad epoch between the port and the capital hundreds or thousands of feet above and many miles inland. Thus the capital cities of Ecuador and Colombia at or near the equator are more than three hundred miles from the sea and nearly two miles in elevation, with all the hardships of travel and agriculture that that elevation involves —but with the compensation of a cool climate. Even Costa Rica has its capital at an elevation of nearly a mile. The only exception to the plateau location of tropic Latin-America capitals is Rio de Janeiro, a city upon the edge of the tropics, with a plateau immediately in the rear, and on the plateau a suburb containing the residences of the dominant whites and the foreign colony. The significance of the locations of these cities becomes clear when one notes that the location of every capital in north Europe is either a seaport or is so low in elevation as to be reached by efficient water transportation.

Despite this retreat of the white races of tropic America to the cool interior they have always remained a small, very small minority. The native Indian makes up the bulk of the population, and the half-breeds the second element in numerical importance. But the handful of white people rules—a fact not without significance.

If these vacant tropic plains which we claim, but may not inhabit, are to become peopled, apparently the population must consist of the various black, brown, or yellow races that have become somewhat adjusted to the tropic climate. Left to their own desires, these men have formed small tribes with sultans, wars, murders, piracies, slavery, and pestilences that effectively kept down population. They have never yet developed even a second-rate power or civilization and have fallen an easy prey to colonizing European powers. Given order and protection and guidance as in Java, they clear up the jungle, populate the earth, and have crops to sell. By the aid of the acclimated peoples and apparently thus only will these untouched continents yield unlimited amounts of rice and rubber, sugar, cocoa, oil and nuts, cotton, hemp, and other fibers, and a whole host of tropical products which we can buy with our northern goods, especially with the products of factories located in comfortable and stimulating climates.

c. Relation of Tropic Peoples to Northern Prosperity.—The growth of the dense populations of the Barbados, Porto Rico, Java, and Bengal shows that these lands are almost certain to remain essentially agricultural or, at best, at a low stage of manufacturing. The tropic lack of ambition indicates that these countries will probably remain indefinitely as colonies or mandatories, negligible as political powers. The white races of America and Europe would have nothing to fear from three or five or ten billions of black, brown, or yellow people in the torrid zone. They would be non-militant agriculturists, carrying out, as now, the instructions of white men,* and our trade with them, largely the exchange of manufactures for raw materials, would be a great source of riches for the temperate zone, and would easily enable northern lands to double or treble their population. The sooner we recognize and act on the fact that we have a brown man's world and as distinct from the white man's world, the more comfortable we shall all be.

Modern science, with its development of mechanics and sanitation, makes this development of the tropics much easier than it has ever been in the past. Within twenty years we have learned that many of the dreaded tropic diseases such as the yellow fever, the even more dreadful malaria, the sleeping sickness of Africa, and many others, are due to the action of specific germs in our blood, put there by insects whose habits we now know. We have at last located our enemy, and, as a result of these discoveries, yellow fever, which for ages was the scourge of the tropics and has occasionally invaded the temperate zone in the summer season, has now virtually disappeared. With the advance of protective medicine and sanitary science, there is no reason why the tropic death-rate should not be greatly reduced, provided white men can govern. The real crux is the maintenance of the white man.

Now that the airplane has given us unprecedented speed of transportation and an entire independence of the earthly road, so hard to make and keep in repair, it is possible for twenty supervising white men to get into their plane on the slopes of Chimborazo and in an hour sail down nine thousand feet and one hundred miles to the coconut or rubber or sugar plantations

* The alternative is that in most cases they obey the local tyrant of their own color. This contrast is admirably drawn by comparing the two West Indian Islands of Jamaica and Hayti during the last half of the nineteenth century. Both had a population chiefly composed of emancipated negroes. One had British rule, the other was independent. The one had order and fair justice. The other was in almost continual civil war, with all that it implies.

of the hot plains of Ecuador, do their day's work, and in the evening, to the roaring sound of the airplane, soar home to their wives and children on the cool slopes of the Andes. An enormous area of uninhabited tropic low plain is within this one hundred mile distance of some cool and reasonable healthy volcanic peak, mountain range, or wide plateau.

Another possibility, even more suggestive, is that of building of a many compartment house, a veritable village, or town under one roof, in which the process by which man has entered the land of frost and snow shall be reversed—cooling the air of his dwelling instead of heating it. Most of the troubles of the tropics arise from the atmospheric conditions of heat, humidity, and constancy of temperature. We now know how to control heat, humidity, and temperature. We know how to build a city under one roof and with mechanical power make the temperature exactly the temperature that man needs, and make the humidity just the humidity that man needs, so that there is perhaps no reason why he might not live and raise children in the tropics almost as well as in England, France, or the United States. He would go out of doors into the hot sunshine just as in northern countries we go out of doors in winter when the weather is cold; but the tropic community-dwelling would have wholesome atmospheric conditions instead of the unwholesome conditions which now so commonly prevail in the cold lands because of the extreme aridity of the air in a heated house in a northern winter.*

d. The Soundness and Richness of Tropic Agriculture.—If we do undertake seriously the development of the tropics as a source of food supply, both for the natives and for ourselves, we shall find an interesting agriculture of three types, each of which exceeds in permanency the type prevailing in the temperate zone.

1. Irrigation. So much of the tropics has heavy rainfall that most of the agriculture of the present depends, as previously stated (see chapters on sugar and rice), on irrigation, which may be extended in the torrid zone until it covers an area many times that possible in the temperate zone. These are the lands for

* *Review of Reviews*, September, 1918. Two very valuable articles for every user of a heated room.

sugar, rice, corn, and starch roots, such as cassava, sweet potato, yam, taro, and others.

2. Tree Crops. If tree crops offer great possibilities for the temperate zone, they have even greater possibilities in the tropics. In fact, tropic agriculture is to a surprising extent already an agriculture of tree crops, as a brief review of the origin of tropic exports will show. Trees produce coffee, tea, most of the spices, and cinchona. Trees give us cocoa, coconut, the palm nuts in several varieties, the Brazil nuts. This group as a source of fats has great present importance, rapidly increasing importance, and enormous possibilities. From the sago palm the native makes sago, a staple starch, and from the sugar palm in some parts of the tropics he also makes sugar. From trees also come that invaluable raw material, rubber, just now in process of transformation from a wild to a plantation product. Also from trees come gutta percha and gutta joolatong, of which Java now sends us five thousand tons which we eventually misuse as chewing gum.

Other tropic trees give us the banana, the orange, and the avocado, a wonderful fruit produced in large quantities and rivaling the olive as a source of edible fat (see chapter on Edible Fats), of which it contains twenty to thirty per cent. The number of tropic trees yielding fruits is quite unknown, and their undeveloped state is well exemplified by the mango, a tree widely grown in India, the West Indies, and many other tropic countries. At the present time the growers do not graft the trees, but merely raise them from seed, which gives trees of much lower productivity. The common practice is to let the trees grow where they come up. The fruit goes to tropic city markets, but it is shaken off and bruised so that it will keep only a short time. Yet good varieties can be grafted and will stand shipment from the West Indies to the United States. The possibility of using new fruits is well shown by the importation before the war of pineapples from equatorial Africa to Germany packed in peat dust.

Thus the tropic lowlands can be irrigated and the tropic hillsides planted with tree crops.

3. Also soil saving and non-erosive is the native type of plowless agriculture common in many parts of the tropics. (See Fig.

34.) These three types of tropic agriculture, none of which carries with it the soil destruction so common in the plow agriculture of the temperate zone, serve to show that perhaps we

FIG. 144.—Panama Indian farmer's family, home, and all the tools of agriculture—a machete (in man's right hand) to cut the bushes and weeds and a sharp stick to make holes for seeds. These people are from another world, the tropic world. They have not developed from savagery through the pastoral or animal-tending state. That is the Aryan method. These tropic people seem never to have used animals to any important extent but developed at once a hand agriculture depending largely on starchy roots, sweet potato, yam, manioc, taro, caladium, and others which have been tilled so long that they have lost the power of producing seed. The banana, corn, and sugar cane are important additions to this untilled soil-preserving agriculture which has, with the jungle, alternately occupied parts of tropic America for a length of time that no man knows. (Photo H. H Bennett, United States Bureau of Soils.)

can depend upon the tropics after we have destroyed our own lands, for at the present time we and not the tropic farmers are the agricultural barbarians of the world, if destruction be regarded as the test of barbarism.

Certainly the examination of the unused resources of the temperate zone and of the unused resources of the tropics in the light of known science and its reasonable applications, shows that the present food supply of the world may be increased many fold without increasing the number of hours per day that man must work, or in any way reducing his physical well-being; indeed permitting him to increase his social welfare. The time has come for us to use constructively the powers that lie in our hands. If we will do so, famine, for many generations at least, may be put in the same class with witchcraft, and, let us hope, war—three agencies that have equally good reason for entering seriously into our lives.

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CHAPTER XXVIII

HUNGER, TRADE, AND WAR

WORLD CONQUEST OR WORLD GOVERNMENT

THE world as pictured in this book, a world of almost countless comfortable millions of men with plenty of food, developing trade, education, the arts, and the great art of living, can only become real if we can banish from it permanently several conspicuous characters of history—Captain Kidd, Alexander, Caesar, Tamerlane, William Hohenzollern. Those accursed twins, the conqueror and the pirate, the one using government as a sham, the other boldly flouting it, are the arch enemies of world peace. They are the enemies of the comfortable world herein described, for that world requires peace and the unrestricted use of the sea. If the food supply is ever fully developed, the lives of thousands of millions of people will depend on the continuance of sea trade; that is, they will depend on the mercy of any power that controls the sea. The sudden increase of population in the past century, from six to sixteen hundred millions, has been largely due to sea trade, which could become important only with the disappearance of the pirate, and the assurance of safety. For ages, down to one hundred and fifteen years ago, the black flag of the pirate was the dread of the men who went down to the sea in ships. Even at the time of the establishment of the government of the United States, the man who took an ocean journey put his earthly affairs in order and bade his friends a solemn farewell, for good and sufficient reasons. In that day trade was a luxury; the world's population, much smaller than it is now, was kept down in large part by the pirate, who made trade almost impossible. The last century has seen the conquest of mechanical power and the conquest of the pirate.

History seems to indicate that man is by nature a marauder, a conqueror. The history of the race is a sad chronicle of almost unending marauding conquest. Why did the prehistoric Swiss have lake dwellings, and the prehistoric Spaniards live in caves, and why was Rome built on seven hills? What befell Babylon, Nineveh, Carthage, the Aztecs, and Louvain? There is but one answer—conquest. Family has fought family, clan has fought clan, tribe has fought tribe, people has fought people, until the number of such episodes must certainly run to seven figures if not indeed to seventeen. Civilizations for the last seven thousand years have risen and then fallen under the smashing blow of some vigorous band of rovers. How long this state of affairs went on in the prehistoric past no man can even guess, but it was certainly tens of thousands of years. Organized society arises in spots that can be protected and survives for a time, until attack from without overcomes defense from within. America was possessed by one roving band after another, except for the almost inaccessible and arid plateaus of the southwest, where cliff dwellers, growing a meager food supply in some narrow irrigated valley, climbed up a train or ladder to some perilous height and there protected themselves while they developed the most advanced civilization in America. Of the great civilizations now extant, only China has had a long history; she has survived because nature placed her in a situation with almost marvelous natural protection,* where the people had so little need for defensive war that they could develop pacifist principles to a high degree and make them not only an ideal but a practice—the fortunate result of a favorable location. For a time, the people of America dreamed of a second China, based on the principles set forth in Washington's farewell address, but suddenly the machinery of modern science once more strengthened the hand of conquest.

As the 42-centimeter gun and the march toward Calais put an end to England's insular isolation, so the submarine showed America that she, too, must fight or submit.

Pacificism is no longer a workable principle. The whole world must defend itself or take the mercy of the conqueror, which history shows to be a scanty mercy, alike in Carthage, Rome, and Belgium. Even China has changed. Pacifist for forty centuries, she now has a military academy and drills her

* See J. Russell Smith, *Industrial and Commercial Geography,* Chapter XVI, Part II.

sons in Western war tactics because the steamships and the railroads of the Western peoples have shown her that her isolation is no more, and that the conquerors are at her doors, each taking a slice of her territory. She knows that now she must defend herself. More suddenly, but even more completely, has the United States changed her attitude, upon the appearance of the submarine, a mechanism of conquest, in the hands of a people ambitious to dominate the earth after the manner of Alexander and Caesar.

The world is one. It is one in trade; it must also become one in government. The most serious question at present facing the human race is this: whose government shall it be? Shall we have world empire, world dominance, world obedience, world tribute, world submission, or shall we have a democracy of peoples, each free to develop its bit of the earth, to perfect its own way of living, to trade with its neighbors, to live as do the citizens of any well-ordered community—tending their gardens training their children, buying and selling, coming and going among their fellows, obedient to no one and to no class, but obedient to the concerted will of all? World empire with its attendant slavery could be more easily achieved today with our modern machinery than was the Roman Empire, with its enslavement of all the rest of the world that was known and was considered worth the taking.

Of course we want world democracy, but the recent war has shown us that the utilization of the earth requires both the control of nature and, to some extent at least, the control of human nature so that nations may have equality of opportunity.

WORLD THINKING AND THE DEVELOPMENT OF GOVERNMENT

We must use enough geographic imagination to think in terms of the whole world. We have developed world trade, world investment, world enterprise. But enterprise must not be allowed to run loose and uncontrolled because its possibilities are bigger than man's habits of thought. We have been trying to run twentieth century business on seventeenth century principles. The concepts, the mental equipment of most of us, the mental habits of most of us are of an age long past. The most dangerous vermiform appendix in man is not in his stomach, but in his brain cavity, with painful results to human society. We can make a scientific machine in five years and put it to work, but it is a slow job to readjust society to it. We must continue to suffer unless we develop world thinking and develop world government, to protect society and to control the world enterprise in which individuals have engaged for individual profit.

After all, world government is no new idea, but merely one further step in an old process, a process of regional consolidation that accompanies increased ease of transportation and communication. There was a time when the family was the largest unit of government. Then a small group of families banded together; then these were included in a tribe, until finally nations were formed—they have risen and fallen for millenniums, getting ever larger and larger until now we are faced by the very practical demand for a world nation, which, after all, is but one more step in the age-old process of regional consolidation. A recent traveler tells us of a hamlet of twelve houses in the Himalayas so far removed from neighbors, trade routes, and means of access that they were absolutely independent of all mankind—a little world in themselves. A little more than one thousand years ago England comprised seven independent kingdoms, and Wales and Scotland were occupied by a number of independent rival warring clans. France has had a similar history. Within the memory of men still living, Italy was composed of a half-dozen independent governments. Germany was held by scores, some say three hundred, independent states a few centuries ago, and twenty-seven states as late as 1870. In 1787 the United States was virtually thirteen independent commonwealths, and the physical and intellectual task of making those thirteen governments function as one government involved the overcoming of greater natural difficulties than does the task of making the United States of the World out of the ten leading powers. For it took the men of the thirteen states of 1789 far longer to communicate with one another. It took them longer to exchange their products. The freight rate, *i.e.*, the relative cost of exchange, was higher and the basis of trade and economic unity was less stable. Just as our ancestors, driven by the menace of disintegration, made one nation out of the thirteen in 1789, so must this generation make one power out of the leading powers of the world. Just as the thirteen states relinquished the opportunity to exploit one another by war, tariff, trade, and financial disagreement, so the nations of the world, if they would keep the peace, must stop the exploitation of one regional group of people by another.

SOME CONDITIONS OF WORLD GOVERNMENT

To make this world organization survive, several conditions are necessary: first, all must have access to the sea. There must be no more question about the right of a people to have free access to the sea than there is about the right of man to have free access to the public road or street. It may cost the farmer something to make a lane out to the road, but, by right of law and eminent domain, he may make it and pay for it whether his neighbor will or no. So the men of Switzerland and Serbia, Poland, Slavonia and all other peoples must have as unquestioned right of commercial access to the sea as have the people of Ohio or Kentucky.

The sea also must be free, as it normally is, in times of peace. Therefore the real task is to create a world organization that will last, one that will not have in it the germs of war which may break out at some future time and close the sea. Organizing such a League of Peace will be a hard task. Aggressive war arises from two great desires: one, the lust of dominion, which makes people wish to rule others for the mere satisfaction of exercising power, the desire that made Roman emperors have captive kings walk behind them, the desire which is said to have made ex-Kaiser Wilhelm wish to ride down Unter den Linden carrying the keys of conquered cities.

Desire for land is the other great cause of war, and it is a greater menace to world peace than is the lust of dominion. Nearly everybody wishes to own some land. We also like to make our living as easily as possible. If a nation has much good land for each man, living is easy; if it has little land for each man, living is hard. The great advantage of the United States is that it is a country with plenty of room, where living has therefore been easy, where good food has been abundant, and where man can live well with less work than in any other country in the world. For these reasons immigrants have come to us. This abundance of land and consequently of food is the most conspicuous single characteristic of the American continent as contrasted with Europe or Asia. Its effect is shown in the conditions of living in that large part of the country south of Pennsylvania and the Ohio and Missouri rivers and west to the limit of the Eastern forest area. This whole region was originally forest covered, and more than half of it is yet covered by some kind of forest growth. It is spoken of now, and rightly, as a place where the returned soldier may find land for a farm and home. Logs and timber are still abundant for the building of houses, which can be of cheap construction because the winter is milder than that of the north. The same mild climate makes little fuel necessary, and this fuel the abundant woods still furnish.

Natural conditions supply cheap houses and cheap fuel; and custom permits cheap clothing. A large part of the expenditure of city people for clothes is for style rather than for protection; the inexpensive cotton suit is almost as durable as a woolen suit costing several times as much.

FREE FOOD IN SOUTHERN STATES AND ITS INFLUENCE ON MANUFACTURE AND WORLD POLITICS

Food is the most important of the free goods of abundant lands, and the most helpful to cheap living. From the Rio Grande to Delaware Bay the first bright days of spring bring a run of fish upward from the sea in thousands of creeks and rivers, and in these regions a family can be as sure of getting fish by sitting on the stream bank and catching them as can the family that sends to a city market and pays money for them. The herring, which at this season can be caught in nets by the millions, is sold so cheaply that $5 will buy enough to fill a barrel and supply a family with salt fish for the rest of the year. Before the frosts are over the spinach and lettuce of the city market are duplicated by various spring greens which are to be had for the cutting throughout the fields of the Southland. In many parts of the country a law permits every man to pasture one cow along the roadsides, and in other districts pasture for a cow can be had for $1 or $2 per month. This family cow, giving from four to twelve quarts of milk per day, is a cheaper source of supply than the city milkman, charging from ten to twenty cents per quart. In May and June, wild strawberries are to be had for the picking, as are also the black-heart and red-heart cherries. These cherry trees grow wild along the fences and open woods on thousands of roomy farms from Pennsylvania southward, yields of ten bushels per tree are not uncommon, and the fruit is often wasted because there is no one to use it. After the strawberries and cherries come raspberries, and the raspberry season merges into the blackberry season. These two productive briars are regarded as weeds over a territory covering a million square miles in the United States and in most of this region it is common custom for any one to pick the wild berries wherever they may be found away from the immediate vicinity of a farmhouse. The blackberry season merges into that of the huckleberry, which grows in such abundance in swamps and on mountainsides that it has no sale value whatever before it has been picked. After huckleberries come peaches, which grow wild like the cherries along the fence rows in some localities. In autumn comes the persimmon, sweetened by freezing, to hang upon the trees all winter waiting to be eaten. A bushel of apples is usually to be had for a small fraction of the day's wage of an unskilled laborer. In the lowlands and on the moist hillsides the black walnut, which is almost as nutritious as the high-priced English walnut (Persian walnut), is so common that it often lies ungathered on the ground as do hickory nuts by the millions of bushels. Before the first frost the chestnut burrs in the mountain districts open and this sweet nut not only provides an important food supply, but also becomes a money crop of no mean importance. The people roam at will through the woods picking up chestnuts for shipment to all the great cities of the northern and central part of the country.

The generosities of nature do not end here. The natural meat-supply is not limited to fish. In late August and September the young squirrels are full grown, and a good hunter can at times get five or ten in a morning. With the coming of frost the opossum is fat; colored men in the South sometimes report the catching of sixty opossums in a single season. This meat supply is quite as abundant as that bought with the wages earned by arduously digging a sewer or working on a trolley track on a noisy street. Moreover, opossum hunting is generally considered better fun than is digging a sewer. With the falling leaves the oak trees shower down their acorns, the natural food of the hog. Often allowed to run at large in the forests, by December these hogs are fat enough to slaughter for the year's supply of ham and bacon.

In addition to these free offerings of nature, almost every family in the country districts and small towns of this part of the United States has a garden where the common vegetables can be grown, as well as tobacco, the sweet potato, and a few hills of peanuts. The "roasting ear," the partly ripened ear of corn, is a great standby of the summer diet.

The working man in this region has two alternatives. He may work regularly, get wages and buy food, or he may work occasionally on the farm and get an equal amount of food by going hunting, fishing, or berrying. In fact, a very large part of the laboring class in the southern and southeastern part of the United States will not accept a regular job by the year. Even the pressure of the Great War could not entirely change it. This ease of getting a living has exercised profound influence in checking the development of manufactures and making the contrast between America and Europe, or America and the Orient, so striking that millions yearn to come to America as to a land of opportunity.

THE EXACTING DEMANDS OF MANUFACTURE

Manufactured goods are produced in a factory, where work begins on Monday morning at the blow of the whistle and continues on a schedule until Saturday afternoon. The demand on labor is exacting. But the people of Europe, the people of Japan, and the people of China are glad of the chance to earn a living in this way. They cannot go fishing, or hunting, or berrying, or nutting.

The average population of the United States is less than 50 per square mile, that of Germany is 290; that of Holland is

454; and that of Belgium is 645, or more than one person to each acre. As previously stated Japan has a population of more than 2,500 per cultivated square mile. This dense population requires much food; that need in turn makes necessary the careful cultivation of land; and the consequent high yields give the land a high price, often several hundred dollars an acre. It often costs as much to rent a field for a single year in Japan or Italy as it does to buy land in the southern or eastern part of the United States. In these closely cultivated territories, there are no fence rows with berry bushes, fruit and nut trees because there are no fences. All the land is tilled, and one man's grain field touches his neighbor's as do two connecting lawns with no fence between. The roadsides are often lined with fruit trees, but the fruit is not a free gift of nature to be taken by any one in the neighborhood, but a crop grown by the farmer or even by the local government and sold like any other crop. He who eats the product of the land must either produce it with much labor or buy it with hard-won money. Food prices are high, and wages are low. Under these conditions people must work, and work regularly; the great difficulty is to get a chance to labor. Thus the factories can easily get laborers and northwestern Europe with its dense population has become a veritable hive of manufacturing industries. The great concern of the young man for his future and of the parent for his child is that he may get a job. What is there for the young Dutchman or Belgian to do? Every farm is tilled. Perhaps the factories are full. The young man therefore thinks of emigrating, or at least of getting a job in some foreign place.

The cultivated part of Japan supports about four persons to the acre, or a family of five to one and one-fourth acres. The food requirements and land requirements for a family of five in the state of Georgia are set forth by Andrew H. Soule, president of the Georgia Agricultural College, in a hearing before a committee of the United States Senate in 1917.*

* *Standard dietary for adult male.*—Protein, 663 calories; fat, 936 calories; carbohydrates, 1,761 calories; total, 3,360 calories.

For adult female.—Protein, 442 calories; fat, 515 calories; carbohydrates, 1,175 calories; total, 2,132 calories.

For girl of sixteen.—Protein, 512 calories; fat, 410 calories; carbohydrates, 1,275 calories; total, 2,197 calories.

Whereas the Japanese family has one and one-fourth acres, Mr. Soule states that the Georgia family should have ten acres in crops in addition to the equal or greater area required to support the two cows, the yearling beef, and the ten or fifteen pigs. As a matter of fact, land in America is so abundant that the family does have all this land; yet the South may still, without much exaggeration, be said to lie undeveloped.

That contrast between Japan and Georgia, between one and one-fourth and twenty or more acres per family, is the stuff of which war is made. It provides the motive of land hunger, which may arise most naturally, without the aid of any bad actions or bad intentions on the part of individuals. Dr. Isaiah Bowman,

For child of twelve.—Protein, 665 calories; fat, 410 calories; carbohydrates, 1,175 calories; total, 2,250 calories.

For child of six.—Protein, 565 calories; fat, 410 calories; carbohydrates, 325 calories; total, 1,600 calories.

FEEDING THE AVERAGE MAN

To furnish the food units needed by an adult man weighing 154 pounds, doing active muscular work, it would be necessary to provide the following amounts of food daily or satisfactory substitutes therefor:

	Calories
4 eggs (with fat to cook)	400
2 glasses milk	300
2/5 lb. steak or other lean meat	660
1/4 pound butter	800
4 slices bacon	200
Lima beans (one-half cup, cooked)	100
Corn (one-half cup, cooked)	100
Potatoes (10 ounces, cooked)	200
6 slices wheat bread or equivalent of corn or wheat flour substitute	600
Sugar (4 tablespoonsful in dessert or beverage)	300
Total	3,660

FOOD REQUIREMENTS FOR A FAMILY OF FIVE

The following supplies of food will be required to provide a family of five for one year with rations based on the above standard dietary:

4 barrels flour or substitutes therefor, such as peanuts, potatoes, and soy beans.
12 bushels corn meal (some of this to be used as breakfast cereal and wheat substitute).
728 gallons milk (this to take care of butter).
225 pounds bacon.
150 pounds lard.
1,000 pounds fresh meat (pork, beef, chickens, fish).
250 dozen eggs.

director of the American Geographical Society, called the attention of his class in Yale University in June, 1914, to the fact that the population on the west side of the Franco-German boundary was scanty, while that on the east side was dense. "Therefore," said he, "sooner or later there is sure to be war across that boundary because of the heavy population, land hunger, on one side, and the scanty population with relatively unused land on the other." He did not expect the war to begin the next month, but it did. The land hungry, often physically hungry, millions of China and Japan looking across the Pacific at empty California, empty British Columbia, and empty Australia, are in a natural position to have the keenest kind of land hunger. They want to come and settle in these lands. They

10 bushels fresh fruit.
100 quarts canned fruit (5 to 6 bushels when fresh).
25 gallons sirup.
40 bushels sweet potatoes.
40 bushels Irish potatoes.
One-half acre in vegetables in successive plantings (This will provide an abundance of fresh vegetables and 500 quarts of canned vegetables for winter use.)

LAND NEEDED TO GROW FOOD FOR FAMILY OF FIVE

To grow the food called for in the foregoing table, the following acreage will be required:

One-half acre of carefully cultivated and well fertilized ground should be devoted to vegetables planted in proper sequence and succession

One-half acre should be devoted to orchards, which will supply a variety of fruits such as peaches, apples, grapes, and figs.

One-half acre should be planted to melons

One acre to legumes, such as field beans, cowpeas, peanuts, and soy beans, to be used either in their natural state or, in the case of the two latter crops, as flour substitutes.

One-half acre in sorghum cane for sirup

One acre in sweet potatoes

One acre in Irish potatoes, one-half planted in the spring and one-half in the fall

Two acres in corn.

Three acres in wheat.

On thin or poorly fertilized and prepared land, the acres of most of these crops would probably need to be increased. On particularly rich and well-managed lands the area indicated might be cut down considerably In this connection, it is proper to remember that these areas should be doubled if the cultivator of the soil is to grow a surplus of these products for the use of our urban population. In addition, each family of five will require the milk and butter derived from two good cows which are properly fed and cared for; the meat obtained from the progeny of two brood sows and one yearling beef, and the chickens and eggs available from a flock of fifty hens.

have started to do so, but the white man keeps them out for the best of reasons, from his point of view. He knows that in a short time these districts would become lands of the Mongolian. Because of their habit of working harder and living less expensively, the Chinese and Japanese could pay more for the land than the white man could pay. Community after community would become Chinese and Japanese, and the white men would move away. There would be no end to the process, for the more that came the more there would be to come. Emigration is no cure for overpopulation. It is merely an encouragement, a kind of free inheritance for the children. Thus would Mongolia advance into Caucasia. Therefore, we pass exclusion acts; but they are no cure for land hunger. They are an aggravation. They are an insult to a proud, sensitive, intelligent, and powerful people. They are not only an insult; they are a dare. Yet the possession of a piece of land by a people and their government of it by themselves is one of the conditions upon which apparently a union of nations must be made. How can the government survive if it excludes other peoples and continually exposes them to land hunger?

It would, of course, greatly facilitate world peace if all nations had developed to about the same degree their utilization of resources. Unfortunately they have not; and the almost static population of Australia and France affords remote prospect of such uniformity.

How can the danger from land hunger be reduced? It cannot be removed while the difference of ratio between men and resources lasts, but we must mitigate it so far as possible by the abolishing restrictions on trade. The free exchange of commodities will make it easy to share the advantages of exclusive possession of territory and to reduce the need which densely peopled China and Japan must feel for the empty lands of the white man in Australia, California, and British Columbia.

International trade thus becomes one of the great cares of those who would organize the world for peace and permit man's food supply to increase.

The question of tariffs is the chief problem in determining trade policy. The reasons for tariffs, recognized by economists, are (*a*) the protection of infant industries, which can be aided by bounties as well as by tariffs, and often are so aided, and (*b*) the industrial completeness necessary for war. Closely akin to the first argument is the need of protection of industry in any country from the practice of dumping, that is, of selling surplus at less than cost in a distant market in order to avoid a break in price in the customary market. This practice is a frequent fact in the demoralization of trade; it may also be deliberately used by the producers of one country to stifle rivals that promise to develop competition in other countries. Fortunately, however, this undoubted evil can be controlled without the establishment of any general tariff system. It has in fact already been dealt with by the legislation of Canada and several other countries by the establishment of anti-dumping statutes. Under these laws foreign goods may not be sold in the country of import for smaller prices than they bring in the country of production.

The second reason for maintaining tariffs is much more potent and looms particularly large in the present moment; that is the necessity of developing a variety of industries in the attempt to produce the astonishing industrial completeness necessary for war. There is almost no limit to the application of this philosophy since war has itself become industrial. All economists recognize in the tariff a factor increasing the cost of living in the country possessing it. In other words, tariff, except as a protector of infant industries, tends to impoverish; it puts up the price. Conversely, free trade tends to enrich by giving the importing country the advantage of the specialization that may be developed in every other country. An example of impoverishment by tariff is Portugal, a country that insists on taxing everything that comes into it, and has thus forced the cost of living to a fearful height and ground its people down to the point of malnutrition. An example of enrichment by free trade, is the prosperity of England and Holland, with cheap supplies and a low cost of living based on the use of goods from the world's cheapest markets. Hungry Portugal, on the other hand, has to buy in the high-tariff market and sell in the cheap markets in competition with all the world.

At the present moment the pains and perils of the Great War have served to emphasize the importance of tariffs as factors aiding the industrial completeness necessary for national defense.

We have, however, already passed the point where this is possible as a general policy for the nations of the world. We have developed population and trade too far; industry and war have become too complex for any nation to hope to be commercially independent, even if its variety of resources is as great as that of the United States. Every one knows that England and Holland, France and Norway are dependent on the sea; but so also is the United States. Its vast steel industry could be ruined by cutting off the supplies of imported ores used for hardening the metal.

As trade grows, we tend to become less independent rather than more independent. Science, while it may in a sense make the commercial independence of nations possible, does so only at the price of discomfort and waste of resource. A nation like England could be almost entirely independent only with a scanty population one-fourth or one-tenth that which might live there in comfort with a fully developed trade. The natural tendency of trade is to develop ever-increasing dependence because of the increasing variety of products that enter into our daily life. Thus China for ages was a world to herself. She scorned the outside world, which could bring her nothing that she herself did not have. But in this age of science, she wants our machines and our specialized productions. Economic independence is practically undesirable and impossible. Would that it might not linger in men's minds to menace the world's peace for decades!

Tariffs cannot make even the United States independent in war, although, if deliberately used for that purpose, they could make the country *nearly* independent, at great cost in increased living expenses and inefficiency of industry. For the conduct of a war a nation needs access to the sea or colossal preparation such as Germany made, followed by almost instantaneous success, such as Germany failed to achieve.

Every year science is making military completeness less possible, attack more deadly, and isolation such as comforted the past of China and the United States more unthinkable. The provincial past, the nationalistic past, is gone, for isolation is gone. The world has given hostages to peace. Our century of world trade has already developed interdependence of nations and dependence on the sea and ships, which compel us to maintain this commerce to relapse into a past epoch of small population or obedience to some tyrant. The Revolutionary motto, "Unite or Die," used to bring the American colonies together, was never more applicable than today and now it applies to the nations of the world. We must unite in world organization with a free sea permitting a great world trade, or enter upon an epoch of militarism with the chance of being forcibly united by some world conqueror who would take a rich world tribute.

We have some chance of keeping the lust of dominion under control if it does not form an alliance with land hunger. To prevent this union, we must weaken land hunger by establishing freedom of trade. By this means we may succeed in forming a world organization that can keep in check the two great national appetites: the lust for power and the lust for land.

FOOD VALUES (AVERAGE)

(From Bulletin No. 28, United States Department of Agriculture [1])

Food Material	Refuse Per cent.	Water Per cent.	Protein Per cent.	Fat Per cent.	Total Carbohydrate Per cent.	Fuel Value Per lb. Calories
I CEREALS AND SUBSTITUTES:						
Wheat flour, entire wheat		11.4	13.8	1.9	71.9	1675
Wheat flour, patent roller process, high grade		12.4	11.2	1.0	74.9	1645
Wheat, shredded		9.6	12.1	1.8	75.2	1700
Potatoes, evap., a. p.[2]		7.1	8.5	.4	80.9	1680
Potatoes, fresh, a. p.		78.3	2.2	.1	18.4	385
Potatoes, sweet, fresh, a. p.		55.2	1.4	.6	21.9	460
Bananas, yellow, a. p.	35	48.9	.8	.4	14.3	300
Rye flour		11.4	13.6	2.0	71.5	1665
Corn flour		12.6	7.1	1.3	78.4	1645
Corn, green, canned		76.1	2.8	1.2	19	455
Barley flour		11.9	10.5	2.2	72.8	1640
Biotes (acorns), ed. por.[3]		4.1	8.1	37.4	48.0	2620
Oatmeal		7.3	16.1	7.2	67.5	1860
Oatmeal, boiled		84.5	2.8	.5	11.5	285
Rice		12.3	8.0	.3	79.0	1630
Rice, boiled		72.5	2.8	.1	24.4	510
Bread, white		35.3	9.2	1.3	53.1	1215
Crackers, soda, a. p.		5.9	9.8	9.1	73.1	1925
Macaroni a. p.		10.3	13.4	.9	74.1	1665
Cornstarch, a. p.					90.0	1675
Starch, tapioca, a. p.		11.4	.4	.1	88.0	1650
II MEATS AND SUBSTITUTES:						
Sirloin steak, a. p.	12.8	54.0	16.5	16.1		985
Neck of beef	27.6	45.9	14.5	11.9		1165
Bacon, smoked, medium fat	7.7	17.4	9.1	62.2		2795
Corned beef		51.8	26.3	18.7		1280
Frankfort, a. p.		57.2	19.6	18.6	1.1	1170
Fowls, a. p.	25.9	47.1	13.7	12.3		775
Halibut, steaks or sections, a. p.	17.7	61.9	15.3	4.4		470
Ham, smoked, fat medium, a. p.	13.6	34.8	14.2	33.4		1675
Herring, whole, a. p.	42.6	41.7	11.2	3.9		375
Cod, dressed, a. p.	29.9	58.5	11.1	.2		215
Salmon, canned, a. p.	14.2	56.8	19.5	7.5		680
Eggs, hen, uncooked, a. p.		73.7	13.4	10.5		720
Milk, whole, a. p.		87.0	3.3	4.0	5.0	325
Milk, skimmed, a. p.		90.5	3.4	.3	5.1	170

[1] Many other food analyses are given in this bulletin.
[2] a. p. = as purchased
[3] ed. por. = edible portion.

Food Material	Refuse Per cent.	Water Per cent.	Protein Per cent.	Fat Per cent.	Total Carbo-hydrate Per cent.	Fuel Value Per lb. Calories
Milk, condensed, unsweetened, a. p.		68.2	9.6	9.3	11.2	780
Buttermilk, a. p.		91.0	3.0	.5	4.8	165
Cheese, cottage, a. p.		72.0	20.9	1.0	4.3	510
Cheese, full cream, a. p.		34.2	25.9	33.7	2.4	1950
Beans, dried, a. p.		12.6	22.5	1.8	59.6	1605
Lentils, dried, a. p.		8.4	25.7	1.0	59.2	1620
Peas, dried, a. p.		9.5	24.6	1.0	62.0	1655
Peas, green, ed. por.		74.6	7.0	.5	16.9	465
Almonds, ed. por.		4.8	21.0	54.9	17.3	3030
Macaroons, a. p.		12.3	6.5	15.2	65.2	1975
Brazil nuts, ed. por.		5.3	17.0	66.8	7.0	3265
Hickory nuts, ed. por.		3.7	15.4	67.4	11.4	3345
Pecans, ed. por.		2.7	9.6	70.5	15.3	3435
Walnuts, Cal. soft shell, ed. por.		2.5	16.6	63.4	16.1	3285
Peanuts, ed. por.		9.2	25.8	38.6	24.4	2560
III. Fats (*see also above*, Cheese, and nuts [including almonds and acorns]):						
Butter, a. p.		11.0	1.0	85.0		3605
Clear fat (beef)		13.4	4.1	82.1		3540
Lard, unrefined		4.8	2.2	94.0		4010
Oil, pure (peanut, cottonseed, olive, coconut)				100.0		4040
Coconut, ed. por.		14.1	5.7	50.6	27.9	2760
Chocolate, a. p.		5.9	12.9	48.7	30.3	2860
Cocoa, a. p.		4.6	21.6	28.9	37.7	2320
IV. Fibrous and Green Vegetables:						
Beets, fresh, ed. por.		87.5	1.6	.1	9.7	215
Cabbage, ed. por.		91.5	1.6	.3	5.6	145
Carrots, evap., ed. por.		3.5	7.7	3.6	80.3	1790
Carrots, fresh		88.2	1.1	.4	9.3	210
Onions, fresh, ed. por.		87.6	1.6	.3	9.9	225
Spinach, fresh, a. p.		92.3	2.1	4.1	2.6	260
Tomatoes, fresh, a. p.		94.0	1.2	.2	4.0	105
Lettuce, ed. por.		94.7	1.2	.3	2.9	90
V. Fruits:						
Apples, a. p.		63.3	.4	.5	14.2	290
Oranges, a. p.	27.0	63.4	.6	.1	8.5	170
Persimmons, ed. por.		66.1	.8	.7	31.5	630
Grapes, a. p.	25.0	58.0	1.0	1.2	14.4	335
Raisins, a. p.	10.0	13.1	2.3	3.0	68.5	1445
Apricots, dried a. p.		29.4	4.7	1.0	62.5	1290
Dates, a. p.	10.0	13.8	1.9	2.5	70.6	1450
Figs, a. p.		18.8	4.3	.3	74.2	1475
Prunes, a. p.	15.0	19.0	1.8		62.2	1190
VI. Sugars:						
Granulated sugar, a. p.					100.0	1860
Candy, a. p.					96.0	1785
Molasses, cane, a. p.		25.1	2.4		69.3	1290

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