PRODUCTIVE AGRICULTURE

GEHRS

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PRODUCTIVE AGRICULTURE

BY

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PREFACE

THIS book is the outgrowth of the author's feeling that there is a need and a demand for a book that will standardize seventh and eighth grade agriculture. It is the author's belief that children in the seventh and eighth grades in the rural schools are as well if not better prepared to do superior work in agriculture than are freshmen in many of our town schools. The town pupil knows little about agriculture. The experience of the country boy or girl is rich in the practical affairs of agriculture.

The Table of Contents indicates that the subject matter treated in this book fits closely the agricultural interests of the North Central States. The arrangement of the chapters follows as closely as possible the farmer's seasonal occupations. But since the seasonal sequence varies, the chapters may be studied in any order desired. The topics treated cover the demands of the courses of study of the North Central States.

Such topics as the origin, history, and importance of farm crops and animals are about agriculture; but such topics as how to produce larger yields, use of more prolific varieties, the use of high-grade or pure-bred stock, how to feed well and economically, how to improve the soil, how to combat enemies, and how to choose, plan, and manage a farm, are topics that deal with making our agriculture more productive. This is not primarily a book ABOUT agriculture; but one ON "Productive Agriculture."

Contrary to the popular opinion, our crop yields per acre in the United States are not decreasing, but increasing. This is shown in the following table based upon the United States Yearbooks of Agriculture:

INCREASE IN YIELD IN FARM CROPS OF THE UNITED STATES

Average Yield per Acre

	PERIOD 1890–1899, BUSHELS	PERIOD 1906–1915, BUSHELS	PERCENTAGE INCREASE
Barley	23.2	25.6	10.3
Corn	24.1	28.6	10.4
Wheat	13.2	14.9	12.8
Oats	26.1	30.2	15.3
Rye	14.0	16.4	17.1
Potatoes	70.4	97.4	38.2

The average acreage yields of the leading crops of the United States for the period 1906–1915 have been greater than for any other equal period in American agriculture. Unless this book helps to increase the acreage yields, improve stock, make for better and more fruit, and promote better farm management, it will have failed of the purpose for which it has been written.

Since the Extension Departments of the Agricultural Colleges are devoting so much time to organizing and directing club and home project work, this topic is wholly omitted from the discussions. Some club work can be done with profit. For information regarding the organizing of clubs, write the Extension Department of your State Agricultural College. These Extension workers are specialists, and can give the best information obtainable on club work.

Laboratory Exercises are provided at the close of each chapter. These exercises illustrate and make clearer the principles brought out in the text. They can be done with a small amount of equipment, and will help to make the work in agriculture more concrete. Laboratory work makes the subject more interesting, educative, and practical.

A small amount of suggested correlation with other subjects, especially language and arithmetic, is found in the Laboratory Exercises. When other subjects are correlated with agriculture, agriculture should be the basis for correlation. Correlation in which nine-tenths of the time is devoted to subjects other than agriculture destroys the vital influence that agriculture should have in every rural community.

The limitations due to the size of this volume, and the time of the pupils, compel the omission of many subjects that would be interesting and profitable. Special treatises in the form of bulletins from your State Experiment Station and the United States Department of Agriculture should be consulted. Many questions of local interest may thus be studied. Lists giving the available bulletins of your State Station and the United States Department of Agriculture should be sent for.

Grateful acknowledgments are due the following agricultural specialists: C. B. Hutchison, formerly teacher of Farm Crops, University of Missouri, and now a student at Cornell University, for reading the section on Farm Crops; E. A. Trowbridge, Professor of Animal Husbandry, University of Missouri, for reading the section on Farm Animals; G. H. Benkendorf, Professor of Dairying, University of Wisconsin for reading the section on Dairying; C. T. Patterson, Director of the Missouri Poultry Experiment Station, Mountain Grove, Missouri, for reading the chapter on Poultry; A. R. Whitson, in charge of the Soils Department of the University of Wisconsin, for reading the section on Soils; Dr. J. C. Whitten, Professor of Horticulture, University of Missouri, for reading the section on Horticulture; and G. W. Gehrand, Professor of Animal Husbandry, University of Minnesota, for reading the section on Farm Management; and, also, W. W. Parker, Associate Professor in English in the Warrensburg State Normal School, for reading the manuscript. To these specialists is due, in a large measure, whatever merit this book may have.

Acknowledgments are due also to Dr. E. L. Hendricks, President of the Warrensburg State Normal School; A. E. Davidson, Teacher of Agriculture of the Warrensburg State Normal School; Prof. T. J. Walker, Rural School Inspector; and R. H. Boston, County Superintendent of Schools of Johnson County, Missouri, for valuable suggestions on the entire book.

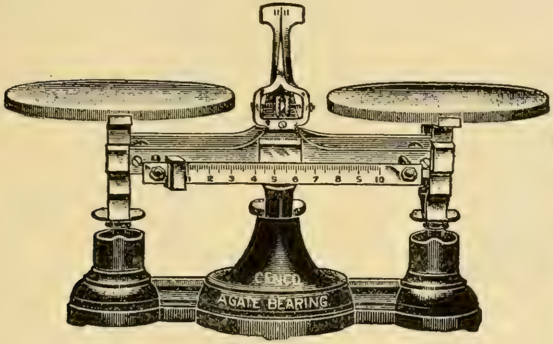
To all of these, and to those who have assisted the author in testing the workability of most of the subject matter and exercises of this text, the author is profoundly grateful.

JOHN H. GEHRS.

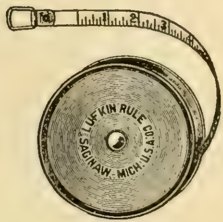
Warrensburg State Normal School,
Warrensburg, Missouri,
February 2, 1917.

APPARATUS AND EQUIPMENT[1]

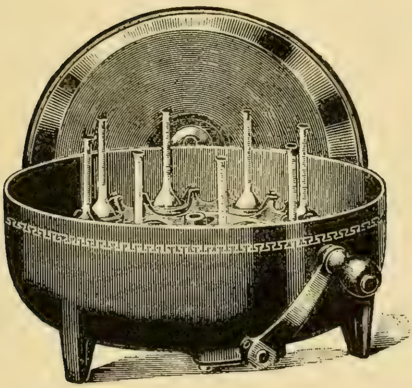
Apparatus and equipment every school should have, and their approximate cost, are given below. Other equipment may be supplied when needed.



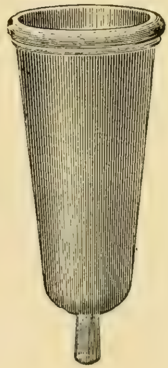
Trip balances, — weighing to grams — $6.65



Five-foot measuring tape

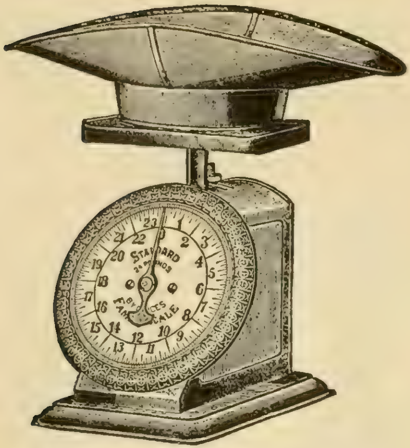


Babcock tester (and necessary glassware and chemicals) — $10.00

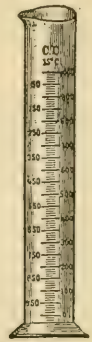


Six percolators, — each $.27

[1] This apparatus may be had from the following: The Central Scientific Company, 412–420 Orleans St., Chicago, Illinois, and W. M. Welsh Scientific Company, 1516 Orleans St., Chicago, Illinois.



Scales, — weighing to ounces — $1.65



One-half dozen 100 c.c. graduates, — each $.56

One dozen pint glass jars . . . . $ .60
One dozen paper plates 10

Tall bottles with bottoms out.

Six one-gallon buckets.

Blue litmus paper (had at drug stores).

Red litmus paper (had at drug stores).

Samples of commercial fertilizers (obtained from packing houses or fertilizer companies).

Soil auger.

Standard of Perfection, — published by the American Poultry Association, Mansfield, Ohio $2.00

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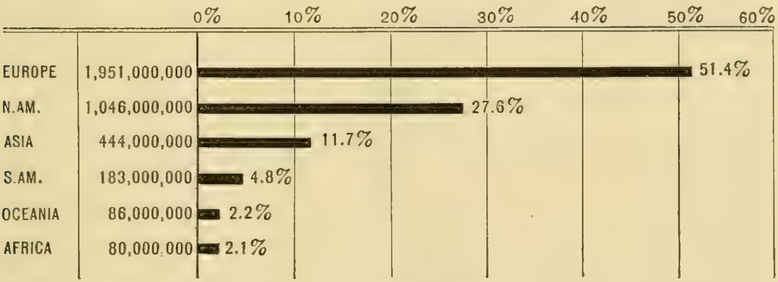
CHAPTER I

WHEAT

Importance of the Wheat Crop. — The wheat crop of the world is the most important crop grown. Wheat is used more extensively by civilized people as a food than any other crop. In money value wheat ranks next to corn among the farm crops of the United States. The production of wheat of the grand divisions recently for a period of five years was as follows:[1]



GRAPH 1. Wheat production in bushels.

From this graph it may be seen that Europe produces more than half of the world's wheat crop. In fact, European Russia produces almost as much wheat as North America.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this Chapter are:

A pint each of hard and soft wheat flour, several pint samples of threshed wheat, and a dozen paper (preferable) or porcelain plates.

[1] *United States Yearbooks of Agriculture*, 1911–1915.

In the United States the weight of the wheat crop ranks second, corn being first. The average acreage yield of wheat in the United States for a recent period of ten years was fifteen bushels.[1] The average price per bushel of wheat over this decade was nearly 87 cents (86.8).[2] At this rate the value of our wheat crop for 1915 was $930,302,000. Wheat is the source of a large supply of our daily food products. (See Exercise 1.)

History of Wheat. — Just when wheat was first grown is not known. However, it may be safely stated that it was grown a long time before history was recorded. The Chinese raised wheat about 3000 B.C. The Egyptians, Hebrews, and the people of Switzerland produced wheat in prehistoric times. Wheat is mentioned in the first book of the Bible, and the early writings of various ancient peoples abound in references to wheat.

Wheat was not grown in America until after the discovery by Columbus. The first colonists introduced wheat into America, and about 1540 sowed the first seed on American soil. The colonists were largely unsuccessful in their attempts at growing wheat in New England. The Middle Atlantic colonists succeeded better, and exported a great deal of wheat and flour in colonial times.

All laboratory work should be neatly, carefully, and systematically recorded in a well-kept notebook. It may be desirable to write up each exercise in the usual way, namely, the object of the exercise, the materials used, the procedure or operation, and the conclusion. A loose-leaf notebook 8 × 10½ inches will be found most satisfactory. Notebooks should be uniform in size.

Lists of Free Bulletins from your Agricultural College and the United States Department of Agriculture should be written for, and the Bulletins received should be a part of the permanent school library. The Bulletins should be classified and several Bulletins on the same topic bound together by punching holes in the proper place, and tying.

[1] 1906–1915 inclusive. [2] *The United States Yearbooks of Agriculture.*

Wheat Districts in the United States. — There are six important wheat districts in the United States. Though each district grows a number of varieties of wheat, the kernels of the varieties of a district possess similar characteristics. Hardness, due to the gluten content, color of kernel, and the time of growth are the principal characters which serve as a basis for the wheat districts of the United States. Market quotations are based upon these characters. Each of the six districts and the character of the wheat produced will be briefly discussed.

1. The semi-hard winter wheat district includes the states of Missouri, Illinois, Iowa, Indiana, Ohio, Pennsylvania, Kentucky, and the eastern part of Kansas, Oklahoma, and Nebraska. The abundance of rainfall produces a wheat high in starch and lower in protein content. It ranges from a soft to a semi-hard wheat, according to the amount of rainfall in different seasons and sections. Where the rainfall is less, the wheat is harder.

2. The hard winter wheat district includes the states of Kansas, Nebraska, and Montana and overlaps into Missouri, Iowa, Nebraska, and Oklahoma, according to seasonal variations. The kernels of the wheat grown in this district are long, slender, hard, and red in color. A cross section of the kernel is of a grayish amber color. Hard wheat flour is excellent for the making of light bread.

3. The hard spring wheat district includes the upper Mississippi basin states, namely, Minnesota, North and South Dakota, parts of Wisconsin, Iowa, Nebraska, Montana, and Colorado. The wheat of this section is spring sown. It is like the hard wheats except that the kernels are smaller and harder. It is the best bread-producing wheat grown. About one-third of the wheat grown in the United States is grown in this district and large quantities of flour are manufactured here.

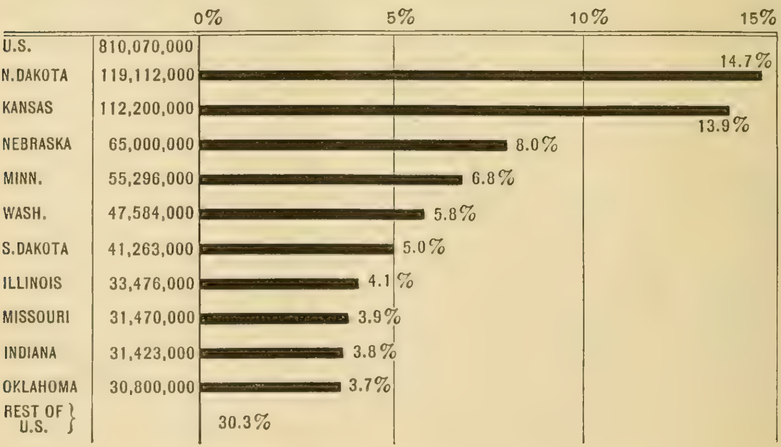
4. The soft wheat district, sometimes called the Pacific

Coast or the white wheat district, includes the states of Washington, Oregon, and California. The wheat has soft, plump, large, white kernels. The flour of this wheat is used for pastries, crackers, and biscuits, because of its large starchy content.

5. The Atlantic Coast wheat district includes the states along the Atlantic seaboard. This district produces a soft wheat similar to that produced in California, Oregon, and Washington. This is a relatively unimportant district, except as it supplies the local demands of the district.

6. The Durum wheat district includes parts of the Dakotas, Colorado, Montana, Kansas, and Nebraska. Durum wheat requires less rainfall than any other kind of wheat, and is adaptable to the arid and semi-arid states. When other varieties can be grown, they are preferred because their yields are greater. (See Exercise 2.)

Wheat States. — The largest production of wheat in the United States was in 1915 when the total yield was 1,011,505,000 bushels. And the ten leading states in the order of wheat produced from 1912 to 1916 inclusive was as follows:



Graph 2. Wheat production in bushels.

The ten states mentioned above produced a little more than 68 per cent of the wheat produced in the United States for the period given.

Low Yields of Wheat. — The average yield for 1906 to 1915 inclusive in the United States was fifteen bushels an acre. This low average is due mainly to the following factors:

1. Use of poor seed.
2. Poor cultural methods.
3. Insects and fungous diseases.
4. Unfavorable seasons.

The wheat yield per acre in European countries exceeds that of the United States. The average cost to produce a bushel, with the average yield per acre of a few of the leading countries, for a recent period[1] of ten years, follows:[2]

	Cost of Bushel Production	Average Yield
United Kingdom	45¢ not including land rent	33.4
Germany	92¢ including land rent	30.7
France	58¢ including land rent	20.1
Hungary	55¢ not including land rent	18.1
United States	85¢ including land rent	15.0
European Russia	42¢ not including land rent	11.0

Why European countries produce larger yields an acre than the United States, is an important question for study. Our natural resources are ordinarily as great as those of European countries.

Place of Wheat in American Agriculture. — Wheat is an important product because it succeeds in a very wide range of conditions of soil and climate. Wheat is grown in every state of the Union. It is grown in cold Canada and in hot Mexico.

[1] 1905–1914. [2] *United States Yearbook of Agriculture.*

It is adaptable to wide temperature conditions. Wheat is grown under wide variations of rainfall. In the semi-arid regions less than twenty inches of annual rainfall may mature a crop of wheat. In other places thirty-five or forty inches of rainfall may not seriously affect a good wheat yield. As to soils in which wheat may thrive, we may indicate that it grows on the poorest and the richest of soils. It grows in the thick clays of the New England States and in the semi-arid sandy sections of the Western plains.

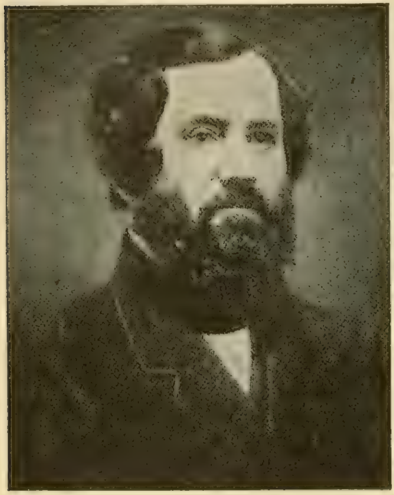


FIG. 1. — Cyrus H. McCormick, whose inventions and improvements of the reaper caused the wheat cradle to become an implement of past history.

Wheat is a desirable crop because it requires, in its production and harvesting, seasons of the year that could not be well utilized in connection with other crops.

As we have said before, wheat will always be one of our crops, because it furnishes a product that can be easily converted into foods usable by man.

Cost of Wheat Production. — The cost per acre of wheat production depends upon the section of the United States in which the wheat is grown, the kind of soil, the tools used in its production, value of land, the price of labor, and upon the amount of wheat raised per acre. The average cost of an acre of wheat production in the various sections of the United States has been estimated to be as follows: [1]

[1] *Crop Reporter 1911*, U. S. Department of Agriculture.

1. Rental on land or interest on source	$3.30
2. Preparation of soil	2.11
3. Seed	1.42
4. Fertilizer	.58
5. Sowing	.46
6. Harvesting	1.33
7. Threshing and preparing for market	1.48
8. Other items	.48
Total	$11.16

If the average production was fifteen bushels per acre, and it cost $11.16 to produce it, the cost to produce a bushel of wheat was about 79 cents. If wheat sells at 90 cents a bushel, and it cost 5 cents to haul it to market, then the profit a bushel to the farmer is 6 cents. At this rate what would a farmer make on five hundred bushels of wheat? One thousand?

In the preceding calculation, the fertility stored in the wheat kernels and taken out of the soil was not included. It has been stated that the fertilizing constituents in one thousand pounds of wheat are as follows:[1] Nitrogen, 19.8 pounds; phosphorus, 8.6 pounds; potash, 5.3 pounds.

If nitrogen is worth 15 cents a pound, and phosphorus and potash 6 cents a pound each, then for each one thousand pounds of wheat kernels removed, estimate the land fertility taken out of soil.	19.8 × 15	$2.97
	8.6 × 6	.50
	5.3 × 6	.31
	Total	$3.79

(See Exercises 3 and 4.)

If all the wheat straw is left on the land, and the wheat grains only are removed, it is quite certain that for every thousand pounds of wheat sold off the farm the fertility of the land has been lowered about $3.79. Therefore the farmer, the scientist, the teacher, and the student should study how to maintain the fertility of the soil, and how to produce wheat more economically.

The problem that we shall study next is how to produce the larg-

[1] Henry and Morrison: *Feeds and Feeding*, Table III.

est crop of wheat with the smallest amount of labor, at the lowest cost a bushel. The amount of human labor required to produce

FIG. 2. — The old way of harvesting grain crops, still occasionally in use on small areas. The use of this method increases the cost of wheat production.

a bushel of wheat has decreased a great deal. This decrease is mostly due to the improvement of farm machinery, especially the reaper. How much the human labor required to produce, reap, and thresh a bushel of wheat at different periods has been reduced, may be seen from the following table:

DATE	TIME REQUIRED OF MAN LABOR	COST OF MAN LABOR	MAN PLUS HORSE LABOR
1832 . . .	3 hours — 30 minutes	$17\frac{3}{4}$ cents	20 cents
1896 . . .	10 minutes	$3\frac{1}{3}$ cents	10 cents

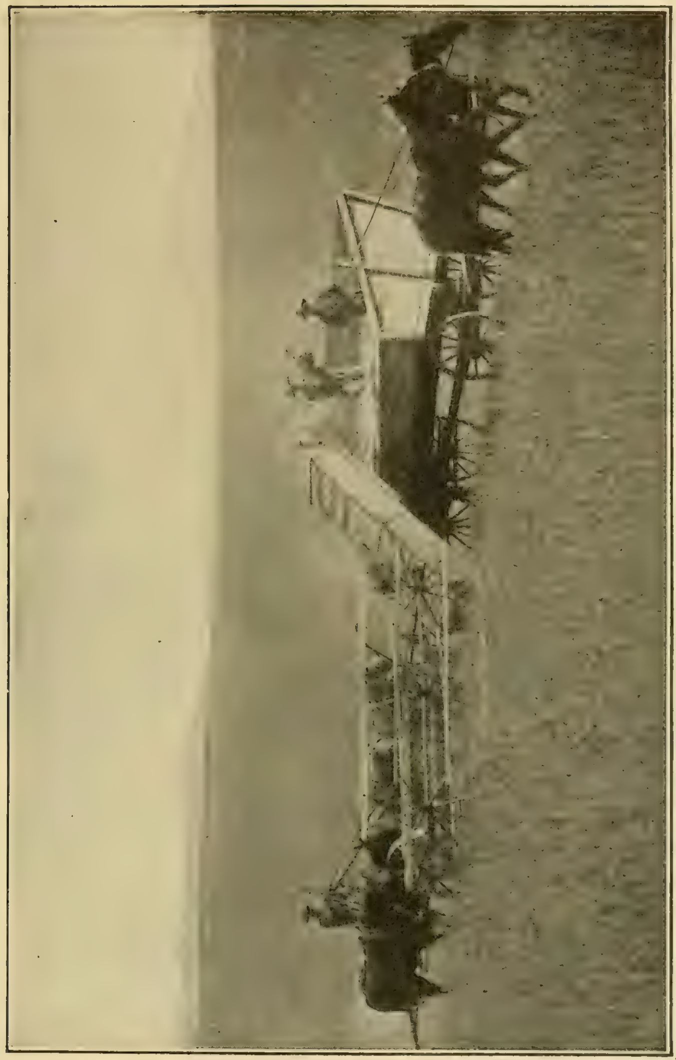
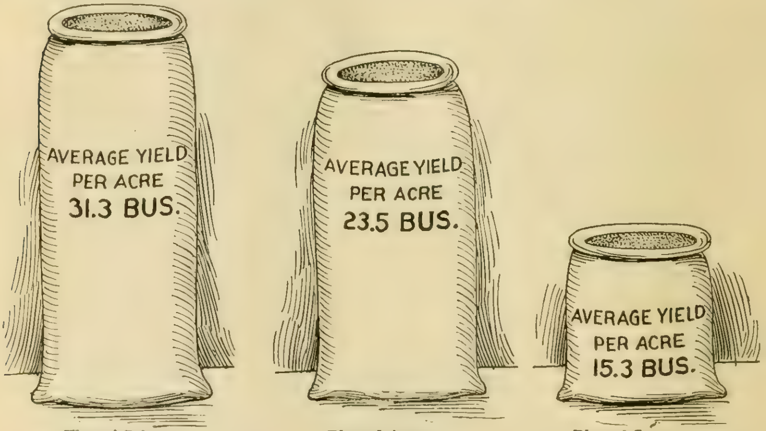


FIG. 3. — The new way of harvesting wheat on large areas. The use of this method reduces the cost of wheat production.

Preparation of Seed Bed to Lessen Cost of Production. — Although it is difficult to cover all soil conditions and kinds of seasons as far as preparing the seed bed is concerned, yet there are two points which are to be considered in economic wheat production. These two points are:

1. The time of seed-bed preparation.
2. The depth of plowing the soil.

1. *Time of Seed-bed Preparation.* — At the Oklahoma Station,[1] similar soils were plowed on July 19th, August 15th, and September 11th. The soil plowed July 19th was in the proper state of moisture to plow well. That plowed August 15th was somewhat hard and lumpy; and that plowed September 11th was dry and cloddy. Each plot was seeded September 15th. The germination on the plot last plowed was not good. While not exclusively due to time of plowing, the following results were obtained:



Plowed July 19. Plowed Aug. 15. Plowed Sept. 11.

FIG. 4. — The effect of time of plowing upon economic wheat production.

[1] *Bulletin No. 47.*

Soil Plowed	Bushels an Acre Yield
July 19th	31.3
Aug. 15th	23.5
Sept. 11th	15.3

From this data it may be seen that the time of seed-bed preparation greatly affects wheat yields, for when the soil was plowed July 19th, the yield was 31.3 bushels, and when plowed Sept. 11th, the yield was only 15.3 bushels. From this it is apparent that early plowing for wheat production is profitable.

If wheat follows oats, the soil should be plowed as soon as the oat crop is harvested. Generally it is best to work down the soil well as soon as it is plowed, and to harrow or drag it after each rain. In this way weeds may be kept down, and an earth mulch may be kept, so that the soil moisture is conserved.

2. *Depth of Plowing the Soil.*—This has an important bearing upon the economic yields and returns of wheat. At the Kansas Agricultural Experiment Station an experiment to show the effect of depth of plowing gave the following results:[1]

Date of Plowing	Depth	Cost of Preparation	Yield Bu.	Value	Balance on Acre
July 15 . . .	7 inches	$5.35	27.22	22.22	$16.87
July 15 . . .	5 inches	4.05	22.77	18.58	14.53
July 15 . . .	3 inches	4.85	20.7	17.10	12.25

This experiment seems to warrant the conclusion that when the soils were plowed July 15th, a depth of 7 inches plowing gave the best results. Plowing less than 4 inches deep or deeper than 7 inches has not been found economic. Subsoiling has not met with success in wheat production. However, depth of plowing and time of plowing are important in economic wheat production.

[1] *Bulletin No. 176.*

Very often wheat is sown on corn land. If the corn has had a good seed bed, and has been well cultivated, a good seed bed for wheat can be easily and cheaply prepared.

Methods and Depth of Seeding. — There are in common practice two methods of sowing:

1. Drilling 2. Broadcasting

Drilling wheat is the general practice all over the United States; *broadcasting* is still practiced in some sections. It has been proved that the harvests from drilled wheat are from 2 to 5 bushels more on an average than from broadcasted wheat. The reasons for this are:

FIG. 5. — A wheat drill properly used reduces the cost of wheat production.

1. All kernels are evenly covered with moist soil and therefore germinate evenly.

2. Wheat standing in the drilled furrows does not winterkill so easily.

3. The drilled wheat does not heave out of the soil so easily on account of freezing and thawing.

4. The drilled furrows aid in holding the snows.

Wheat should be drilled just deep enough to be well covered with moist soil. In a well-compacted soil, drilling from one inch to $1\frac{1}{2}$ inches is deep enough to insure the most rapid germination. In very loose, dry, cloddy soils, wheat should be sown about 3 inches deep.

Rate of Seeding. — There has been a tendency to reduce the amount of seed wheat sown. The amount that needs to be sown depends upon time, soil, and season. If soil and season are favorable, less seed will be needed. But if wheat is sown late, it is advisable to sow a larger amount. On 8 plots, where from

3 to 8 pecks of wheat were sown, the variations in yields were about 4 bushels. The plot where 3 pecks were sown yielded the least, and where $5\frac{1}{2}$ pecks were sown the yield was the most. At five stations covering an aggregate of a large number of trials, it was found that from 6 to 8 pecks of seed wheat sown produced

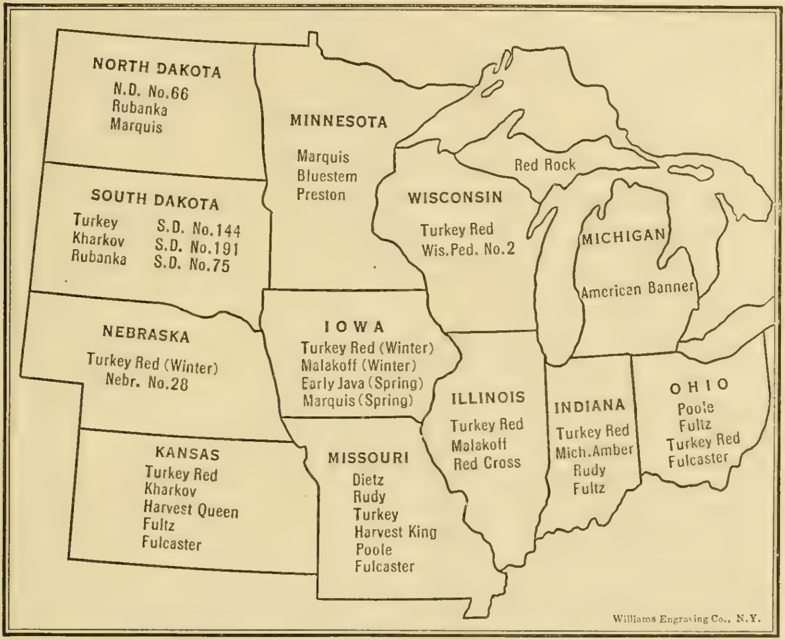


FIG. 6. — Wheat varieties your State Experiment Stations recommend. Write to your station.

the largest yields. So the general statement may be made that from 5 to 8 pecks per acre should be sown, depending upon soil conditions, the size of kernels, the season, and the time of sowing.

Large Heavy Seed Wheat Increases the Yield. — Experimental evidence from a number of experiment stations clearly indicates that large, plump, heavy kernels of seed wheat give better yields than do small, shriveled seed kernels. Good seed produces from 2 to 5 bushels an acre more than poor seed. If it is true that the wheat yield can be increased from 10 to 20 per cent by sowing good seed, it is advisable to use the fanning mill to remove all small, shrunken, cracked, and shriveled grains.

Some wheat is more productive than other wheat. Select that wheat which has produced the best results. Your state experiment station has found that the varieties indicated in the map (Fig. 6) produce the largest crops, and recommends them as the best varieties to use in your state.

Wheat varieties growing side by side vary a great deal in their powers of reproduction. It was found many years ago (1857) that by selection the wheat yields could be increased. Here are the facts:

		Length	Number Kernels	Number Heads Due to One Kernel
First year	Original head	$4\frac{3}{8}$ in.	47	
Second year	Best head raised	$6\frac{1}{4}$ in.	79	10
Third year	Best head raised	$7\frac{3}{4}$ in.	91	22
Fourth year	Heads imperfect			39
Fifth year	Best heads	$8\frac{3}{4}$ in.	123	52

From this it will be seen that by the fifth generation the heads were almost twice as long, had more than twice as many kernels, and that there was five times as much stooling. The most productive plants should serve as the basis for seed wheat. (See Exercises 5 and 6.)

Cultivating Wheat. — When wheat is sown in the fall it is often profitable to harrow the ground the following spring. Harrowing is especially beneficial when the soil is covered with a dry, hard crust. Breaking the crust, making a soil mulch and so conserving the soil moisture, often increases the harvests from 4 to 7 bushels an acre. Harrowing should be done only along the drilled rows, never crosswise.

When the ground is heaving, on account of thawing and freezing, rolling may prevent the roots of the wheat plants from being broken by the frost. If smaller grass seeds have been sown in the wheat, rolling helps both the wheat plants and the grass seeds.

Harvesting Wheat. — The hand sickle, the cradle, the reaper, the self-binder, the header, and the combined harvester and thresher, are the historical emblems of the evolution of the wheat industry. Milling machinery has undergone even greater changes. Wheat is harvested the year round, in different parts of the world. Argentina and New Zealand harvest their wheat in January; East India, Egypt, and Chile, in February and March; the United States, France, England, and Germany, in June, July, and August; and Africa and Peru in November.

Sometimes when wheat is cut it is put into shocks; at other times it is threshed when it is cut. Stacking wheat is a common practice in many sections of the United States. When wheat is stacked it usually goes through a sweating or a heating process which takes out much moisture from the kernels and improves the quality. Wheat, after it is threshed, should be stored in a dry, cool place, because insects do not thrive in cold places. Granaries should, therefore, be built in dry, exposed places. (See Exercise 7.)

Uses of Wheat. — From the manufacture of wheat, many food products are obtained, — breakfast foods, bran, wheat middlings, and flour. There are three wheat flours, — *white flour*, *whole wheat flour*, and *graham flour*.

White flour, the kind generally used, is made from the wheat kernel from which the bran and germ have been removed.

Whole wheat flour contains all the parts of the wheat kernel except the larger particles of bran.

Graham flour is made from the whole grain, and is unbolted. There is another kind of flour called macaroni flour, which is made from Durum wheat.

Wheat middlings, a by-product in the manufacture of flour, is composed of the bran covering and the germs of the wheat kernels. It contains much protein and is therefore a splendid food for cattle, hogs, and horses. Wheat bran is simply the outer coat of the wheat and is used as a feed for stock.

Wheat straw, which contains little protein and little fat, and much woody fiber, is hard to digest, but it may be used as food for cattle, horses, and sheep that are roughed through the winter, and for this reason should be carefully stacked or baled for winter use. A small amount of cottonseed meal or other food rich in protein, fed with the wheat straw, will generally bring economic returns. (See Exercise 8.)

Enemies of Wheat. — The two important enemies of the wheat crop are fungous growths and insects. It is said that they destroy sometimes as much as one-fourth of our yearly wheat crop. And often a farmer loses his entire crop as a result of their ravages.

The fungous growths are smuts and rusts. There are two kinds of smuts: the loose smut, and the stinking smut. The loose smut converts the entire wheat head into a black powdery mass; the stinking smut attacks the kernels only. If a kernel of wheat that has stinking smut be cut open, no starchy material will be found. Instead, there will be a black smutty material. Wheat smuts or oat smuts may be largely controlled by the use of a formaldehyde solution. Mix one pound of formaldehyde with fifty gallons of water. Spread the wheat or oats on a floor. Then sprinkle the seed thoroughly, until every kernel is well moistened. The seed wheat should be turned over and over with a shovel while it is being treated.

As soon as the seed is well moistened, cover with a canvas for six to ten hours. This will keep the formaldehyde fumes around the kernels. Then spread the wheat out to dry. When dry, it is ready to sow.

Rusts attack the leaves and stems of the wheat plant. They

FIG. 7.—The formalin method of treating wheat for smut.

flourish in damp, cool weather, and sometimes destroy nearly the entire crop. There is no effective remedy for rusts.

The two chief insect enemies are the Hessian fly and the chinch bug. It is estimated that Hessian flies cause an annual loss of over four million bushels. The adult Hessian fly resembles a mosquito. It lays its eggs on the young wheat plant. When the eggs hatch, the young crawl down between the leaf sheath and the stem, and make their winter home near the joints of the wheat plant. In a few weeks they change into a pupa stage, — generally spoken of as the flaxseed stage because they look like a flaxseed. In this form they remain for the winter. In the larva stage and after the pupa stage, they weaken the wheat stem to such an extent that it usually falls down several days before the crop matures. There are two broods of Hessian flies. One of these hatches in the springtime, and the other about wheat sowing time in the autumn. If a trap crop of wheat is sown three or four weeks before the regular crop, they will gather in this and may be plowed under and the soil rolled so that the flies and eggs will be destroyed. Sowing the wheat crop about ten to fourteen days later than the regular seeding time will also generally evade the Hessian fly, for the females will have gone before the wheat crop comes up.

FIG. 8. — An adult Hessian fly, an injurious insect of wheat.

The chinch bug reduces the wheat yields by sucking the sap from the wheat plant. There is no way to destroy them while they are in the wheat, but, as soon as the wheat is cut, they begin to migrate on foot to the near-by oat and corn fields. Six or eight feet of plowed soil finely pulverized, with one deep furrow in it, will obstruct their progress. Sometimes a hole about two feet deep is dug in the furrow. The bugs fall into this hole. Sometimes kerosene is poured into the hole. After the summer is over the chinch bugs hibernate in the grass, fence corners, and other rubbish. Cleaning up and burning all rubbish is the best way to prevent them the following spring.

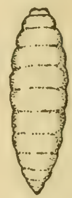


FIG. 9. — Hessian fly larva before flaxseed stage is reached. Found upon the back of leaves of the wheat plant.

Every female chinch bug destroyed in the winter or early spring is equal to from two hundred to three hundred chinch bugs destroyed in early May, and from forty to sixty thousand in August.

The grain weevil is very destructive to stored grains. Carbon bisulphide set in an empty dish evaporates and settles to the bottom, because it is heavier than air. The carbon bisulphide destroys the weevils. Use about one pound of carbon bisulphide for every two thousand pounds of grain. (See Exercise 9.)

Summary. — Wheat and wheat products have been the staff of life since prehistoric time. It is such an important crop that it is grown all over the world, and is harvested in different parts of the world every month of the year. Better methods of culture, more care in selecting seeds, and greater precautions taken in combating the enemies of

FIG. 10. — The chinch bug and its progeny. These bugs multiply rapidly.

wheat, will aid in making the wheat crop more productive and profitable.

LABORATORY EXERCISES

1. **A Wheat Survey of the School District.** – Every pupil in the school may help in taking this survey. Secure the following data from every farmer of the district. Have pupils keep data in a notebook, and leave a permanent record in the school. Record as follows:

Name of Farmer	Acres in Farm	Acres in Wheat	Per Cent of Farm in Wheat	Variety of Wheat

2. **To Find the Gluten Content of Soft and Hard Wheat Flour.** — Weigh about 50 grams of each flour named. Make each batch into a thick dough by adding water and working. Then wash each until the starch has been washed out. Set away for several days to dry. When dry, weigh the dough. Divide this weight by the original weight. This will be the per cent of gluten. Record results.

3. **To Study the Cost of Wheat Production.** — Have pupils, with the help of their parents, figure the cost of production of an acre of wheat, using the same items as those given in this chapter.

4. **To Find the Cost of Each Implement Used in Wheat Production.** — Find the cost of each tool and machine used in wheat production. Itemize the charge for each implement used. Find total charge for each implement used. Find total charge for all tools used. If tools last ten years, what is the depreciation of each one yearly?

5. **Germinating Test of Good and Poor Wheat Kernels.** — From a sample of wheat, sort out fifty good, plump, heavy kernels, and fifty poor, shriveled,

light kernels. Germinate each by placing between moist blotters placed in a plate. Maintain proper conditions for germination. Record your results.

6. To Study Kernels of Wheat.

DESCRIPTION OF GRAINS OF WHEAT. CHECK CHARACTER THUS: √

	Variety				
	Fultz				
1. Hardness					
1. Very hard flinty.					
2. Medium	√				
3. Soft					
4. Very soft starchy					
2. Appearance of cross section . . .					
1. Very horny					
2. Horny					
3. Starchy	√				
4. Very starchy					
3. Color					
1. Red					
2. Medium red					
3. White	√				
4. Plumpness					
1. Plump					
2. Medium plump					
3. Shriveled	√				
5. Cheeks					
1. Full and plump					
2. Flat and thin					
6. Crease	√				
1. Very deep					
2. Medium deep					
3. Shallow					
4. Very shallow	√				

7. To Score Wheat.

SCORE CARD. WINTER WHEAT

Scale of Points	Sample						
	Standard						
1. Uniformity of kernels	10						
2. Color and purity	10						
3. Size and plumpness of kernels	15						
4. Hardness	15						
5. Per cent foreign matter	15						
6. Soundness	20						
7. Weight per bushel	15						
Total	100						

Explanation of the Score Card.

1. *Uniformity* (10). — To secure full score the kernels in the sample should be characteristic of the variety, similar in shape, and practically of the same size.

2. *Color and Purity* (10). — The kernels should be clean and bright in color, characteristic of the variety. If the sample contains kernels different in shade of color from the majority, cut one point for each two per cent of these present.

3. *Size and Plumpness of Kernel* (15). — The size of the kernel is important both from the farmers' and millers' standpoint. The kernels should be large, plump, and well filled; the crease narrow and deep; the cheeks well rounded. Cut one point for each two per cent of small or shriveled kernels found.

4. *Hardness* (15). — The grains should be hard and horny. Hardness is determined by cutting a number of grains in cross section. If the majority show white and starchy, give a rather low score.

5. *Per Cent of Foreign Matter* (15). — The sample should be free from all weed seed, dirt, and other foreign matter. Cut one point for each weed seed found, and according to judgment for other foreign matter.

6. *Soundness* (20). — The sample should be free from all broken,

sprouted, smutty, or musty kernels. The bran should not be cracked, blistered, weathered, or streaked. Separate these from the sample and estimate the per cent. Cut one point for each per cent present.

7. *Weight per Bushel* (15). — A good wheat sample should weigh 60 pounds per bushel. Deduct two points for each pound below the standard.

8. **Soil Fertility Removed by Wheat.** — If a man raises 21 bushels of wheat on an acre, how much nitrogen, phosphorus, and potash is taken out of the soil? What is the money value of the fertility removed? A bushel of wheat weighs 60 pounds. Figure this on the actual number of bushels raised by the farmers of your locality.

9. **Language Lesson on Wheat Production.** — Write a four hundred word paper on How Wheat is Grown on Your Home Farm or Elsewhere.

CHAPTER II

CORN

Importance of the Corn Crop. — Between 3,000,000,000 and 4,000,000,000 bushels of corn are produced in the world annually. Of this amount approximately 78 per cent is produced in the United States. Austria produces 3.6 per cent; Argentina, 4.0 per cent; and Mexico, 2.5 per cent. The rest of the world produces the other 12 per cent. Corn ranks highest in both money value and food value of any farm crop grown.

The money value of the corn crop of the United States is large. If corn is valued at 50 cents a bushel, the corn crop of the United States will annually average about $1,500,000,000. This is approximately $15.00 for each person in the United States. Corn is grown in almost half of the acreage devoted to cultivated crops. "Corn is King." The table on page 25 will indicate the comparative importance of corn in American agriculture.

Corn, in 1915, occupied 42.3 per cent of the tilled crops above indicated; wheat, 23.4 per cent; cotton, 11.3 per cent; and oats, 16.4 per cent. Hay, not classified as a tilled crop, occupied 20 per cent of the land used in the production of the above crops. (See Table on page 25. See Exercise 1.)

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Stalks of dent, pop, and sweet corn, several ten ear samples of the leading varieties of dent corn, a corn tree, a seed-testing box filled with sand, a few yards of white muslin for making rag-doll tests, a bucket, and a pair of trip balances weighing to grams.

Acreage, Yield, and Value of the Leading Farm Crops of the United States for 1915[1]

Crop	Acreage	Yield	Value in Dollars
Corn . .	108,321,000	3,054,535,000 bu.	$1,766,859,000
Wheat . .	59,898,000	1,011,505,000 bu.	930,302,000
Hay . . .	50,872,000	88,225,000 tons	912,320,000
Cotton . .	30,957,000	16,134,930 bales	887,221,000
Oats . .	40,780,000	1,540,362,000 bu.	555,569,000
Potatoes .	3,761,000	359,103,000 bu.	221,104,000
Barley . .	7,395,000	237,009,000 bu.	122,499,000
Tobacco .	1,368,000	1,060,587,000 lb.	96,041,000
Rye . .	2,856,000	49,190,000 bu.	41,295,000
Rice . .	802,000	8,947,000 bu.	26,212,000
Total .	256,380,000		$5,528,342,000

History of Corn. — Corn is a native of America. It is believed upon good authority that the Indians of Old Mexico and Central

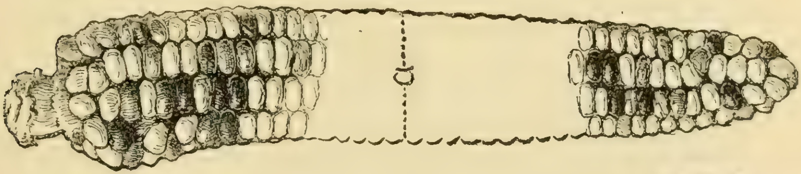


Fig. 11. — A far advanced link in the evolution of our splendid varieties of corn from Indian maize grown by the inhabitants of New Mexico. A section through the ear at *a* is shown below.

America have raised and used corn for about two thousand years. Columbus wrote a letter to Ferdinand and Isabella in 1498, saying, "During my journey in the interior I found a dense population entirely agricultural, and at one place passed through eighteen miles of corn fields." Columbus introduced corn into Spain, and from there it was distributed

[1] *United States Yearbook of Agriculture.*

in turn to France, Italy, Switzerland, Hungary, and Austria. From these countries it was scattered over the entire world.

Types of Corn. — There are six types of corn: dent corn, flint corn, pop corn, sweet corn, soft corn, and pod corn.

Dent Corn gets its name from the dent at the crown of the kernels. This indentation is caused by the shrinking of the crown starch in drying during the maturing process. Dent corn, of which there are more than one hundred varieties, constitutes more than 90 per cent of all the corn raised.

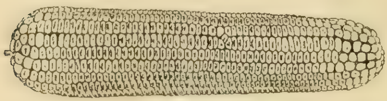


Fig. 12. — An ear of dent corn. Years of evolution intervened between this ear and the one shown in Fig. 11.

Flint Corn is a small, hard, flinty, early maturing type. Because it matures early, it is grown in the New England States, and other parts of the world where the spring and summer are short. Although flint corn is not as productive as dent corn, the New England farmers secure larger yields an acre than do the farmers in the "corn belt" states.

Pop Corn is grown for household use. This type has small kernels and ears, and will pop easily. Popping is caused by the explosion of the heated moisture contained in the kernels.

Sweet Corn, produced also for household use, has a sugary composition, shriveled covering, and a glassy appearance.

Pod Corn is the ancestor of all our varieties of corn. Each kernel of this corn is covered by little husks. It is thought that the little scales which form the place in which the kernels grow in our corn are the remnants of the husks on the kernels of pod corn. The ears of pod corn are also covered by husks. This variety is grown as a curiosity only at the present time.

Soft Corn is not grown in the United States. It is a soft, white, starchy corn, and lacks the hard horny portion we find in our dent varieties. (See Exercise 2.)

The Corn Plant. — Corn belongs to the grass family because it possesses fibrous roots, a jointed stalk, and veins running the long way of the leaf.

Corn has two kinds of roots: *feeding roots* that gather plant food from the soil, and *brace roots* that grow from the first two or three joints of the corn plant, and prevent the stalk from being blown down. The feeding roots naturally develop first; the brace roots develop after the corn plant has almost attained its growth. Eighty per cent of the roots grow within 4 or 5 inches of the surface of the soil.

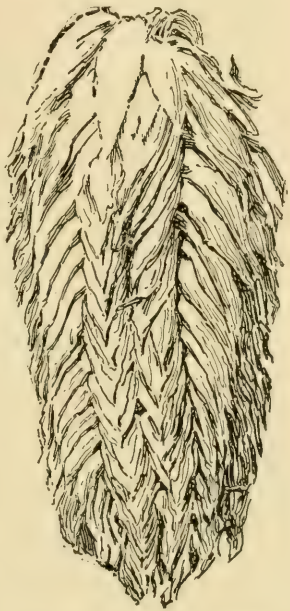


FIG. 13. — Pod corn — the supposed ancestor of all groups and varieties of corn.

The healthy stalk is of medium height and tapers from the ground to the tassel. If we examine closely a stalk of corn, we shall see that it consists of joints called nodes, and sections between the joints called internodes. If we cut the stalk through lengthwise, we shall find that the internodes are filled with a soft, pithy substance, in which there are a number of little threads which run to the nodes. These threads are a part of the veins of the circulatory system of the plant by which the water passes through the leaves from the ground. If we look closely we shall notice a small groove on one side of the internodes. This helps to strengthen the stalk.

The leaves grow from the joints on alternate sides of the stem, clasp firmly around the internode, and extend almost straight out from the stalk.

The corn plant has two sets of flowers, the tassel at the top of the stalk, and the silks on the ear. The tassels produce pollen grains, which fall upon the silks, and throw out a pollen tube into the hollow silk. When the pollen tube has grown to the place where the kernel is to be formed, fertilization is said to have taken place, and the kernels begin to grow. Very dry or very wet weather may hinder fertilization. Because the tassel matures its pollen several days before the silks appear, corn has to depend largely upon surrounding plants for fertilization. For this reason a stalk growing alone seldom has much corn on it.

From fifteen to twenty million pollen grains may be borne on one corn plant. These may be carried by the wind or by insects a quarter of a mile or more. Thus it happens that we sometimes see yellow kernels on white ears of corn, or white kernels on yellow ears. This is caused by cross fertilization.

Place of Corn in American Agriculture. — There are three reasons why corn holds an important place among our crops:

1. It will grow in many different soils, conditions, and climates. It grows in the warm, long summers of Central America and Mexico, and also in the short summers of the Northern States and Canada. The time required for ripening varies, according to the type of corn is from eighty days in the North to two hundred days in the South.

2. Corn produces more food on an acre than any other cereal crop. So it is grown in almost half the acreage devoted to cultivated crops.

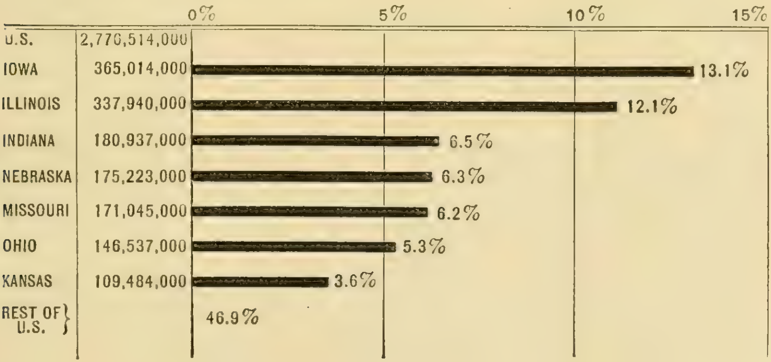
3. Corn holds an important place in our agriculture because it fits into our systems of crop rotations, and is easily grown. In regions where only one crop is grown, — for instance, wheat in the North, cotton in the South, — corn has found a place, and is rapidly becoming more popular, because, being a cultivated crop, it helps to eradicate weeds and insects.

AVERAGE YIELD, NUMBER OF POUNDS, TOTAL DIGESTIBLE FOOD, AND MONEY VALUE OF CORN, WHEAT, AND OATS, 1905 TO 1915, INCLUSIVE[1]

	AVERAGE YIELD PER ACRE, BU.	AVERAGE YIELD IN POUNDS	TOTAL DIGESTIBLE FOOD PER ACRE, POUNDS	MONEY VALUE PER ACRE
Corn	26.6	1490.0	1286.5	$14.92
Wheat . . .	15.0	900.0	720.0	13.02
Oats	30.0	960.0	672.0	11.82

It will be observed from the above table that corn on an average produces much more digestible food per acre than does wheat or oats.

The Corn States. — The seven states, Iowa, Illinois, Indiana, Nebraska, Missouri, Ohio, and Kansas, are known as the "corn belt" states. Their average yearly corn production recently for five years was as follows:[2]



GRAPH 3. Corn production in bushels.

These seven states raised in the period mentioned more than 53 per cent of all the corn produced in the United States.

[1] Figures based upon *United States Yearbooks of Agriculture*.

[2] Data for 1912 to 1916 taken from the *United States Yearbooks of Agriculture*.

Iowa, Illinois, and Indiana during the same time produced almost one-third of the total corn crop. Nevertheless it should be stated that the three states having the highest yields an acre were Connecticut, Massachusetts, and Pennsylvania. The average yield in these states was 37.8 bushels. In the South, where long seasons prevail and the temperature and rainfall are more suitable, the highest production is possible.

Cost of Corn Production. — The cost of production and the profit or loss from an acre vary, of course, for the different sections of the United States. It has been estimated that it costs about $12 to produce an acre of corn.[1] The items of cost in production are as follows:

1. Land rental or interest	$ 3.75
2. Preparation of land	2.11
3. Seed	.24
4. Planting	.44
5. Cultivation	2.24
6. Fertilizer	.62
7. Harvesting	2.20
8. Miscellaneous	.47
Total	$12.07

It must also be remembered that the production of corn takes from the soil much fertility, especially nitrogen, phosphorus, and potash.

Nitrogen, phosphorus, and potash are worth about eighteen, six, and six cents a pound, respectively. Consequently if 18 bushels of corn are removed from an acre, the values of fertilizing constituents taken off are

16 × 18 cents	$2.88
6.9 × 6 cents	.414
4 × 6 cents	.24
Total	$3.534

This fertility value added to the cost of production ($12.07 + $3.534) actually makes the cost of production $15.504. The

[1] *Crop Reporter* (April, 1911), published by United States Department of Agriculture.

question presents itself in this way — Can 40 acres of corn be produced for $620.00? In the above items the depreciation on machinery, cost of keeping a team the entire year, and the time the labor was not employed, were not counted. According to the report above quoted, it was found that the average value of corn per acre in the United States was $12.53. How can we improve our yields?

It costs almost as much to till an acre of corn that produces nothing as it does to till one that produces 70 bushels. If 30 bushels of corn offsets the cost of production, then one acre producing 40 bushels yields as much profit as 2 acres producing 35 bushels an acre. For in each case we have only 10 bushels left after the cost of production has been canceled. And one acre of corn, according to above figures, producing 70 bushels would be equal to 7 acres producing 35 bushels an acre; that is, after the first 30 bushels required for the cost of production in each case is canceled. (See Exercises 3 and 4.)

The Ear. — The size of an ear of corn depends upon the length of seasons. Where the season is long, the ear will be longer and larger than where the seasons are short. In the "corn belt," a good ear is from 9 to 10½ inches long, 7¼ to 7½ inches in circumference, and weighs about 8 ounces. It is cylindrical and tapers but little from butt to tip. The butt should be cup-shaped and almost covered with uniform kernels of corn. Such an ear will shell a high percentage of corn.

The kernels should be free from mixture with corn of other colors. In white corn a foreign mixture discolors the sides, in yellow corn it discolors the crown. A mixture of varieties of the same colors is difficult to detect, but this should also be avoided unless a new variety is wanted. The cob should show the color characteristics of the variety. In all white varieties except St.

Charles White, which has a red cob, the cob generally is white; in all yellow varieties the cob is red.

An ear of corn should be well matured and in good market condition. An ear that is poorly covered at the tip and that has loose grains is immature. Ears that are worm-eaten, decayed, or discolored are in poor market condition. The man who buys corn for feed or uses it for seed must heed the points on maturity and market condition.

The kernels of an ear of corn should be wedge-shaped, fit closely together in the rows, both at the crown and the tip; a good kernel

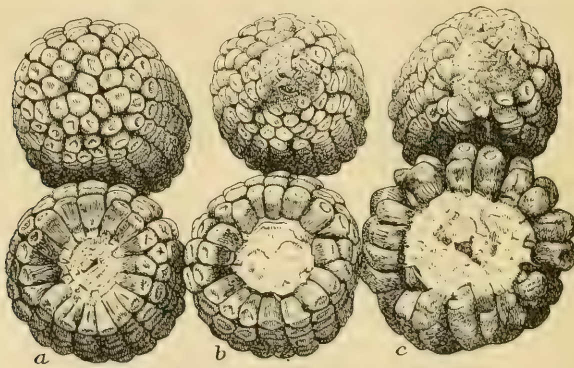


FIG. 14. — Tips and butts of corn: *a*, good; *b*, fair; *c*, poor.

is about one and one-half times as long as it is wide. The kernels should be uniform in size, shape, and composition, and should be of a bright healthy color, full, smooth, bright, and oily. The germs should be large, for kernels with small germs have a low feeding value for both animals and growing plants.

The cob should be of medium size, about twice as thick as the kernels are deep. Too large a cob gives a small amount of shelled corn, and too small a cob produces a small yield per acre. (See Exercise 5.)

Ten Ear Samples of Corn. — In exhibiting corn it is customary to show samples of ten ears. Each ear should have the characteristics of the ear described in the last paragraph. The ears should be uniform in length, shape, circumference, color of kernel and cob, indentation, and kind of kernel.

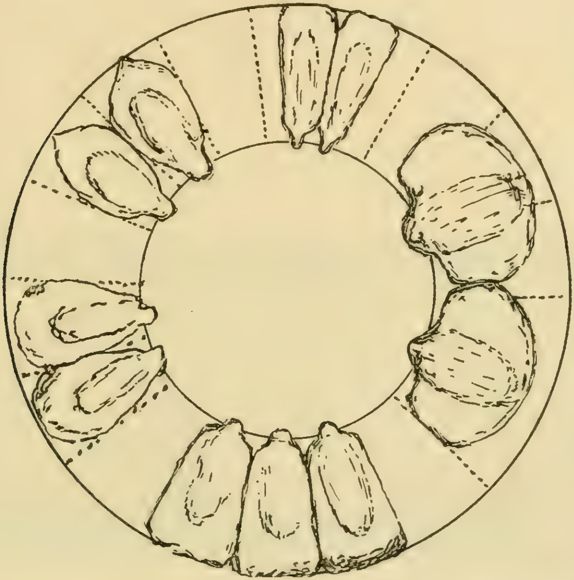


FIG. 15. — Various shapes of corn kernels. Lower kernels are well shaped; all others are poorly shaped. The lower kind will shell out the highest per cent of shelled corn.

If the ears are alike and all good, it shows that they have been obtained from several years of growth of the same strain of corn, and is a feature of improved corn.

In judging a ten-ear sample, two kernels should be taken from each ear and laid with germs up, just before the ear. They should be uniform in germs, shape of kernels, and color. (See Exercise 6.)

Larger Returns from Corn. — The important factors in producing larger yields with less land and less work or cost are as follows:

1. Seed selection.
2. Seed testing.
3. Cultivation.
4. Methods of harvesting and feeding.

Methods of Seed Selection. — There are three methods of seed selection: out of the crib; when corn is gathered; from the field when corn is maturing.

1. Selecting seed corn out of the crib in the spring is not a good practice, for then the germination power is often lowered and

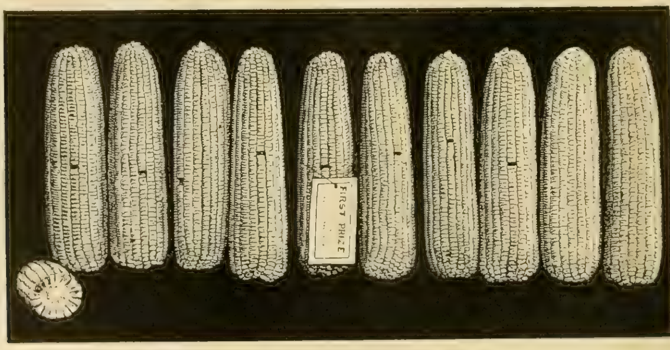


FIG. 16. — Ten ear samples of corn. A good sample of market, show, or seed corn. These ears show corn improvement.

sometimes actually destroyed. How does it happen that the germination power is destroyed? Corn when husked contains from 25 to 50 per cent moisture. The cold of early fall freezes the moisture, which by expansion breaks the germs. This kind of ear is called frost-bitten, and cannot be told at sight. The planting of one frost-bitten ear causes a loss of from eight hundred to nine hundred stalks or 7 to 8 bushels of corn. If the frost does not entirely destroy the germ, it will take away much of its strength. For this reason every seed-corn poster says, " Be sure to air dry, preferably, or store dry seed corn early in the fall." Selecting seed corn from the crib has also another disadvantage. We are unable to know upon what kind of stalk the ear grew. The ideal stalk should have a medium height, taper from ground to tassel, and indicate strength. Cornstalks as well as cows and horses have constitutions, and show vitality.

2. The second method of selecting seed corn when it is gathered is better than the first, but it too has disadvantages. The desirable ears are thrown at gathering time into a separate box, but there is no way of knowing the time when each matured. The number of days required for corn to mature from the time it came out of the ground up to the time it is gathered should be carefully noted. One variety may vary as much as 15 to 20 days. This is very important in seed selection and cannot be ascertained if seed corn is selected at gathering time.

3. By the third method of early fall seed corn selection, the farmer goes into the field and gathers about twice the amount of seed corn actually needed the following spring. By this method, the stalk, the ear, the conditions under which the plant grew, its powers of production, and the maturing qualities of the plant can all be observed. The stalk and ear that mature early and possess the other good points are best. Select a seed ear from a stalk that has two good ears on it instead of only one. Select an ear grown on a stalk where there are three plants in a hill instead of one grown in a hill of only one stalk. If the plant grew under adverse conditions and still is equal to other plants grown under more favorable conditions, it is preferable for seed. Poor seed corn means wasted land and wasted labor.

Storing Seed Corn. — After seed corn has been selected, it should be allowed to air dry, and then be kept in a fairly warm place for the winter. The seed corn may be either hung on a "corn tree," or a "binder twine seed hanger," as shown in Fig. 17. The kitchen attic, or any place with open windows, is good for drying corn. After the corn is dry it should be kept in a moderately warm, dry place for the winter. (See Exercises 7 and 8.)

Reasons for Seed Corn Testing. — The average corn yield in the United States is about 27 bushels an acre. If the seed corn is

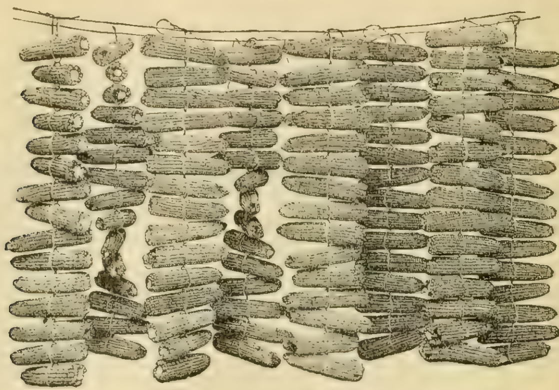


FIG. 17. — The right way to hang up seed corn.

tested, this yield can be increased, for it has been estimated that generally there is only one-half or three-quarters of a stand. The United States Government has demonstrated that, by seed selection alone, the yield of corn in the United States can be increased 20 per cent. In Iowa the average stand is not more than 62 per cent.[1] The average yield in Iowa from 1902 to 1912 was 347,790,000 bushels. If there had been a perfect stand, the yields yearly for the ten-year period would have been 560,957,000 bushels; or a difference of 212,161,000 bushels. Its value at 50 cents a bushel would be $106,081,500. This is approximately the

[1] *Iowa Bulletin, No. 135.*

value of the entire corn crop of Missouri. Similar conditions pertaining to a stand will be found in other states.

It has been shown also that vigor of germination has a large effect upon yielding power. Tests have shown that corn showing strong germination will yield 80 bushels an acre, medium germination 40 bushels, and weak germination 20 bushels an acre. An ear, therefore, that germinates with little vigor should be thrown out. Annually from one-third to one-half more land is plowed and tilled than would be necessary to get the same yield if perfect stands were secured.

Seed corn should be carefully graded in order that the planter may drop the same number of kernels each time. This helps in getting an even stand. The reason we test and grade seed corn is to lessen waste of land and labor.

Methods of Testing Seed Corn. — The "germination box" and "rag doll" methods are usually employed to test seed corn. However, under proper conditions it may be tested in the soil outdoors. The germination box, 20 × 20 inches, and 4 or 5 inches deep, is filled with coarse sand or sawdust, over which a white cloth marked into 2-inch squares is laid. The squares may be numbered from one to one hundred. Six kernels taken from different parts of the ear are placed in the squares. The ear is marked according to the number of the square upon which the kernels are laid. A dry cloth is placed over the seeds. Then about one-half to one inch of sand is thrown over the cloth, and another cloth is placed over the sand. In about six to eight days the test is ready, if the conditions for germination have been right. These conditions are: proper temperature (about 70° to 80° Fahr.), proper supply of moisture, and free oxygen. Unless every kernel germinates, the ear should be discarded.

In the rag doll test, a white muslin cloth is marked into 2-inch squares, and six kernels of corn are laid on each square.

The square and ear from which the kernels are taken are labeled correspondingly. The cloth is rolled up not too tightly and a string is tied around it. The lower end of the rag doll is then set in a bucket containing about two inches of water. Keep the bucket covered. If conditions are favorable for germination, the test will be ready to read in about eight days. (See Exercises 9 and 10.)

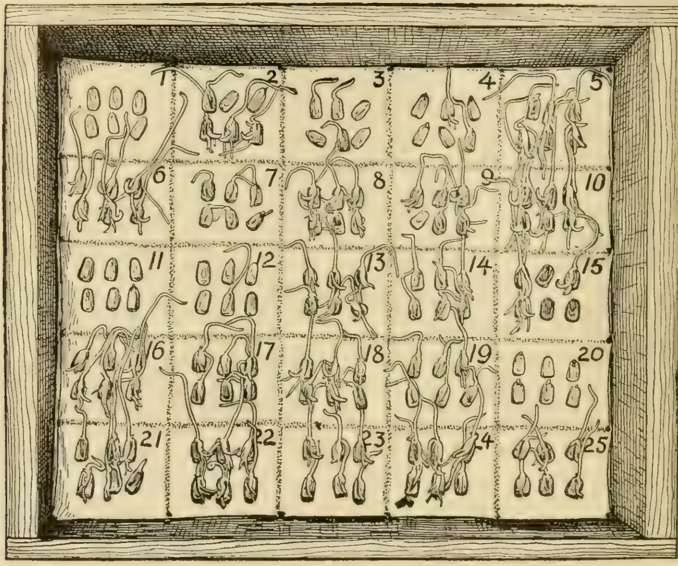
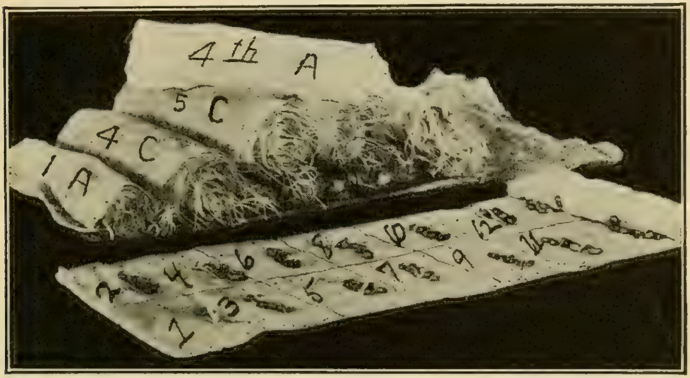


FIG. 18. — Germination test of different ears of corn. Discard ears 1, 2, 3, 4, 5, 7, 9, 11, 12, 15, 20. Selection by test is an important factor in increasing corn yield.

Productive Variations of Corn. — Plants and animals vary in their yielding or reproductive capacities. The reproductive capacity of corn has been increased by cultivation. The corn of the Indians produced ears with ten or twelve rows of kernels or less, and with 20 or 30 kernels in a row. One stalk and one ear were usually produced in a hill. This would mean corn production at the rate of about 200 to 300 kernels per hill, about

7 or 8 bushels an acre. We have increased the yield to 30, 40, or 50 bushels an acre. But it is possible to increase our yields still more by selecting corn that is prolific. We find sometimes three or four plants growing in the same hill, under the same conditions. One stalk may have a nubbin, and another stalk in the same hill may have two good-sized ears. There may be 300 poor quality kernels on the one stalk, and 1800 to 2000 good kernels on the other. The one is producing corn at the rate of

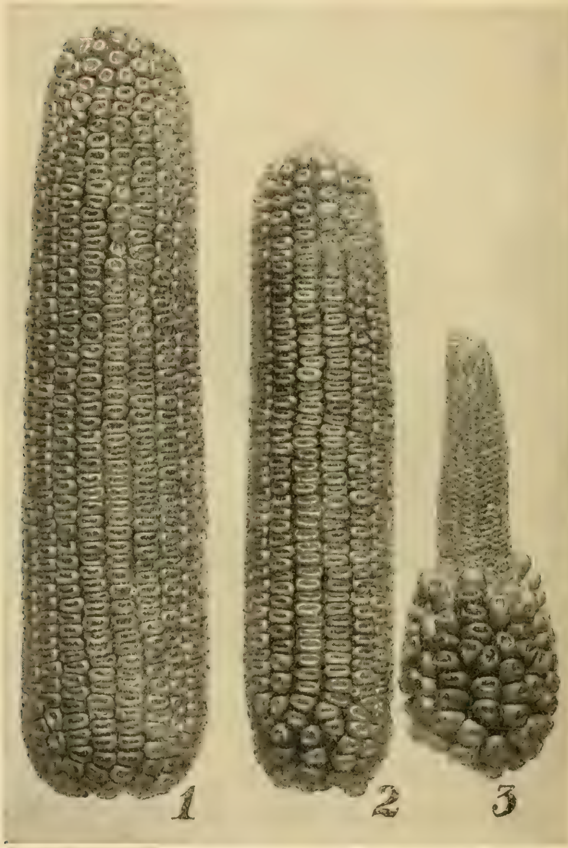


Courtesy Iowa State College.

FIG. 19. — The "rag-doll" seed tester. 1, 2, 3, 4, etc., correspond to the numbers on the ears; 1 *A*, 4 *C*, 5 *C*, etc., correspond to numbers on the strings of ears.

about 7 bushels to the acre, and the other is producing it at the rate of 48 bushels an acre.

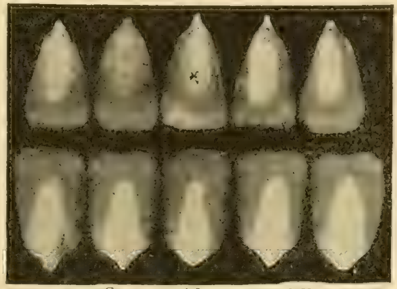
What is the reason for the difference in production? The plants had the same sunshine, the same soil, the same rainfall, and the same culture; so we cannot explain the difference in results from soil, surroundings, and cultivation. The explanation is that the original seed of the two plants came from plants that varied in productiveness. That productiveness is largely a matter of heredity may be clearly seen. The farmer should



Courtesy of the International Harvester Co

FIG. 20. — These three ears came from the same hill. The difference between them is due to the producing power of their parents.

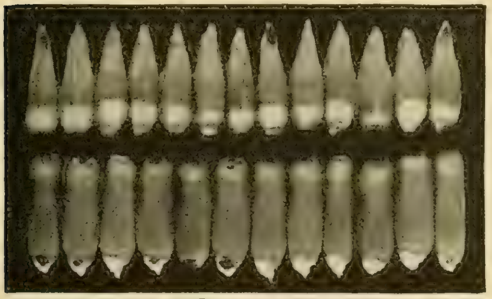
therefore select seed that has inherited yielding capacity. He should take the seed ear from a hill where four stalks grew, rather than from the stalk that grew alone in a hill. Why? He should take the ear from a stalk that bore two ears in a hill of three stalks instead of an ear from a hill of two stalks each of which bore only one good ear. (See Exercise 11.)



Courtesy of International Harvester Co.

FIG. 21. — Good and poor types. The top kernels came from an ear with too much space at cob, indicating low yield, poor feeding value, immaturity. Compare them with the kernels in the bottom row.

Yielding Power of Corn. — Along with the prolificacy of corn should go yielding power. By yielding power is meant the weight of sound, well-matured corn produced an acre. The corn must also have a high feeding value. One ear of corn weighing 8 ounces to a hill will produce a yield of 26 bushels an acre. Such a yield is not large enough unless the corn possesses the best type of kernel and is well matured.



Courtesy of International Harvester Co.

FIG. 22. — If corn is to yield well, it must fit both ways. The upper ones do not fit.

Well-shaped kernels with a large germ contain the best feed, for the germ is rich in fat and protein. In the following table, notice the composition of the germ and of the rest of the kernel.

	Protein	Fat	Carbohydrates	Ash
Germ	20.0	50.0	20.0	10.0
Rest of kernel . . .	10.0	5.0	88.0	1.5

Immature corn does not feed as well, does not keep as well, and is worth less, for it contains more moisture. It will not nourish the new growing plant properly.

The amount of shelled corn to cob depends on the shape and depth of the kernel. In Fig. 21, the poor types will shell out about one-fifth to one-fourth less.

Yielding capacity depends among other things upon the shape of the ear, upon soil, and cultivation. For this we must know the entire story of corn production, and know the varieties that have proved most productive in our locality. The best yielders for your state, recommended by your experiment station, are indicated by the map on the opposite page. (See Exercise 12.)

How Cultivation will Increase Corn Yields. — The time and depth for breaking the soil depends upon the kind of soil, the amount of organic matter, the lay of the land, and the number of insects. These vary greatly and depend upon local conditions to such an extent that they will not be discussed here. But your teacher will tell you the facts about your own county and state.

The principal objects in tilling corn are:

1. To keep down the weeds.
2. To conserve the moisture.

The best time to kill weeds is when they begin to germinate. For this reason corn is harrowed or weeded a few days after it is planted. A weeder or smoothing harrow is used. After the corn is well up, it should be harrowed again. This destroys weeds and also maintains a soil mulch which conserves the moisture.

The depth of cultivation depends upon the growth of the corn. The first cultivation may be deep and close to the corn. Thereafter the cultivation should be shallow, and as the corn becomes larger the depth of cultivation should be decreased, and the

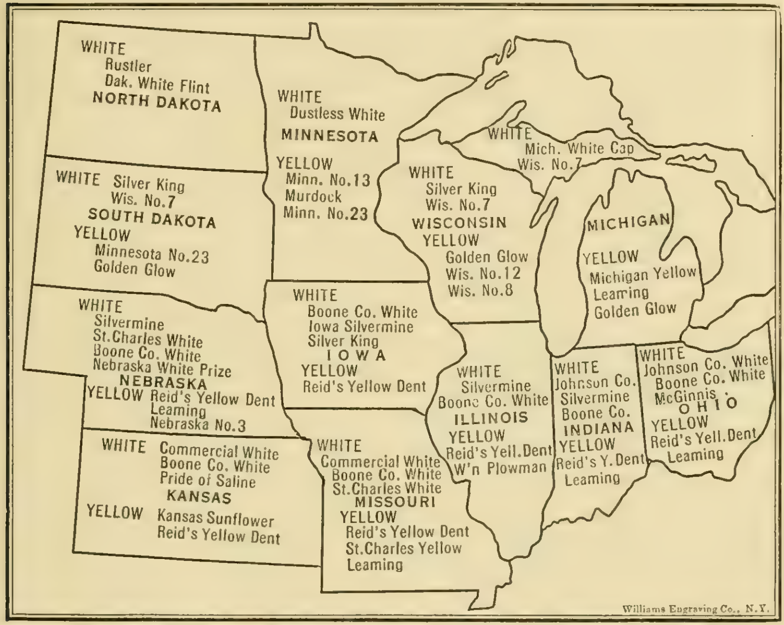
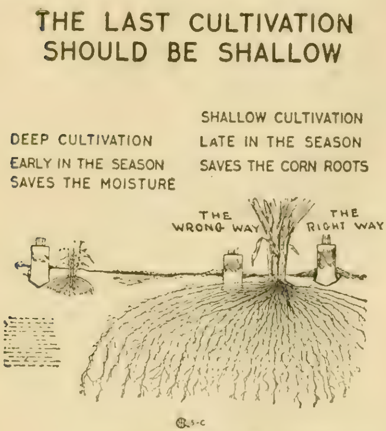


FIG. 23.— Varieties of corn recommended by your State Experiment Stations. Write your station for information on the best varieties for your neighborhood.

shovels be set farther away from the corn. Overdeep cultivation is one of the first causes of reduced yields, because it cuts the roots.

Sixty-one tests of deep cultivation at thirteen experiment stations gave an average of 9.8 bushels per acre less than shallow cultivation of from one to two inches. In most cases, one to two inches has been called shallow, and four or more inches, deep cultivation.

Cultivating the soil frequently does not greatly change the yield. But the crust which forms after a rain must be broken up by shallow tillage as soon as the soil is in good condition. Crusts on the soil soon crack open, and through them soil moisture is rapidly taken out of the soil by sun and wind. Many farmers keep down the weeds and retain the dust mulch, after corn has grown too big to be cultivated with a cultivator, with a one horse tooth-harrow or drag. Level tillage, except in very wet soils and seasons, brings larger yields than ridging. Ridging exposes more surface of the soil, and therefore causes more soil moisture to evaporate, and it breaks many of the corn roots. Generally speaking, ridging is bad farm practice.



Courtesy of International Harvester Co.

Fig. 24. — The last cultivation should be shallow. It provides an earth-mulch and does not break the roots of the corn.

Land and Labor-saving Methods of Corn Harvesting. — Many farmers do not husk their corn crop, but let the sheep, cattle, and hogs gather it. Hogging down corn is a common practice. By this method, little, if any, corn is wasted. Sometimes farmers will fence off small parts of the field by fastening the hog fence wire to the rows of cornstalks. Hogging down corn has the following advantages:

1. It saves the labor and cost of husking.
2. It improves the land, for it leaves all the fertility in the soil.

3. It keeps the hogs healthy and prevents hog cholera.

Animals have more time than man to gather the corn, and like the job better. Why not give them the chance?

Silo with Every Farm. — Every farmer who has 10 head of beef or dairy cattle, 25 or 30 sheep or some mules, should have a silo. An average acre of corn will produce from 6 to 8 tons of silage. Corn yielding 30 bushels an acre will make about 6 tons of silage; and corn yielding 60 bushels an acre will make from 11 to 12 tons of silage. By using a silo, nearly all the food of the corn is preserved. If corn is cut up into fodder, from 20 to 30 per cent of the food nutrients is lost. If an acre produces 9 tons of silage, 3 tons of the food value is lost if it is cut up into fodder. For this reason from one-fourth to one-third more stock can be kept on a given acreage when the corn is put into the silo. Corn fodder during the average winter weather is not liked as well by cattle as silage. A cow will eat 40 pounds of silage, and if given fodder will eat only from 12 to 18 pounds of it. Silage has some other advantages:

1. It has a beneficial effect upon the digestive tract.
2. If provides a succulent (green) feed in winter time.
3. It tones up the entire system of cattle and sheep.
4. Corn can be put into a silo cheaper than it can be husked and shredded.
5. More feed can be stored in smaller space in the silo than in a haymow or shed.

To the dairyman the silo means succulence of pasture all the year round, cheaper feeding, thrifty animals, and increased production.[1] At the Ohio College it was found that 100 pounds of whole milk can be produced at the rate of 68 cents, when silage is fed, and butter at a cost of 13.1 cents a pound. However, when an average feed is fed without silage, it costs $1.95 to

[1] *U.S. Yearbook of Agriculture* for 1912.

FIG. 25. — "Hogging-off" corn. Good for the hogs, good for the land, and saves labor.

produce 100 pounds of whole milk and 22 cents to produce a pound of butter. The same can be said for beef production. Silage and a little cottonseed meal, or clover hay, soybeans, or cowpeas make a well-balanced ration. Moldy silage should not be fed to stock at any time.

The Principle of the Silo. — Foods and feeds are preserved by canning, drying, salting, pickling, cold storage, and the silo. Bacteria and molds that cause decay need heat, moisture, air, and food that they may grow. In each of the methods used to preserve food one or more of the things necessary for bacterial growth are absent. In the silo there is no free oxygen. When the silo is not air tight, the silage spoils. A thin layer of silage at the top spoils. But a layer of moldy silage protects the rest from the air, and preserves it.

Silage Feeding Table

Number of Cows	Estimated Capacity in Tons	Silo Diameter, Feet	Silo Height, Feet
7	26	10	20
13	47	10	30
14	51	10	32
19	68	12	30
21	73	12	32
25	93	14	30
27	101	14	32
30	109	14	34
33	119	16	30
36	131	16	32
40	143	16	34
43	155	16	36
46	166	18	32
50	181	18	34
54	196	18	36

FIG. 26. — Filling the silo, and saving the maximum amount of feed.

Materials Used in Silo Construction. — Silos are made of wood, concrete blocks, brick, solid cement, glazed tile, and sheet steel. In some states, especially the semi-arid and arid states, silos are often made in the ground and are known as pit silos. The pit silo is often lined with a cement wall. The material used in silo construction has no relation to the keeping qualities and feeding value or palatability of the ensilage. The kind of silo made depends upon the cheapness of the materials to be used in its construction. The brick and solid cement silos are more expensive, but of course they last longer than the ordinary wooden stave silo. Ask your experiment station for literature on silos.

Silage Crops. — Corn is the best silage crop. But sorghums, alfalfa, clover, cowpeas, soybeans, and other crops may be used. Silage of corn, soybeans, and cowpeas furnish an excellent ration for dairy cattle, growing cattle, or sheep.

When Corn should be Put into the Silo. — Corn should not be put into the silo when it is green, for it does not contain as much food as it does when it is more mature. The proper time to fill the silo is when the corn shows signs of maturity. Then the husks are turning white, the lower leaves are getting dry, and the kernels are entirely past the milk stage, and are dented. If the corn is still more mature and drier, water must be added to it. The amount of water depends upon the dryness of the corn used. A good general rule is: Add enough water to make the moisture content equal to that of green corn. All parts of the corn should be moistened, for the parts that are not well moistened often get moldy. Corn that shows signs of maturity contains more fat, more protein, more sugar, and more starch.

According to the table on page 50 it may be observed that there is less water to be handled when the corn is about ripe and that it contains more dry matter, more protein, more sugar, more starch, and more fat. These are the essential food nutrients, and therefore corn should be put in the silo when it shows signs of ripening.

INCREASE OF PROTEIN, CRUDE FAT, DRY MATTER, SUGAR AND STARCH[1]
(YIELD PER ACRE)

	Gross Weight Pounds	Water in Crop	Dry Matter	Ash	Crude Protein	Sugar and Starch	Crude Fat	Crude Fiber
Tasseled	18,045	16,426	1619	138.9	239.8	239.8	72.2	514.2
Silked .	25,745	22,666	3708	201.3	436.8	436.8	167.8	872.9
Milk .	32,600	27,957	4642	232.6	478.7	378.8	228.9	1262.0
Glazed .	32,295	25,993	7202	302.5	643.9	643.9	260.0	2755.9
Ripe .	28,460	20,542	7818	364.2	677.8	677.8	314.3	1734.0

Plants harvested for their stems, leaves, and kernels should be cut when almost matured, and scarcely any leaves are lost. Where the stems and leaves are to be kept as in the making of hay, plants should be cut slightly greener. The best time to cut hay is when about one-third of the plants are in bloom. If hay is made when it is so dry that it will not pack well, it is not in the best condition. Plants gathered for their grains should be well matured when harvested.

Necessity of Rotation. — It is well known by the average farmer that, if he plants corn on the same ground for several years in succession, the soil loses its producing capacity. We can see from the following table, which was obtained by experiment, that rotation is much more productive than non-rotation.

Why does production rapidly decrease where no rotation is practiced? Because the available plant foods are depleted, and because humus is lacking. One reason why the crop rotation mentioned in the table aided production, is because a legume was used. Clover, which is a legume, adds nitrogen to the soil, and at the same time gathers its foods from a deeper layer. In this

[1] *Data from Professor Ladd*, Geneva Station. Bowman and Crossley, p. 391.

way the near surface soil is rested for one year. Data similar to that given in the following table may be had from almost every State Experiment Station.

EFFECT OF CONTINUOUS CROPPING AND OF ROTATION

METHOD OF TREATMENT[1]	YIELD
Corn grown continuously for seventeen years	12 bushels
Rotation of corn, wheat, and clover for seventeen years	51 bushels
Rotation of corn, wheat, and clover plus manure for seventeen years	78 bushels

Uses of Corn. — Corn is used as a feed for horses, cattle, sheep, swine, and poultry. For economic fat production corn has no equal. The feeding value of corn may be enhanced by adding to it feeds rich in protein content. Clover hay, alfalfa, soybeans, cottonseed meal, or tankage help in balancing the corn ration, and aid in growing or fattening animals economically.

Corn is used for feed as silage, fodder, green feed, and roughage. A number of experiment stations have found that 5 or 6 pounds of corn are required to produce a pound of pork; and that 5 to $5\frac{1}{2}$ pounds of corn plus some hay will put on a pound of mutton; and from 10 to 11 pounds of corn plus hay is required to put on a pound of beef. The amount of feed required to put on a pound of meat depends upon the kind of animal, its age and health, and upon the weather conditions. If 6 pounds of corn are required to put on a pound of pork, and the pork sells for 7 cents a pound, and corn is worth 75 cents a bushel, it can easily be determined whether or not it is profitable to feed swine.

More than one hundred commercial products are manufactured from the corn plant. Starch, corn sirup, breakfast foods, alcohol and distilled liquors, corn gluten meal, and germ oil meal are made

[1] *Missouri Circular, No. 38.*

from the ear. Corn husks are used in the manufacture of horse collars and coarse door mats. The cornstalk is made into paper, and the pith is used as a packing for war vessels, because it expands rapidly when it becomes wet, and closes any gunshot openings. The cob is made into cob pipes; and as they are rich in potash, cobs are used in the manufacture of commercial fertilizers.

Summary. — Corn is a native of America, and is one of our most important grasses. It is adaptable to a wide range of conditions. The several types of corn have been developed to meet different purposes and conditions. Corn is grown in every state of the Union, but the seven states, Iowa, Illinois, Missouri, Indiana, Nebraska, Ohio, and Kansas, produce about 60 per cent of all the corn of the United States and are known as the "Corn Belt" states.

Selection of proper seed corn, storing, and testing are important points in raising corn yields. It is very important to select seed corn from prolific stalks, and to cast aside low-yielding ears. Proper methods of cultivation are also important in increasing yields. By hogging down corn, and by putting corn in the silo, the economic value of corn may be increased.

Review the topics in this chapter.

Recall the facts that you have learned under each topic, using the paragraph headings to aid you in the review. Read each topic again and see what important points you have omitted.

What information have you gained that you can use in your home work?

LABORATORY EXERCISES

1. To Study the Local Importance of Corn. (Survey of district.) — Any pupil may help in this survey. Have pupils bring the following data from the homes of every farmer in the district if possible, and record in a table like the one following.

Names of Farmers	Acres in Farm	Acres in Corn	Per Cent of Farm in Corn	Variety

2. Study of Groups of Corn. — (Dent, pop, and sweet corn.) With plants and ears in hand, fill out a table similar to the one below.

Description of Groups of Corn

Group Belonging to	Number of Leaves	Kind of Roots	Height of Stalks	Number of Kernels	Character of Kernels

3. To Estimate the Cost of Corn Production. — Figure out, with the help of your parents, the cost to produce an acre of corn on your father's farm, using the same points as a basis to figure cost as found in the above paragraph.

4. To Find the Cost of Implements Used in Corn Production. — Find the cost of each tool and machine used in corn production. Itemize the same. How long will the tools last? How much then do the tools decrease in value each year?

5. Description of Several Ears of Corn. — Examine ears and fill out the following outline. Mark thus (√) the character in its proper place.

	Characteristic (Mark ✓)				
1. Shape of ear					
1. Cylindrical					
2. Partly cylindrical					
3. Tapering					

	Characteristic (Mark ✓)				
2. Length of ear in inches					
3. Circumference of ear one-third distance from butt to tip					
4. Color of kernel					
1. White					
2. Yellow					
3. Mixed					
5. Indentation					
1. Smooth					
2. Rough					
3. Creased					
6. Number of kernels					
7. Number of kernels to row					
8. Number of kernels on ear					
9. Space between rows					
1. Close					
2. Wide					
10. Arrangement of rows					
1. Straight					
2. Twist to right					
3. Twist to left					
11. Butt					
1. Flat					
2. Cup-shaped					
3. Deep					
4. Enlarged					
5. Compressed					
6. Cylindrical like rest of ear					
12. Tip					
1. Covered					
2. Exposed					
3. Cylindrical					
4. Tapering					
13. Cob					
1. Color					
2. Size					

6. To Score Corn.

SCORE CARD — CORN

SCALE OF POINTS		SAMPLE OF VARIETY						
Trueness to type and breed characteristics:								
1. Uniformity of type	10							
2. Shape of ears	10							
3. Length of ears	10							
4. Circumference of ears	5							
5. Purity (*a*) kernel	5							
(*b*) cob	5							
	45							
Maturity and market condition:								
6. Maturity	5							
7. Market condition	5							
	10							
Yielding qualities and vitality:								
8. Character of germ	10							
9. Kernels (*a*) shape	5							
(*b*) uniformity	5							
10. Butts	5							
11. Tips	5							
12. Space	5							
13. Size of cob	10							
	45							
Total	100							

Explanation of Score Card.

1. *Uniformity of Type* (10). — For each ear differing in shape, color, or indentation from the type of the variety cut from one-quarter to one point. In scoring single ears cut from one to ten points according to lack of conformity to breed of ideal type.

2. *Shape of Ear* (10). — Ears should be as nearly cylindrical as possible and have straight rows running from butt to tip. These characteristics usually indicate a high per cent of corn to cob, and a large number of kernels

of uniform size and shape for planting. Cut one-fourth to one point for each ear that tapers too greatly.

3. *Length of Ears* (10). — Add together the deficiency and excess in length of all ears not conforming to the standard of the variety, and for each inch thus obtained cut one point. Should the deficiency exceed 10 inches, a cut of two points for each additional inch shall be made on the total score.

4. *Circumference of Ears* (5). — The deficiency and excess in circumference (one-third the distance from butt to tip) of all ears not conforming to the standard of the variety shall be added together, and for each inch thus obtained a cut of one-half point shall be made.

5. *Purity — Kernel* (5). — Kernels should be free from mixture with corn of opposite color. Mixture in yellow corn is shown on caps of kernels; in white corn on the sides. For each mixed kernel in an exhibit cut one-fourth point.

Purity — Cob (5). — Cobs should be one color; in yellow corn, red; and in white corn, white. (Except St. Charles White, which has a red cob.) For pink cobs cut one-fourth to one-half for each according to shade. One cob of the opposite color shall bar the exhibit.

6. *Maturity* (5). — Ears should be well matured, heavy, dry, and the kernels bright and firm on the cob. For immature or loose ears cut not to exceed one-half point.

7. *Market Condition* (5). — Ears should be free from injury or decayed spots. Ears showing rotten spots or injuries should be cut one-fourth to one-half point. A dead ear should be cut five points. Two dead ears shall bar the exhibit.

8. *Character of the Germ* (10). — Germ should be full, smooth, bright, not blistered, shriveled, or discolored. When broken it should show a fresh oily appearance. Cut not more than one point for each ear showing inferior germs.

9. *Kernel — Shape* (5). — The ideal kernel is slightly wedge-shaped but not pointed, and its length is approximately one and one-half times as great as its width at the widest part. For each ear showing kernels of poor shape, cut from one-fourth to one-half point.

10. *Kernels — Uniformity* (5). — The kernels from the different ears should be of the same size and shape; also those in each ear should be uniform. For each ear having kernels which differ in shape or size from the majority, cut from one-fourth to one-half point. For each ear with very irregular kernels, cut from one-fourth to one point.

11. *Butts* (5). — An ideal butt on an ear of corn should be well rounded out, with regular rows of deep kernels, solidly and evenly compacted around a clean cup-shaped cavity. Cut not to exceed one-half point for each defective butt.

12. *Tips* (5). — The tips should be filled out to the end with deep kernels in regular rows. The ideal tip is completely covered, but if kernels are deep and regular to end of cob, no cut need be made. Cut not to exceed one-half point for each defective tip.

13. *Space* (5). — There should be no open space between the kernels in the row, either at the crown or at the cob. Cut not to exceed one-half point for each ear seriously defective in this respect.

14. *Size of the Cob* (10). — The cob should be medium in size with diameter about twice the depth of the kernel. Too large a cob gives a low per cent of corn, while too small a cob does not favor a large yield per acre. Cut one-half to one point from each cob markedly out of proportion in this respect.

Note. — The score card is designed for scoring ten-ear samples. To score single ears, cut in tenths of points according to judgment.

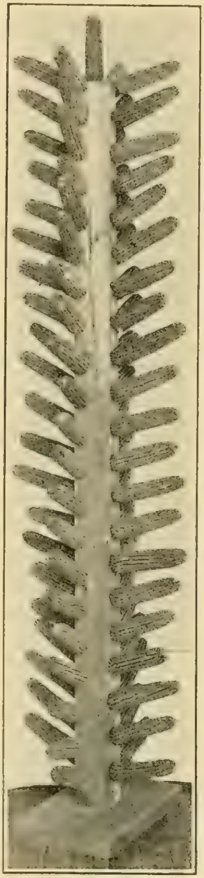


FIG. 27. — A corn tree — one method of storing seed corn.

7. To Illustrate Method of Storing Seed Corn. — Hang in a dry place a sample of seed corn as illustrated in the picture for hanging seed corn.

8. Making a Corn Tree. — Have class make a corn tree, and have them illustrate the method of seed storing with it.

9. Testing Seed Corn. — Test ten ears of seed corn. Take six kernels from different places of the ear and plant in box of sawdust or sand. Pack sand or sawdust well. Lay over it a white cloth, marked into two-inch squares. Lay six kernels from one ear, taken from the butt, middle, and tip, in a square. Test all ten ears in this manner. Moisten well. Keep in a warm place (70° to 80° Fahr.) until kernels germinate. Record what you find, after kernels have had time to germinate.

10. Reasons for Testing Seed Corn. — On a field trip figure the per cent of stand. There are 43,560 square feet in an acre. If corn is planted three feet and six inches each way, there are 3556 hills on an acre. (Sixteen hills square or two hundred fifty-six hills is one-twelfth acre.) There should be three kernels per hill or 768 stalks in one-twelfth acre. Count the number of stalks in sixteen hills square and divide the result by 768. This will give the per cent of stand. After the class exercise have pupils bring data from their parents' farms.

11. Find Per Cent of Shelled Corn to Ear. — Do this with four or five ears of different types. Weigh the ears. Then shell. Weigh shelled corn. Divide the weight of shelled corn with two ciphers annexed, by the total weight of the ear. This gives the per cent of shelled corn.

DATA ON EARS

Ear Number	Total Weight	Weight of Shelled Corn	Per Cent of Shelled Corn
1			
2			

12. Find by Count the Productive Variations of Corn. — Take hills where two, three, or four stalks are growing. Count or approximate closely the number of kernels on each stalk. Record as follows :

PRODUCTIVE VARIATIONS OF CORN

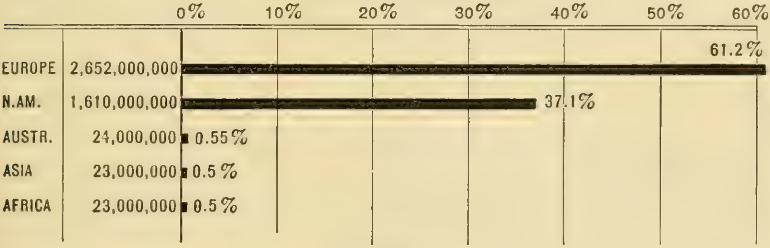
Hill Number	Number of Kernels			
	Ear No. 1	Ear No. 2	Ear No. 3	Ear No. 4

CHAPTER III

OATS

Importance of the Oat Crop. — The oat crop of the world is about the same in bushels as the wheat or corn crop; it slightly exceeds the wheat crop, and does not quite equal the corn crop in bushels. However, the wheat crop exceeds the oat crop in weight.

The following graph shows the oat production of the important countries and their relative production for a recent period of five years:[1]



GRAPH 4.

The oat crop is one of the important crops in the United States; corn, cotton, hay, and wheat are the only crops of greater value. The average production of oats in the United States from 1911

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

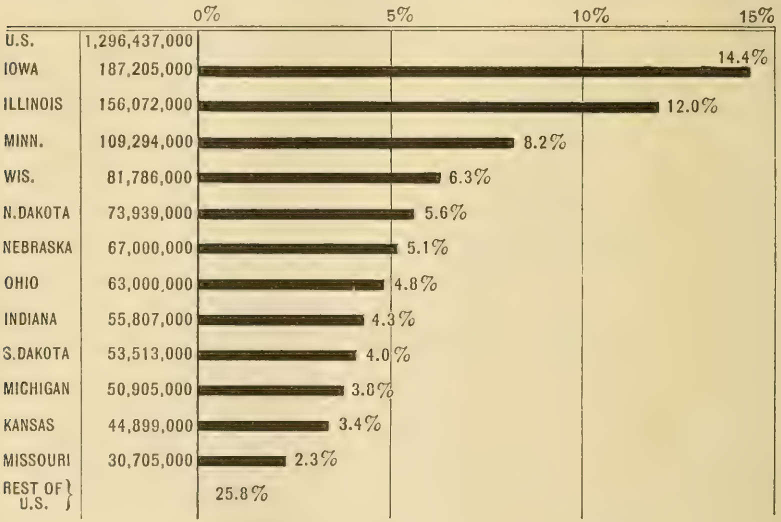
Several samples of shelled oats; scales; several heads of oats, showing the widest variation of kernels per head produced under conditions as nearly similar as possible.

[1] *United States Yearbook of Agriculture* (years 1911–1915 inclusive).

to 1915 was 1,150,960,000 bushels and the average acreage yield was thirty bushels. (See Exercise 1.)

The Oat States. — The twelve states, Iowa, Illinois, Minnesota, Wisconsin, North Dakota, Ohio, Nebraska, Indiana, Michigan, South Dakota, Kansas, and Missouri, produce almost 75 per cent of the entire oat crop of the United States. Iowa and Illinois alone produce more than 25 per cent of the entire oat crop.

The following table shows the average yearly oat production of the twelve leading oat-producing states of the Union:[1]



Graph 5.

A little more than one-fourteenth of the entire improved farm acreage is devoted to oat production. The greatest oat states, however, do not have the largest acreage yield. Iowa's average was 32.8 bushels for 1907 to 1916 inclusive. The state of Wash-

[1] *United States Yearbook of Agriculture* (years 1911–1916 inclusive).

ington for the same period averaged 48.2 bushels. In the North Central States the average acreage yield for that decade was 29.2 bushels, while the Pacific States averaged 40.9 bushels.

Conditions of Oat Production. — If other conditions are right, oats will produce as well on poor soils as will any other crop. Barnyard manures and commercial fertilizers are seldom applied to soils for oat production. On very rich soils, oats will frequently lodge, or become thickly matted on the ground, and for this reason oats are usually sown on the poorer fields of the farm. The experiment stations have been and are still attempting to originate varieties of oats that have stiffer straw. Up to the present time they have not succeeded.

Oats thrive best in cool, moist soils. The heaviest yields of oats are made in cool, moist years. It has been found that it required 504 pounds of water to produce one pound of dry matter in oats. It is for this reason that a fairly wet season produces the best oats. But besides this, in the early periods of growth, tillering, or stooling, is best produced in moist, cool weather.

Oats grow best in a cool climate. They will thrive farther north than either corn or wheat. The North Central States are the best suited to raising oats, because there the summers are cool and moist. Norway and Sweden, Scotland, and Canada produce large quantities of oats. The center of production in the United States now is Iowa, Illinois, Wisconsin, Minnesota, Ohio, Indiana, and Nebraska. These states make what is called the "Oat Belt." Why is it probable that they will remain the principal oat states? (See Exercise 2.)

Cost of Oat Production. — As in wheat, the cost of producing oats has become very much less. However, it still costs so much to raise oats that there is little profit in the crop. Farmers often lose on a crop of oats. The cost of producing an acre as given by the Bureau of Statistics of the United States Department of Agriculture is as follows: [1]

1.	Land rent	$ 3.78
2.	Preparation of soil	1.88
3.	Seed	1.12
4.	Harvesting	1.34
5.	Threshing	1.51
6.	Miscellaneous	1.38
	Total	$11.01

If this acre produces $35\frac{1}{2}$ bushels, then it costs 31 cents to raise a bushel of oats. The average value of an acre was $14.08, or 40 cents per bushel. This leaves a net balance of $3.17 per acre, above the cost of production. When less than 20 bushels of oats are produced, it may be safely estimated that oats are being produced at a loss. How to raise oats cheaper is an important question.

It is the belief generally that poorly prepared soil, poor seed, and enemies cause low yields and raise the cost of production. If 50 bushels can be produced per acre, the cost per bushel will be nearly 20 cents per bushel. In the countries of Europe more bushels of oats are raised to an acre than in the United States. In Germany nearly twice as many bushels are produced on an acre; in the United Kingdom of Great Britain about one and one-half times as many.

Average for Ten Years of Oats Produced on an Acre in Countries of Europe [2]

Germany	57.4 bushels
United Kingdom	44.7 bushels
France	30.0 bushels
Austria-Hungary	31.0 bushels
United States	29.4 bushels

[1] *Crop Reporter* for 1911.

[2] *United States Yearbook of Agriculture* (years 1902–1911 inclusive).

How to produce oats more cheaply in our own country will be discussed next. (See Exercise 3.)

Preparation of Seed Bed. — In the states of the corn belt, where oats follows corn, the seed is usually broadcasted on the corn ground, and then cross disked and harrowed. Although this does not produce the largest yields, it does not greatly lessen the yields; and it is probably the most economic way of preparing, sowing, and producing the oat crop. Oats sown in this way may be put in early in the spring. What is lost because the seed bed has been poorly prepared, is gained in the ripening of the crop. This is important in oat production.

Where soils are hard and compact, they should be plowed from 3 to 5 inches deep in the autumn. Fall plowing has the following advantages:

1. Fall-plowed soils catch and hold all the moisture that falls.
2. These soils dry earlier in the spring and are therefore warmer.
3. Oats can be sown earlier on fall-plowed soils.
4. All vegetable matter that is turned under decays through the winter, and makes the seed bed more fertile and uniform.

With little preparation, a soil that is plowed in the fall may be prepared for drill seedage. Drilling oats has the following advantages:

1. Every seed has an equal chance to grow.
2. The seeds are evenly distributed.
3. The crop will mature more evenly and uniformly.
4. The yields are larger.
5. It requires less seed.

Oats should be planted from 1 to 2 inches deep.

Amount and Kind of Seed. — The amount of seed per acre depends upon soil, season, time of sowing, and variety of seed. It may be less on rich than on poor soil, for stooling, or sprout-ing and taking root, is more abundant on rich soils. In a cool, moist season, stooling increases, and so less seed may be sown. When oats are sown early, the amount of seed may be slightly lessened. Why? The number of oat kernels in a bushel varies from 352,000 to 960,000 seeds. This also will affect the amount of seed sown. Can you tell how? There is no fixed rule for how many bushel should always be sown to an acre, but it is safe to say that from 2 to 3 bushels is the average. At the Illinois, Indiana, and Ohio Stations, it was found that from 8 to 10 pecks gave the best yields.

Seed oats should be clean, show improvement, and weigh at least 32 pounds to the measured bushel. They should be free from weed seeds, sticks, chaff, etc. Seed oats should be uniform in color, showing that the variety is pure. If the seeds vary a great deal, it is a sign of a mixed variety and therefore shows lack of improvement. If oats do not weigh 32 pounds, the grains are probably not well filled, — there may be empty hulls. In good oats there may be as little as 30 per cent hulls, and as much as 70 per cent kernel. Home-grown seed raised within 100 miles should be used in preference to imported seed. It may be well enough to test out a few samples with this in mind, *i.e.*, finding the per cent of hull to kernel. (See Exercise 4.)

Characteristics of a Good Oat. — The qualities that oats should possess are:

1. Each head must have a high percentage of kernel.
2. It must yield well.
3. It must have a good weight per bushel.

No oats should be taken as seed unless it has large heads full of good kernels. Two oat plants may be growing under exactly the same condition, — the one bearing 25 or 30 seeds, and the other 150. How do you explain this variation? It was not due to rain, soil, sunshine, or environment. It was due to the fact that one inherited a greater tendency to reproduce. Then it must yield well; that is, produce a large number of bushels per

Fig. 28. — A prolific and non-prolific head of oats.

acre. And, again, it must be filled so that it will weigh well. Some factors that will aid in the yield and quality of oats are:

1. Earliness of maturing.
2. Stiffness of straw.
3. Resistance to heat and drought.
4. Rust resistant.
5. Prolificacy.
6. Hardiness.

The time for maturity in oat varieties ranges from about 80 to 115 days. Early maturing varieties are generally the safest and best yielders, because they do not lodge so easily, escape in hot, dry weather, and are mature before they are injured by rust and other enemies. There are varieties best suited to each locality. It is advisable that the teacher or pupils write to their own experiment station regarding this point.

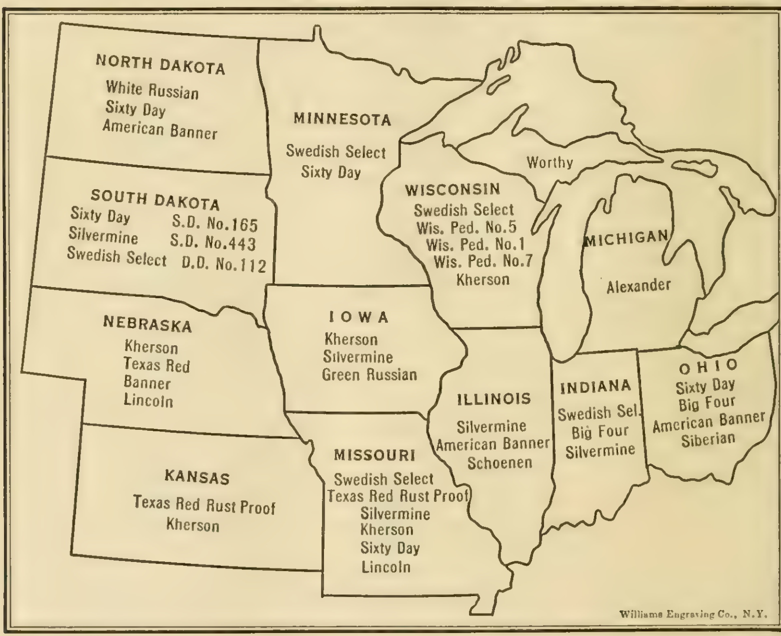


FIG. 29. — Oat varieties your State Experiment Stations recommend. Write to them.

Texas Red Rust Proof was recommended as being among the best varieties by 8 out of 25 stations; American Banner by 10; Badger Queen by 6. Kherson, or Sixty-day Oats, is growing in popularity. Swedish Select, White Bonanza, Lincoln Siberian, Clydesdale, and Wide Awake and Welcome varieties are popular in some localities. The varieties of oats recommended by your experiment station are indicated in the map on page 66. (See Exercise 5.)

Uses of Oats. — The *digestible* composition of one hundred pounds of oats, oatmeal, and oat straw is as follows:

	Dry Matter	Fats	Carbohydrates	Protein	Nutritive Ratio
Oats	90.8	9.7	52.1	3.8	1 : 6.3
Oatmeal	92.1	12.8	56.9	6.0	1 : 5.5
Oat straw	88.5	1.0	41.1	1.3	1 : 44.6

For horses, dairy cows, growing calves, laying hens, oats, on account of the protein content, is an excellent feed. Oats have a stimulating and conditioning effect upon horses that is possessed by no other grain. "The horse feels his oats," is a common expression. What does it mean? It means that the horse possesses life, vigor, energy, ambition. To the work horse, oats give strength, power, and willingness to go. To the dairy cow, oats give greater milk production; and to the laying hen, more eggs.

Oat straw is a splendid feed for cattle, horses, and sheep that are simply roughed through the winter. It is superior to wheat straw in feeding value because it contains more digestible food nutrients. If a little feed rich in protein — alfalfa hay, clover hay, or soybeans — is fed along with oat straw, cattle, horses, or sheep may be cheaply roughed through the winter. The fertility in a ton of oat straw is worth about $3, and, for that reason, it should never be burned. Oat straw makes an excellent absorbent as bedding, and is used extensively for that purpose.

Oats are made extensively into oatmeal. For oatmeal, a white variety that contains large berries is raised. In oatmeal making, the hulls are taken off the kernel, and the rest of the kernel is passed through rollers that flatten the kernels well. Then it is ready for the market. After oatmeal is cooked, it is a very palatable, nutritious dish, and is eaten by people in northern climates in order to give heat energy, and by the workingman, for the heat and muscle energy it gives. The Scottish people have used oatmeal as a standard food for many years, and the people of the United States are consuming large quantities of it.

FIG. 30. — Oat head affected by smut.

Enemies of Oats. — The insect enemies of oats are chinch bugs, grasshoppers, and army worms. The chinch bug is the most important insect oat enemy. The method of combating chinch bugs was mentioned in connection with the wheat industry, and need not be repeated here.

The most important fungous enemies are rusts and smuts. There are two kinds of rusts, the leaf rust and the stem rust. Rusts attack oats usually from ten to fifteen days before maturity. The only means of combating rusts is by the selection of early-maturing and rust-resisting varieties.

There is only one kind of smut in oats. It is the loose smut. The formaldehyde treatment described in connection with the discussion on wheat is the cheapest and safest remedial treatment.

Summary. — Oats is one of the important crops in the United States. The North Central States are the great oat-producing states. Oats thrives best in cool, moist conditions. A better preparation of the seed bed, sowing good seed, drilling in oats, and using varieties that are prolific, are important factors in the economic production of oats. Oats is an excellent feed and for this reason will always be one of our important farm crops.

LABORATORY EXERCISES

1. Local Importance of Oat Crop. (Oat survey of district.) — Any pupil in school may aid in this survey. Get the following data from every farmer of the district. Keep as a permanent record.

OAT SURVEY OF DISTRICT DATE TEACHER

NAMES OF FARMERS	ACRES IN FARM	ACRES IN OATS	PER CENT OF FARM IN OATS	VARIETY OF OATS

2. What year, or years, have the farmers of your locality raised the best oat crops? Write the reasons.

3. To Study the Cost of Oat Production. — Estimate, with the help of your father, the cost to produce an acre of oats on his farm, using the same points and others used in the above discussion on the same topic.

4. To Find Per Cent of Hull. — Weigh out about 50 or 100 grams of oats. Remove the hulls and weigh them. Divide the weight of the hulls by the weight of the sample. This will give the per cent of hull. Record as follows:

SAMPLE NO.	VARIETY	WEIGHT OF SAMPLE	WEIGHT OF HULL	PER CENT OF HULL	PER CENT OATMEAL

5. A Study on the Prolificacy of Oats. — Bring to school samples of oat plants having the widest possible variations in number of kernels in the head. Count kernels and record your findings.

6. Judging Oats by Score Card.

OAT SCORE CARD

Scale of Points	Standard		Sample of Variety				
1. Uniformity of grains	10						
2. Color	10						
3. Size and plumpness	15						
4. Per cent hull	15						
5. Per cent foreign matter	15						
6. Per cent damaged grain	15						
7. Weight per bushel	20						
Total	100						

Explanation of the Score Card.

1. *Uniformity* (10). — Size, shape, and color. The sample should have grains uniform in size and shape, and of the same shade of color. Divide the sample into two parts and by count find the per cent of grains differing in size or color from the majority. Cut one point for each 3 per cent found.

2. *Color* (10). — The color should be true to the variety, bright, free from weathered, binburned, or otherwise discolored grains. Divide the sample into two parts and cut one point for each 2 per cent found to be off color.

3. *Size and Plumpness* (15). — Grains should be long, thick, and plump. Divide the sample into two parts, separating out pin oats, those hulls which are empty, and those which are shrunken, light kernels. Cut one point for each 2 per cent found.

4. *Per Cent of Hull* (15). — The per cent of hull depends upon the variety, the locality in which grown, and the season. Good oats may have as little as 30 per cent hull. Separate the hull from a number of berries and estimate the per cent. Cut two points for each per cent of hull above thirty.

5. *Per Cent of Foreign Matter* (15). — Sample should be free from all weed seed, dirt, and other foreign matter. Separate these out from the sample and estimate the per cent. Cut one point for each weed seed found and according to judgment for other foreign matter.

6. *Damaged Grains* (15). — Sprouted or decayed grains have little more feeding value than so much trash. Separate out the musty, smutty, and sprouted grains and estimate the per cent. Cut one point for each per cent found.

7. *Weight per Bushel* (20). — The sample should weigh at least 32 pounds per measured bushel. For each pound over 32 which the sample weighs, add one point to the final score. Cut one point for each pound below 32.

CHAPTER IV

RED CLOVER

History and Importance of Red Clover. — Red clover originated in Persia, whence it was imported into Europe. Spain, Holland, and Italy grew it in the fifteenth century. Red clover was first grown in England about 1633. Pennsylvania began to grow red clover in 1770, being the first state to grow it. Now it is grown in every state of the Union. The clover district is in the North Central States,—north of the Ohio River and east and north of the Missouri River. The largest centers for red clover seed are Chicago, Cincinnati, Toledo, and Detroit. The yield per acre runs sometimes as high as 4 or 6 bushels. The value of clover seed is usually from $8 to $12 a bushel. (See Exercise 1.)

Cultural Methods and Kind of Seed to Use. — Red clover is frequently sown during the early spring in growing wheat. When the soil is in the "honeycomb" condition, caused by freezing and thawing, is a good time to sow, for the seed is then covered by the alternate freezing and thawing of the soil. The seeds germinate at the opening of spring. From 8 to 15 pounds of seeds are sown to an acre. The amount to sow depends upon the size of the seeds (there being from 12,000,000 to 25,000,000 seeds in a bushel) and upon their germinating power. No seed

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Several pint samples of red clover seeds, a red clover plant showing nodules, a pint sample of white, crimson, and alsike clover seeds. These may be kept for several years.

should be sown unless it will grow to the extent of 80 to 85 seeds to a hundred. Sowing clover early has the advantage that the hard, heavy seed coat is softened and broken down to a consider-

FIG. 31. — Poor and good red clover seeds.

able extent by the rigorous weather. This insures a higher per cent of germination.

Red clover is sometimes sown in oats, but generally grows better in wheat. There are two reasons for this: oats are thicker on the soil, and shade the ground; the oat crop draws very heavily on the soil moisture. There are two ways by which clover may be sown with oats to advantage: (1) By sowing from 4 to 6 pecks less of oats seed, thus giving the clover more room and water, and (2) By having sheep or cattle graze the oats down when they are 14 to 20 inches tall. Grazing very closely often injures the clover. (See Exercises 2 and 3.)

The seed used should be uniform in size, bright in color, large, plump, and free from weed seed and foreign matter. Home-grown seed is generally preferable to imported seed. Frequently very harmful weeds are introduced upon a farm by using seeds that contain weed seed. After weed seeds get a start in a hay crop, they are scattered by the cattle all over the farm. Therefore all seed should be carefully examined before it is purchased to see that it is free from seeds of harmful weeds. (See Exercises 4 and 5.)

Some Advantages in Growing Red Clover and Other Legume Crops. — The legume crops include the clovers, alfalfa, cowpeas, and soybeans. Although some of them are more profitable under certain conditions than others, the growing of each has the following advantages for the farmer:

1. They all take free nitrogen from the air and add it to the soil.

2. They all have a long taproot, and can therefore get some of their plant food from the lower strata of the soil. In this way they open up the soil deep down and improve its physical condition.

Red clover root. Alfalfa root.

FIG. 32. — Note the long taproots and the nodules, which gather nitrogen and store it in the soil.

3. They store up a large proportion of protein, and are therefore helpful in balancing the ration for all kinds of farm animals.

4. By rotating legumes insect life is checked.

The growth of legumes in crop rotations has long been recognized as good farm practice. We shall study each of these advantages more fully.

The legumes replace the nitrogen taken from the soil by other crops. Every farmer boy has observed the "nodules" that grow on the roots of leguminous crops. These nodules are full of bacteria. They gather nitrogen from the soil air and store it in the legume plant. Conditions that help bacterial growth should, therefore, be provided as far as possible by the farmer. A medium dry, fairly warm soil, which contains plenty of well-decomposed organic matter, will stimulate the bacteria. The use of leguminous crops in maintaining the soil nitrogen is the most economic. Nitrogen in the form of commercial fertilizer is worth 15 to 18 cents a pound; sometimes, when in great demand, more. (See Exercise 6.)

The long taproots of the legumes gather plant foods from greater depths than other crops, and therefore rest the surface soils. The growing taproots open up the subsoil, and upon decay leave the subsoil open. They also bring from the subsoil to the surface plant foods which may be used by other crops. The decay of roots aids percolation and capillarity of soil water.

The legumes are rich in protein, and for this reason balance other feeds. The following table illustrates the difference in the *digestible* composition of corn silage and some legume hays:

Article	Dry Matter	Fat	Carbohydrates	Protein	Nutritive Ratio
Corn silage	26.3	0.7	15.0	1.1	1 : 15.1
Alfalfa hay	91.4	0.9	39.0	10.6	1 : 3.9
Cowpeas	90.3	1.0	33.7	13.1	1 : 2.7
Soybeans	91.4	1.2	39.2	11.7	1 : 3.6
Red clover	87.1	1.8	39.3	7.6	1 : 5.7

Examine carefully the column marked protein. See how much more protein there is in red clover than in corn silage. The nutritive ratio in corn silage is 1 : 15.1 and in cowpeas it is 1 : 2.7. The legumes are rich in nitrogen and protein, and therefore help to make a well-balanced feed when used with corn or oats which contain fats and carbohydrates. Carbohydrates and fats produce heat and energy; proteins build tissue, bone, muscle, and cell walls.

Legumes check insects which are injurious to our most important crops. Chinch bugs, Hessian flies, and the corn-root worm do not eat leguminous crops. Where legumes are in the regular crop rotation, insect and fungous pests largely disappear.

Soils Adaptable to Red Clover Production. — Red clover thrives best in a well-drained, porous soil and subsoil rich in lime, and in a soil containing a good deal of well-decomposed vegetable matter. The amount of nitrogen in the soil need not be great, but a good supply of phosphorus and potash aids the growth of red clover. It will not do well in a hard, compact clay soil. A loose, black loam soil, with a porous subsoil, produces it best. Clover is sustained by a long taproot which penetrates into the soil from 3 to 6 feet. A sour or acid soil, which lacks lime, will not grow red clover. From one and one-half to three tons per acre of ground limestone applied to clover lands, especially where the ground is sour, will aid clover production. Well-decomposed organic matter also aids the growth of clover, for the bacteria which produce the nodules on the roots live on food supplied by organic matter. Through the nodules clover takes nitrogen from the air. Too wet soil will likewise hinder bacterial life.

Making Clover Hay. — What is the best time to cut clover and cure it for hay? At what stage of its growth will it contain the most food nutrients and be the most palatable? The following table answers these questions:

YIELD AND NUTRIENTS IN AN ACRE OF RED CLOVER [1]

Stage of Growth when Cut	Yield of Hay per Acre	Ash	Crude Protein	Carbohydrates		Fat
				Fiber	N. Free Extracts	
	Pounds	Pounds	Pounds	Pounds		Pounds
Heads in bloom	4210	260	539	1033	1731	116
Some heads dead	4141	226	469	1248	1379	106
Heads all dead .	3915	208	421	1260	1378	94

This table shows that there is a greater yield of ash, crude protein, and fat, when clover is in bloom than at any later period. This would indicate that the best time to cut clover for hay is when most of the heads are in bloom. However, it is probably best to cut clover when from one-fourth to one-third of the heads are turning brown. Clover should be put in small cocks before the leaves get so dry that they are lost in handling, for the leaves contain a great deal of splendid feed. After hay has stood in cocks one or two days according to the weather, they may be opened into a few large flakes. When hay is fairly dry, it should be stored in a dry haymow. Even if hay is put into the mow when a little green, it will cure up in good shape, for a bulk of hay will produce enough heat to destroy all germs. Hay from clover in which all the heads are dead does not give palatable hay. According to the 1910 census, the average acreage yield was 1.29 tons. Under favorable conditions from 2 to 3 tons of hay may be secured from two cuttings of clover.

Red Clover as Pasture. — Experiments seem to show that the greatest amount of food at least cost can be got from some hay crops by using them for pasturage. At the Missouri Station the following results were obtained from an acre of clover forage. The grain fed the swine was corn.

[1] Professor Jordan, Pennsylvania Experiment Station.

RESULTS WITH RED CLOVER FORAGE[1]

Year	Number Days Pastured	Number Hogs per Acre	Pounds Gain per Acre	Pounds Grain per Acre	Pounds Gain Accredited to Forage	Pounds Grain Per Pound Gain	Value of Clover Forage per Acre Pork @ 6¢
1908	147	13	1372	4330	598.2	3.16	$35.89
1910	119	9.5	1050	2872	537.2	2.74	32.23
Average	133	11	1211	3601	567.7	2.95	34.05

It will be observed that the grazing period was almost $4\frac{1}{2}$ months; that the number of hogs per acre was 11; that the gain per acre forage was 567.7 pounds of pork, and that the gain per pound grain fed was 2.95 pounds. The value of pork produced per acre from the clover forage at 6 cents per pound was $34.05. In the experiment the clover was from 6 to 8 inches high when the hogs were turned on it. Too close pasturing should not be permitted where clover is to be used for forage.

Some of the advantages of this practice are:

1. It reduces the cost of pork production.
2. It harvests the crop in a fairly economic way at little cost.
3. It tends to maintain the fertility of the soil.
4. It produces more pork on less land.
5. W. A. Henry says, "For pigs, clover furnishes sufficient food for maintenance so that all the grain fed goes for gain."

Summary. — Red clover is a native of Persia. It was brought to the United States about 1770. It is one of the legume crops, and is valuable in improving the soil. Red clover grows best in a well-drained, porous, sweet soil. It makes a splendid hay or forage crop because of its large protein content. The

[1] *Bulletin No. 110.*

leaves should be carefully saved when hay is made. Red clover has proved to be an excellent pasture crop in producing pork.

LABORATORY EXERCISES

1. Red Clover Survey of the District. — Find the number of acres of red clover in your school district. Record data as follows. All children may help in getting data.

Red Clover Survey Date Teacher's Name

Names of Farmers	Acres in Farm	Acres in Clover	Per Cent of Farm in Clover	Tons of Hay per A. Last Year

2. Draw and describe red clover seed.

3. Germination Test of Yellow and Purple Red Clover Seeds. — Make a germination test of purple and yellow clover seeds. Count out fifty yellow seeds and fifty purple seeds. Make a germination test between two blotters laid on a plate to see which will grow best.

4. To Study the Foreign Seeds in Several Samples of Red Clover Seed. — From several samples of clover seed find per cent of foreign seeds. Take about one hundred or one hundred fifty seeds and by count find the percent of weed seeds.

5. Identify Weed Seeds Found in a Half Dozen Samples of Red Clover Seed. — Identify, draw, and describe at least a half dozen weed seeds found in samples of clover seed.

6. Study of the Nodules on Roots of Red Clover. — Dig up a red clover plant. Wash off the dirt carefully. Examine and draw the nodules found on the roots.

WHITE CLOVER

White clover is a perennial legume which grows in lawns, pastures, fields, and by roadsides in both Europe and America. It is propagated by seeds and by runners which root freely at each node. The seeds are hard and pass through the digestive tract of animals without being damaged. They are reddish yellow, small, heart-shaped, and sometimes lie in the soil several years before they germinate. White clover is adaptable to a wide range of conditions, and is, therefore, found in almost every part of the world. It grows best in a fairly moist, sweet, well-drained soil. It is desirable in blue grass pastures because it grows well in midsummer when blue grass does not. Another reason why it is desirable is that it feeds at a greater depth and stores nitrogen in the soil. White clover is seldom seeded alone; from 2 to 4 pounds of seed is sown with other pasture grasses. Its creeping nature and its proportion of hard seeds cause it to become permanently set. Every pasture where white clover will grow should contain it, first, because it stores nitrogen in the soil; second, because it furnishes more protein to the grass ration; and, third, because it feeds at a greater depth than do most pasture grasses.

FIG. 33. — White clover stem.

LABORATORY EXERCISE

1. Identify, draw, and describe white clover seed.

ALSIKE CLOVER

Alsike clover originated in Sweden, near a place named Alsyke, from which it gets its name. It is a perennial, which lives from 3 to 5 years. It will grow in acid soils and in wet places where red clover will not grow. Alsike makes an excellent hay because it has a smaller stem, and is more easily cured than red clover. When sown in a mixture with other grasses, from 4 to 6 pounds of seeds are usually sown per acre. It has a white pinkish flower, and purple or yellowish green, heart-shaped seeds a little larger than white clover seeds.

LABORATORY EXERCISE

1. Identify, draw, and describe alsike clover seeds.

CRIMSON CLOVER

Crimson clover is an annual legume. It grows only in warmer latitudes, and, therefore, is not grown where there are hard freezing winters. In the United States it is grown most extensively along the Atlantic Coast. Crimson clover stools readily. The seeds are larger than those of the rest of the clovers, and are a shiny crimson color. The seeds should be identified, drawn, and described.

CHAPTER V

SOYBEANS

Origin of the Soybean. — Soybeans are native to Southern Asia and were cultivated and improved by the Chinese centuries ago. They have been grown in Europe for about a hundred years, but were not extensively cultivated in the United States until about 1900.

The Soybean Plant. Soybeans resemble garden peas. They grow erect with a branching, bushy hairy stem, which is often three and one-half feet in height. The *leaves* are trifoliate, about two-thirds as wide as long. The *flowers* are white, pink, and sometimes purple. The *pods* are short, containing from 1 to 3 oval-shaped, almost round seeds. There are seldom more than three seeds in a pod. The roots are composed of a main taproot and a few lateral roots, on which are found free nitrogen gathering nodules. (See Exercise 1.)

Utility of Soybeans.

1. Because soybeans grow erect, they are more easily cultivated and harvested.

2. Soybeans are not as easily injured by frosts as cowpeas, and therefore may be grown farther north.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

A soybean plant, showing nodules, and the seeds of three or four varieties of soybeans.

3. Because the different varieties of soybeans mature in different lengths of time, from 75 to 165 days, they may be grown from the Canadian country to the Gulf of Mexico.

4. Soybeans yield a large quantity of good seed, sometimes from 12 to 18 bushels.

Fig. 34. — *a.* A mature soybean plant, showing the pods. *b.* Part of a soybean plant.

5. Soybeans store as much nitrogen in the soil in as short a time as any other crop, and store up more protein in the plant than cowpeas.

6. When soybeans and corn are planted together and hogged down, soybeans last longer than cowpeas because they are harder and their pods do not break open as readily.

7. The parts of the soybean seeds are held tightly together so that they can be threshed without splitting and shattering as much as do cowpeas.

Varieties of Soybean. — Soybeans vary in size, the amount of seed produced, and the time required for maturity. The smaller varieties mature in about 75 to 95 days, and produce less growth and mature earlier. The medium-sized varieties mature in 95 to 110 days.

The large and late-maturing varieties require from 120 to 165 days. The characteristics of a few varieties are here itemized.

Description of a Few Soybean Varieties

Variety	Days for Maturity	Size	Characters
Ito San . . .	110–115 days	25–30 inches	Produces average amount of seed and hay
Hollybrook .	125–130 days	30–38 inches	Good for forage and seed production
Mikado . . .	130–135 days	30–35 inches	Is a heavy seed producer, medium in foliage
Dwarf Brown .	90 days	15–18 inches	Small, scant foliage, and little seed
Mammoth Yellow . .	150 days	35–38 inches	Foliage abundant, medium in seed

There are more than two hundred varieties of soybeans in the United States. For the ones adaptable to your locality write to your experiment station. (See Exercise 2.)

Soybean Culture. — Soybeans should be planted in well-prepared, firm, warm soil. In the corn states it is best to plant soybeans just after corn, preferably from the latter part of May to the middle of June. However, under very favorable conditions they may be planted up to the middle of July and still produce a fairly good crop. The methods of planting and the amount of seed sowed vary. If the crop is to be cultivated for seed, soybeans should be planted about $2\frac{1}{2}$ to 3 feet apart. If forage or hay is wanted, the seed may be drilled so that the rows will be from 12 to 18 inches apart. The method of planting 2 to 4 soybean seeds in each hill of corn when the corn is being planted is growing in popularity, since it does not decrease the corn yield much, and at the same time increases the soil fertility and produces more well-balanced feed. The amount of seed sown varies, of course, with the size of the seed and the purpose. If soybeans are grown for seed, about 2 to 4 pecks will be enough, but if grown for forage or hay, from 3 to 5 pecks should be sown. If the seed is broadcasted, more is needed. Broadcasting is not advisable, however.

FIG. 35.—Soybean roots, showing free nitrogen gathering tubercles.

Soil inoculation with the proper bacteria is advisable in fields where soybeans have never grown. The Agriculture Department of the University of Missouri recommends the following: "A gallon of soil taken from among the roots of an inoculated crop should be mixed in and drilled with every bushel of seed. This method of inoculation is simple, safe, and sure. When a field is once properly inoculated, soil from it may be used for inoculating other fields where soybeans are sown."

The methods of harvesting soybeans are similar to those used with other legume crops. If harvested for seed, soybeans should be cut when the pods begin to ripen. If the crop is allowed to mature too much, many of the seeds are lost from splitting and shattering. A regular bean huller is most satisfactory for threshing, but the common threshing machine may be used if the cylinder is run at half speed by putting on a larger pulley, and the rest of the machine run at normal speed. Most of the concave teeth should first be removed from the thresher.

When soybeans are harvested for hay, they should be cut when the pods are about half developed. If cut much later, many of the leaves are lost, and the stems become so woody that their feeding value is greatly reduced. In order to save the leaves which form the most valuable part of the hay, the crop must be handled in a semi-cured condition, put in cocks, and permitted to cure a day or two more, when it should be permanently stored.

The Digestible Nutrients of Soybean Hay

	Dry Matter	Fat	Carbo-hydrates	Protein	Nutritive Ratio
Corn silage for comparison	26.3	0.7	15.0	1.1	1 : 15.1
Soybean hay	91.4	11.7	39.2	11.2	1 : 3.6

Soybean hay contains about eleven times as much digestible protein as corn silage. Therefore soybeans and corn silage make a well-balanced ration.

Soybeans have also been used as a silage crop very satisfactorily. Two parts of corn and one of soybeans produce a silage that makes an almost ideal ration for dairy cattle, growing cattle, or for sheep, because it contains proteins, carbohydrates, and fats in about the proper proportion. (See Exercises 3 and 4.)

Uses of Soybeans. — It would be well for our farmers to investigate the value of soybeans as a crop. Soybeans are almost equal in feeding value to cottonseed meal, gluten meal, or low-grade tankage. They are fed to cattle, sheep, and swine with good results. As a soil builder and a green-manure crop, soybeans have scarcely an equal. They may also be used to advantage for seed production. In China and Japan soybeans are extensively used as household food, as a balance to the rice diet. (See Exercise 5.)

Summary. — Soybeans are a native of Asia, and not until recently has their value been realized in the United States. Soybeans belong to the legumes, and possess all their advantages. Soybeans are easily grown, contain a large amount of protein, and aid in balancing carbonaceous rations.

LABORATORY EXERCISES

1. **Study of Soybean Plant.** — Soybean plants should be brought to class, and be carefully described in a written composition.

2. **Study of Several Varieties of Soybeans.** — The seeds of three or four varieties should be provided and be carefully examined and drawn by the pupils.

3. **Study of Planting, Harvesting, and Feeding Soybeans.** — Have pupils tell how soybeans are planted, harvested, and fed upon any farm from which they may be able to get the information.

4. **To Study the Chemical Composition of Soybean Hay.** — How many pounds of digestible protein are produced on an acre if 1.5 tons of soybean hay is made? How much digestible protein is contained in a ton and a half of corn silage? Compare a ton of silage and soybean hay in a written paragraph.

5. **To Figure Money Value of Soybeans.** — If soybeans produce 12 bushels per acre, how many bushels can be produced on 12.7 acres? What are these worth at $2.45 per bushel?

CHAPTER VI

COWPEAS

History of Cowpeas. — Cowpeas have been grown in China and India for over two thousand years. About the middle of the sixteenth century they were introduced into Europe, and came into America by way of the West Indies the latter part of the seventeenth century. They were probably first brought to the United States in the early part of the eighteenth century. Cowpeas are grown extensively except where the climate is cold and the soil wet during the summer. Although cowpeas are a warm-temperature loving plant, they are grown to a considerable extent in New York, Ohio, Indiana, Missouri, Kansas, and Iowa.

FIG. 36. — The roots of the cowpea, showing the nodules in which the bacteria live that gather free nitrogen from the air.

The Cowpea Plant. — The cowpea is an annual legume. It varies in its growth from an almost erect upright plant to a trailing vine. The hay is sometimes difficult to handle because the long vines hang together. The author has measured vines of cowpeas that were over eleven feet long. The seed

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

The seeds of three or four varieties of cowpeas.

pods are long and contain from 6 to 18 seeds. The leaves have three leaflets and look very much like those of the garden bean. The roots are more extensive than those of the soybean, having a long, deep-penetrating taproot, and an abundance of lateral roots. Cowpeas grow on a depleted soil as well as, or better

FIG. 37. — A cowpea stem, showing leaves and pod.

than, any other legume, and their power to improve the soil is among the first. Cowpeas are adversely sensitive to wet, cold conditions. (See Exercise 1.)

Varieties of the Cowpea. — Of the fifty or more varieties of cowpeas, there are eight or ten that serve the purposes for which cowpeas are grown. The varieties vary in size, length of stems, and time required for maturity, and also in tendency toward seed production. The following table gives the characteristics of a few varieties. For further information write to the experiment station of your state.

VARIETIES OF THE COWPEA

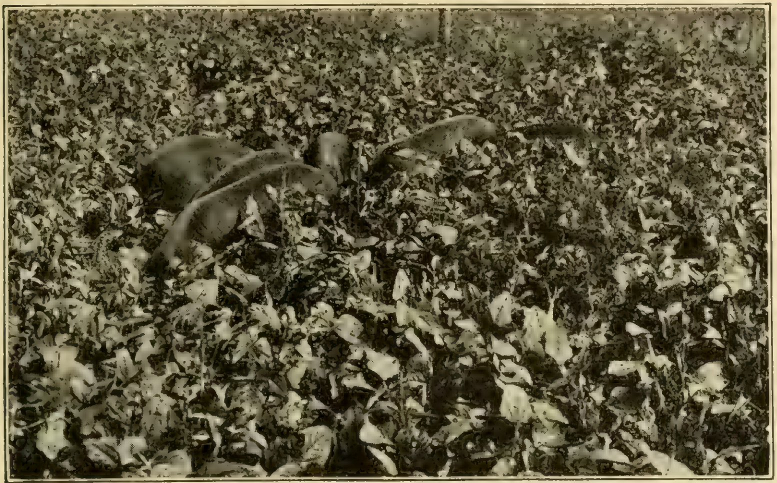
Variety	Days required for Maturity	Regarding Vining	Purposes
New Era . . .	110 to 115	Little	Better for seed
Clay	120 to 125	More	Medium seed and vegetation
Taylor	100 to 110	Less foliage	Produces a fair amount of seeds
Whippoorwill .	115 to 120	Great vines	Better for vegetation, hay, etc.

The seeds of the common varieties of the locality should be studied so that a knowledge of them may become a part of the experience of every country boy and girl. (See Exercises 2 and 3.)

The yields of cowpeas for hay and seed vary with the variety, but yields of from one and one-half to two tons of hay may be expected under average conditions. Cowpeas do not produce quite as much seed as soybeans. However, when soybeans yield from 15 to 18 bushels per acre, cowpeas will yield from 8 to 12 bushels.

Cowpea Culture. — Methods of seeding, cultivating, and harvesting cowpeas are similar to those described for soybeans.

Uses of Cowpeas. — Cowpeas and soybeans are grown in corn as forage crops. When pods begin to turn, sheep may be turned in on the forage. Western lambs are often used to utilize corn and cowpea fields. In from five to six weeks the lambs will fatten and yield to the farmer an average per cent of interest on his investment. Occasionally there will be losses, but when practiced for several years in succession a fair profit is generally realized.



Courtesy College of Agriculture, Columbia, Mo. Bulletin No. 110.

FIG. 38. — An abundance of forage from cowpeas. Cowpeas fit well into a rotation, having the double value of conserving fertility and supplying abundant pasturage.

Cowpeas with corn as a feed have brought the following returns in pork production at the Missouri Station:

RESULTS WITH CORN AND COWPEA FORAGE [1]

YEAR	NUMBER DAYS PASTURED	NUMBER HOGS PER ACRE	POUNDS GAIN PER ACRE	POUNDS GAIN ACCREDITED FORAGE	VALUE OF FORAGE PER ACRE. PORK AT SIX CENTS PER LB.
1909 . . .	30	10	568	568	$34.08
1910 . . .	57	12	276	276	16.56
1911 . . .	28	10	140	140	8.40
1912 . . .	24	24	314	314	18.87
Average . .	$34\frac{3}{4}$	14	324.5	324.5	19.48

[1] *Bulletin 110.*

The results were obtained by hogging down corn and cowpeas. Besides the return in production of pork, the practice of " hogging down corn and cowpeas " is a simple and effective means of preparing the field for tillage and of adding to its fertility. Can you explain this from your study of other leguminous plants, — clover and soybeans?

LABORATORY EXERCISES

1. **Survey of Cowpeas and Soybeans of District.** — Find the number of acres of cowpeas and soybeans produced in your school district.

2. **Study of Several Varieties of Cowpea Seeds.** — Draw the seeds of three or four varieties of cowpeas grown in your locality.

3. **A Language Lesson on the Advantages of Cowpeas.** — Pupils may write three paragraphs on the advantages accruing from the growth of cowpeas.

4. **A Problem on the Money Value of Cowpeas.** — If 40 acres of cowpeas are planted and the yield is 10.6 bushels per acre, what is the money value if they sell for $2.65 per bushel? There are 60 pounds in a bushel of cowpeas. What is a pound worth at the above rate?

CHAPTER VII

ALFALFA

History of Alfalfa. — Alfalfa is among the oldest of forage plants. It originated in Central Asia. The Persians carried alfalfa to Greece in 490 B.C., and the Romans carried it to Rome in 146 B.C. It was probably carried to Spain by the Moors in 711 A.D., and from there it spread to all Europe. The Spanish introduced alfalfa into the New World. Cortez took it with him into Mexico, and it was introduced into California about 1854. Now its distribution is world-wide.

Importance of Alfalfa. — According to recent reports[1] the alfalfa acreage is 7,400,000, and the forage yield per acre is 2.94 tons, worth $22.94 per acre on irrigated lands, and $16.97 on unirrigated lands. The irrigated part contained 2,216,000 acres, or about 30 per cent of the total.

Alfalfa is important because it produces more feed per acre than other hay crops. At the Wisconsin Station, it has been found that alfalfa yields 5.4 tons per acre; red clover, 2.3; and brome grass, 1.3. Although these are higher yields than can be expected under ordinary conditions, still the comparisons are accurate.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Pint samples of alfalfa seeds.

[1] Census, 1910.

In the following table the protein from several crops per acre is given according to data worked out by the New York Experiment Station:

Alfalfa	875 pounds protein
Clover	491 pounds protein
Oats and peas	350 pounds protein
Corn, entire crop	300 pounds protein
Mangels	232 pounds protein
Timothy	228 pounds protein
Sugar beets	213 pounds protein

The importance of alfalfa lies in the fact of its wide adaptability, the total yields it gives, and the large amount of protein it produces. (See Exercise 1.)

Uses of Alfalfa. — Alfalfa has all the advantages attributed to legume crops, discussed in connection with red clover. As a soil builder, as a feed, as to quantity of feed grown on an acre, and as to the amount of protein gathered, alfalfa has no superior. The preceding table[1] brings out some favorable comparisons for alfalfa.

Alfalfa Soils and Sowing. — Alfalfa thrives on deep, pervious soils that admit air and water, and are rich in mineral matter especially lime, potash, and phosphorus. Peaty and clay soils do not furnish the best conditions for alfalfa. However, when clay is tile drained, it may become a good alfalfa soil. Alfalfa will not grow in a wet soil, nor in an acid soil. "Alfalfa will not stand wet feet," is a correct saying. Where the water line is nearer than six feet to the surface, alfalfa should not be sown; and where water occasionally stands on the soil, alfalfa will not thrive. Acid soils, which are often due to wet conditions or overcropping of corn and wheat which need large quantities of lime, will not support alfalfa. Wet soils should be drained and

[1] Henry and Morrison: *Feeds and Feeding.*

acid soils should be made neutral by the addition of ground limestone.

The seed bed for alfalfa should be well prepared. It is important that alfalfa have a firm seed bed such as is desirable for wheat production. The seed bed should be free from weeds; the soil culture a year or two before alfalfa is sown should be of such a nature that the weeds are well in check. The reason for sowing alfalfa in the fall is simply to give it a start of the weeds the following spring. From 10 to 15 pounds of good seed should be sown to an acre. (See Exercises 2, 3, and 4.)

Reasons for Alfalfa Failures. — Failure of an alfalfa crop may be caused by one or more of the following conditions:

1. Wet, impervious soils.
2. Sour, acid soils.
3. Lack of seed-bed preparation. Alfalfa will not grow in a soil unless the soil is well packed and free from weeds.
4. Soil lacking the bacteria which aid alfalfa growing. Putting one hundred fifty to two hundred pounds of soil from a field where alfalfa or sweet clover has been growing will inoculate the soil with the proper bacteria.

FIG. 39. — Alfalfa roots, showing normal nodules.

5. Overcrowding weeds.
6. Cutting alfalfa too late in autumn. A growth of 5 or 6 inches in fall protects alfalfa from freezing, and holds the snows.
7. Close grazing, which soon kills alfalfa.

(See Exercise 5.)

Essentials in Alfalfa Growing. — To raise a good crop of alfalfa, it is necessary to remember the following essentials to its production:

Courtesy U. S. Dept. of Agriculture.

Inoculated Not inoculated

FIG. 40. — Alfalfa showing the effects of soil inoculation

1. Alfalfa thrives on a deep, porous, sweet soil.

2. The seed bed must be well prepared and firm.

3. Frequent cutting aids the alfalfa plant.

4. Soil inoculation never injures alfalfa and generally helps its growth.

5. A good fall growth should be left for winter protection.

6. Lime, potash, and phosphorus are absolutely essential to alfalfa production.

7. Weeds and alfalfa will not grow together. The alfalfa must be given a clean right of way if it is to grow. Eradicate the weeds first.

8. Decaying organic matter or well-rotted manure is an excellent fertilizer for alfalfa.

9. A good quality of seeds should be used.

10. Alfalfa should be cultivated at least once each season, with a disk or a spring tooth harrow. This cultivation may

ordinarily best follow the second cutting. This cultivation destroys the grass and weeds, loosens the surface soil, thereby conserving the soil moistures, and causes the alfalfa to branch more.

RETURNS PER ACRE OF ALFALFA AND OTHER CROPS

	Yield per Acre	Dry Matter	Digestible Crude Protein	Digestible Carbohydrates and Fats	Net Energy in Therms
	Pounds	Pounds	Pounds	Pounds	
Alfalfa hay .	5040	4632	529	2143	1734
Clover hay .	2580	2185	183	1080	896
Timothy . .	2440	2118	68	1106	819
Corn ears and stover . .	3440	2604	140	1824	1762

This table shows a much higher yield, more dry matter, and a great deal more digestible protein in alfalfa hay than in clover, timothy hay, corn ears and stover. The high protein content of alfalfa gives it a high feeding value.

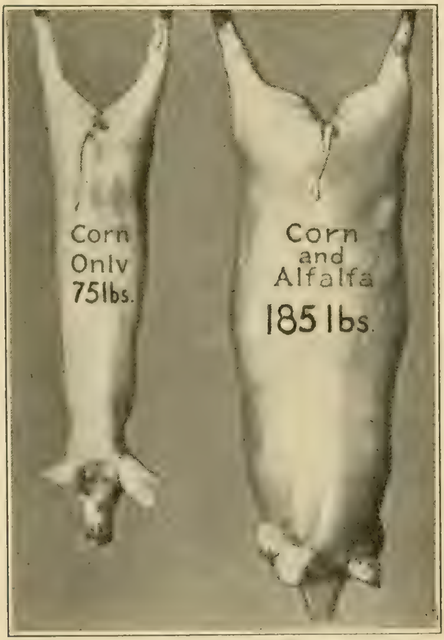
Alfalfa as a forage crop for swine has a great growing and feeding value. There is perhaps no forage crop which will produce as much pork per acre as will alfalfa, since this crop is high in mineral matter and high in protein. It is therefore not necessary to feed any grain in addition to corn when swine are fed on alfalfa forage. In pasturing alfalfa, care should be taken not to pasture too closely as the crop does not seem to be able to stand heavy foraging.

From the following table it will be seen that the alfalfa forage was accredited 591.8 pounds of pork to the acre. This at 6 cents per pound is worth $35.51. This was a very good record for an acre of alfalfa in making pork.

RESULTS WITH ALFALFA. (ONE YEAR'S TRIAL)[1]

1.	Number of days pastured	163	
2.	Number of hogs per acre	10.3	
3.	Gain per acre	1310.0	pounds
4.	Grain fed per acre	4022.0	pounds
5.	Gain accredited to forage	591.8	pounds
6.	Grain fed per pound gain	3.07	pounds
7.	Value of forage with pork at six cents	$35.51	

Alfalfa balances the ration. In Figure 41 one pig was fed corn in a dry pen for 180 days; the other pig was provided corn and alfalfa pasture for 80 days, and then corn and alfalfa hay for 100 days. Although the pigs were practically the same size at the beginning of the experiment, at the end of the period the pig that was fed corn alone averaged 75 pounds and the other averaged 185 pounds. The bones of the pig fed corn and alfalfa were about twice the size of the bones of the pig fed corn alone. The pig fed corn alone made gains at a cost of $31.49 a hundred pounds, while the other pig made one hundred pounds gain at



Courtesy Kansas Exp. Station.

FIG. 41. — Corn and alfalfa were a fairly good ration. Corn alone did not give good results. Alfalfa balances the ration if fed with corn.

[1] *Bulletin 110*, Missouri Station.

a cost of $6.68. This indicates that protein substances are necessary for bone formation and growth.

COST AND FEED TO PRODUCE ONE THOUSAND POUNDS OF BEEF [1]

	WHAT WAS FED	AMOUNT	COST
Lot 1	Prairie hay	16,760 lb.	
	Grain	3,050 lb.	$45.10
Lot 2	Alfalfa	10,000 lb.	
	Grain	1,620 lb.	$28.20

Alfalfa plus grain produced one thousand pounds of beef at a cost of $28.20; and prairie hay and grain at a cost of $45.10.

Making Alfalfa Hay. — In order to get the best results with alfalfa, two points in its harvesting should be observed.

1. The crop should be cut when the new shoots on the crowns of the plants are beginning to grow. If cutting is delayed until these new shoots are cut off, the next crop will be greatly reduced. Maximum yields can be had only when the alfalfa is cut at the proper time.

Some have said that alfalfa should be cut when one-tenth of the plants are in bloom. This is a fair rule to follow, but the rule pertaining to the protection of the new growth is better.

THE STAGE AT WHICH TO CUT ALFALFA [2]

STAGE OF GROWTH	HAY WORTH PER TON	BEEF POUNDS PRODUCED
When one-tenth in bloom	$5.35	706
When in full bloom .	4.90	562
When one-half blooms have fallen . . .	4.35	490

[1] Bulletin, Nebraska Station.

[2] Utah Experiment Station.

The protein content of alfalfa has been found to be:[1]

When one-tenth in bloom	18.5 per cent
When one-half in bloom	17.2 per cent
When in full bloom	14.4 per cent

2. The leaves of alfalfa contain from 75 to 80 per cent of the total protein of the alfalfa plant. For this reason every precaution should be taken in harvesting alfalfa to preserve and keep the leaves of the plant. Cutting the hay at the proper time and handling it in a semi-cured condition, will conserve the leaves. "Make hay while the sun shines," but do not let the sun take all the moisture out of the alfalfa stem and leaves before the alfalfa is put into small cocks. The following day the cocks may be opened into large flakes and left to dry some more. Small caps of canvas placed over the cocks will aid in getting the crop cured properly. When well cured put the alfalfa hay into a barn.

The Composition of Alfalfa Stems and Leaves

	Fat	Carbohydrates	Ash	Protein	Crude Fiber
Stem	0.81	27.79	4.99	6.35	54.33
Leaves	2.96	41.16	14.48	23.33	13.15

If alfalfa is too ripe before it is cut, many of the leaves are lost in harvesting and many young shoots on the crown are clipped. Both points should be carefully observed in alfalfa harvesting.

Summary. — Alfalfa is a native of Asia. Although it was not introduced into the United States until recent years, there are now over seven million acres devoted to this crop. Alfalfa thrives on a deep, porous, sweet soil. Liming and inoculating the soil are frequently essential in securing results in its production. Cutting alfalfa at the proper time is important in growing the

[1] The Kansas Experiment Station.

crop, and in getting the best quality hay. As a forage crop for swine it has great growing and feeding value. With corn it balances the ration. As a feed for milk production 11 pounds are equal to 10 pounds of wheat bran. Where alfalfa thrives it scarcely has an equal in its feed-producing capacity. Its growth should be encouraged where it thrives. (See Exercise 6.)

LABORATORY EXERCISES

1. Alfalfa Survey of the District. — Find the number of acres in alfalfa in the district. All the pupils aid in the survey. Every farmer should be included in this record, even if he has no alfalfa. Record as follows:

ALFALFA SURVEY DATE TEACHER'S NAME

NAMES OF FARMERS	ACRES OF LAND ON FARM	NUMBER OF ACRES ALFALFA	LAND, PER CENT IN ALFALFA	ALFALFA, CUT HOW MANY TIMES

2. Examine and draw alfalfa seeds.

3. To Examine Alfalfa Seed for Adulterants and Weed Seeds. — Examine alfalfa seed to see if it contains weed seeds. What kind of weed seeds did you find in alfalfa?

4. To Plant and Grow Alfalfa with Different Soil Treatment. — School children should plant some alfalfa on school ground. If some of it can be treated with different fertilizer, some limed and some inoculated, the test, if carefully taken care of, may become of real service to the farmers of the district.

5. To Study Alfalfa Roots. — If alfalfa is growing in the locality, it will be interesting to dig up some plants to find the length of the roots, and also to examine the nodules on the roots. Draw them.

6. Comparison of Bran and Alfalfa Hay. — Dairymen claim that 11 pounds of good alfalfa hay is worth as much as 10 pounds of wheat bran for milk production. Compare the two feeds in digestible composition and price. (See table on page 108.)

CHAPTER VIII

PASTURES

If the amount of pasture grasses that are eaten, digested, assimilated, and manufactured into beef, pork, milk, horse flesh energy, and into poultry products, could be known, the amount would compare well with that secured by feeding dry feeds. Many a practical farmer knows that an acre of good pasture may be converted by the right kind of cattle into one hundred to two hundred fifty pounds of beef per season. The dairyman realizes his biggest profits in the spring of the year. Pastures generally receive little attention and care, yet the products from the pasture yield large returns annually. (See Exercise 1.)

Kentucky Blue Grass. — Kentucky blue grass is the most important pasture grass in America. It grows best in a moist limestone, rather compact, firm soil. It grows in every section and state of our nation, but it thrives best in the regions where corn, oats, timothy, and wheat are grown. It is shallow rooted, and therefore does not do well in a dry, or porous loose soil. Blue grass increases or reproduces by underground stems and is very hardy. Tramping and grazing seem to aid in causing this wonderful plant to yield the best results.

White Clover. — This is an important plant for use in pastures. It supplements blue grass, just as red clover supplements timothy. White clover grows from seeds, and its stem, unlike the other clovers, spreads out on the ground and takes root. White clover will grow on very poor soils where other clovers fail. Its growth should be encouraged.

FIG. 42. — A white clover plant grown from a single seed, showing spreading habit.

Mixtures of Grasses and Clover. — Blue grass, red top, white clover, and alsike are a fine combination for pastures. In seeding a pasture 3 pounds of red clover may be included to good advantage. The following is a fair mixture to sow per acre:

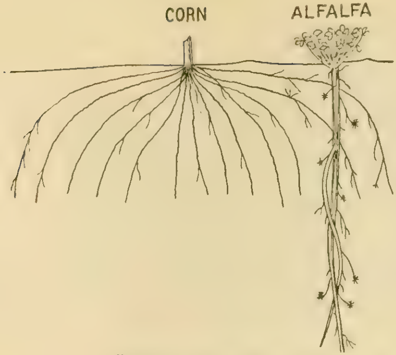
Blue grass	4 pounds
Red top	3 pounds
White clover	3 pounds
Alsike	$1\frac{1}{2}$ pounds

There are several advantages in having a mixture of grasses and clovers for pastures. Among the more important are these:

1. The clover will gather free nitrogen and store it in the soil. Nitrogen is one of the most essential elements making for luxuriant vegetative growth.

2. Mixtures of plants grow at different seasons. Blue grass grows well in early spring and in the late fall, but in dry, hot midsummer it does not thrive so well. White clover and alsike are in their glory in hot midsummer.

3. The mixture of plants is capable of converting more soil plant foods into plant tissue because their root systems feed in



Courtesy of International Harvester Co.

Fig. 43. — Grasses feed near the surface of the soil, and legume roots feed much deeper.

different layers of the soil. The clovers have long tap-roots. The grasses feed at the surface.

4. The mixture above suggested will fit different types of soil. Alsike and red top will grow in wet, cold acid places, and blue grass and white clover will do better in sweet, medium moist soils.

5. A mixture of grasses will furnish a variety of feeds, and will have a greater capacity for producing the product desired. The proportion of protein is increased by the clovers.

Digestible Parts of Pasture Plants

Plant	Dry Matter	Fat	Carbohydrates	Protein	Nutritive Ratio
Blue grass .	31.6	0.6	14.8	2.3	1 : 7.0
Red top . .	39.3	0.6	20.0	1.9	1 : 11.3
White clover	21.8	0.5	9.6	3.1	1 : 3.5
Alsike . .	21.5	0.4	10.4	2.3	1 : 4.9

The narrow nutritive ratio of white clover and alsike indicate the relative high protein content they contain.

There is no one pasture plant that is better than blue grass in beef production, but the above mixture is probably better. That food production of a mixture of grass and clover per acre is greater remains unquestioned.

Management of Pastures. — Weeds of various kinds, " like dogs among sheep in the night," will appear and take for themselves a large part of the soil moisture and soil foods. They reproduce so abundantly that they should be cut twice every year before they mature seeds. Sheep and goats help to renovate a pasture of weeds. If a mower is used, it should be set high enough so that the grass itself is not injured. (See Exercise 2.)

There is an old German adage which states, "The eye of the master fattens cattle." In the fattening of cattle, it has been found a good practice to shift the cattle from poorer to better grass as the fattening process continues. If blue grass is to furnish self-cured grazing herbage for the winter, it should not be pastured in late fall.

Early spring pasturing, before the roots have had a chance to grow and get well set, cripples the growth of grass the entire season. It will be found economical to let it get a good growth in the spring. Any growing plant will manufacture the most food when it has the largest amount of green leaf surface. On the other hand, when grass becomes too large, the part near the surface of the soil becomes bleached. The bleached part is like a dead limb on a tree; it has ceased to manufacture foods and has become functionless. Such a condition indicates that the maximum good is not to be derived from the grass. On the other hand, turning to pasture too early in the spring before the grass has had a chance to grow and expose the maximum amount of green leaf surface to the sun, is wasteful because the green chlorophyll bodies (the real starch

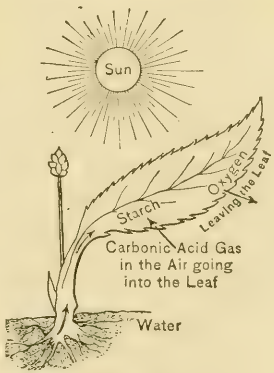


FIG. 44. — The amount of food, starches especially, that a plant can manufacture depends directly upon the amount of leaf surface exposed to the sun.

factories of the plant) are small in number and therefore are unable to manufacture the maximum quantity of foods.

Pasture grasses when small furnish very little feed, because the grass is watery, and it has not had time sufficient to manufacture much plant. More than that, if grass is pastured early, the roots are stunted and do not do their best work the entire season. It is good farm practice to let the pastures get a good growth before stock is turned upon them.

During the months of high temperature, blue grass dries up to a considerable extent. Some farmers have found it profitable to provide a small feed of corn silage for their cows during these months.

Pastures need fertilizing occasionally. Barnyard manures, or a small amount of a nitrogenous top-dressing, may prove economic. From 150 to 300 pounds of nitrate of soda per acre applied in early spring when the grass begins to grow, and three or four weeks before the stock is turned on in the spring, will increase the growth considerably. Other nitrogenous fertilizers may be had from the packing concerns.

Summary. — The beef, dairy, mutton, pork, and poultry products derived from pastures are large. Blue grass, red top, white clover, and alsike clover are our most important pasture plants. Growing a mixture of grasses and legumes has many advantages. Keeping pastures free from weeds, and permitting the grass to get a good start in early summer, are important in the management of pastures.

LABORATORY EXERCISES

1. **Study of the Importance of Pastures.** — Find the number of acres of land in pasture grasses in your school district.

2. **Study of Weeds in Some Pastures.** — Go to a near-by pasture and see how many and what kind of weeds there are growing in it.

CHAPTER IX

FEEDS AND FEEDING

THE matter of feeding well and economically is of the greatest importance to every farmer. Economic feeding means the most nourishing food at the lowest cost. It is often hard to discover the most satisfactory feeds for beef steers, sheep, swine, or poultry. We shall study the subject briefly here. For a fuller treatment of the matter refer to bulletins and textbooks.

Composition of Feeds. — Feeds are chemically composed of water, carbohydrates, fats, proteins, and ash. *Water* in plants is an important part of the feed stuff. Green grasses contain more than three-fourths water and all dry feeds contain about one-tenth water. Blue grass is about three-fourths water. The chemical formula for water is H_2O.

Carbohydrates comprise the starches and sugars in plants. The elements carbon, hydrogen, and oxygen make up the carbohydrates. If we cut a wheat or corn kernel in two parts, we shall see a white substance that is starch. The flour of wheat is nearly all starch. Dry ear corn and wheat kernels contain about three-fifths starch. The chemical formula for starch is $C_6H_{10}O_5$ and for cane sugar it is $C_{12}H_{22}O_{11}$. Plants are largely composed of carbohydrates, and the cells of plants are on a carbohydrate basis.

Fats are found in many grains. Wheat is 2.1 per cent fat; cowpeas and soybeans contain 2.6 and 2.8 per cent of fat, respectively. Fats are composed of the elements carbon, hydrogen, and oxygen. The chemical formula for stearin, one of the fats in butter, is $(C_7H_{35}O_2)_3C_3H_5$.

DIGESTIBLE COMPOSITION OF SOME FEED STUFFS [1]

(All analyses are given)

	Total Dry Matter	Pounds of Digestible Nutrients in 100 Lb.				
		Crude Protein	Carbo-hydrates	Fat	Total	Nutritive Ratio is as 1 is to
Corn products						
Dent corn	89.5	7.5	67.8	4.6	85.7	10.4
Gluten feed	91.2	15.1	57.8	4.8	83.7	4.5
Germ oil meal	92.2	10.0	50.3	10.0	82.8	7.3
Wheat products						
Wheat	89.8	9.2	67.5	1.5	80.1	7.7
Bran	89.9	12.5	41.6	3.0	60.9	3.9
Middlings	89.6	13.4	46.2	4.3	69.3	4.2
Oats						
Oats	90.8	9.7	52.1	3.8	70.4	6.3
Oat straw	88.5	1.0	42.6	0.9	45.6	44.6
Hays						
Timothy	88.4	3.0	42.8	1.2	48.5	15.2
Alfalfa	91.4	10.6	39.0	0.9	51.6	3.9
Red clover	87.1	7.6	39.3	1.8	50.9	5.7
Cowpea	90.3	13.1	33.7	1.0	49.0	2.7
Soybean	91.4	11.7	39.2	1.2	53.6	3.6
Grasses						
Blue grass	31.6	2.3	14.8	0.6	18.5	7.0
White clover	21.8	3.1	9.6	0.5	13.8	3.5
Red top	39.3	1.9	20.0	0.6	23.3	11.3
Meat products						
Tankage	92.5	48.1	0.0	13.7	78.9	0.6
Meat scraps	94.0	37.0	0.0	11.0	61.8	0.7
Cow's milk	13.6	3.3	4.9	4.3	17.9	4.4
Skim milk, gravity	9.6	3.1	4.6	0.9	9.7	2.1
Buttermilk	9.4	3.4	4.9	0.1	8.4	1.5
Corn silage	26.3	1.1	15.0	0.7	17.7	15.1
Cottonseed meal, good	92.1	31.6	25.6	7.8	74.8	1.4

[1] Henry and Morrison: *Feeds and Feeding.*

Proteins are also found in plant tissue. Dent corn has 10 per cent protein; wheat, 12.5 per cent; and oats, 12.5 per cent. Protein substances contain the elements carbon, hydrogen, oxygen, and nitrogen, of which "nitrogen" is the most important. The chemical formula of a protein is $C_7H_8N_4O_2$. The protein substances in grain crops is called gluten; in legumes, legumen; in eggs, albumen; in meat, myosin; and in milk, casein. The cell of animal tissue is on a protein basis.

The ash substances of feeding stuffs comprise the elements sulphur, phosphorus, potassium, calcium, magnesium, iron, sodium, silicon, and chlorine, which remain after a substance has been burned. Dent corn contains 1.5 per cent ash material; wheat, 1.9 per cent; and oats, 3.5 per cent.

The general facts of this table have an important bearing upon feeding, and the study of the composition of feed stuffs has practical value.

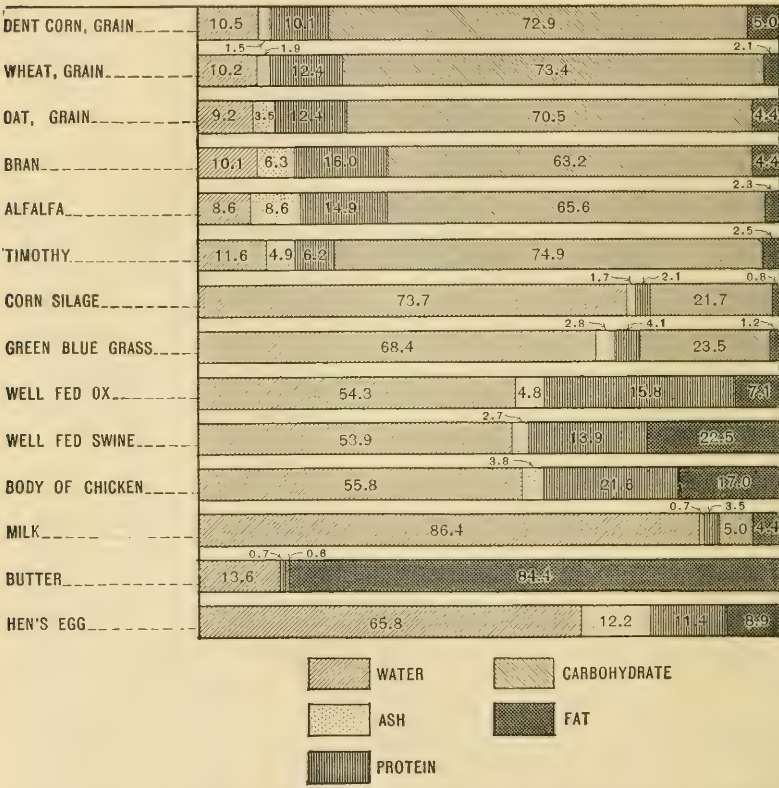
Composition of Animal Bodies and their Products [1]

	Water	Dry Matter	Protein	Fats	Ash	Sugar
(Approximately)						
Beef steer	53.0	47.0	13.5	34.0	3.60	0.0
Fat pig	49.0	51.0	12.0	40.0	2.25	0.0
Fat lamb	47.8	55.2	12.3	28.5	2.94	0.0
Milk	86.4	13.6	3.5	4.4	0.7	5.0
Eggs (edible part)	74.0	26.0	14.9	10.5	0.8	0.0

The study of the above table in comparison to the preceding one brings out the similarity of the composition of animal bodies and their products to the composition of plants and their products.

[1] Henry and Morrison: *Feeds and Feeding.*

This similarity of the chemical composition of animal bodies and plants may be compared by studying the following diagram:



From the above diagram it may be seen that plant and animal tissue is somewhat similar in chemical composition. It may be noted, however, that plants contain a great deal of carbohydrate material, and that animals contain no carbohydrates. On the other hand, it may be observed that animal bodies contain a greater amount of protein material in proportion to the total dry matter found in animal tissue than is found in plant tissue. There is generally a greater proportion of fat in animal bodies than in plant bodies. Corn has 4.6 per cent fat, and a well-fed pig has 22.5 per cent. Corn has 67.8 per cent carbohydrates, and the well-fed pig has none. As we shall see in a following paragraph, the carbohydrates are used for producing heat energy and fat. The diagram deserves close stud˙. The figures show the percentage of nutrients found in each article given.

Function of Food Materials. — *Water* is used to build up body tissue. About 50 per cent of the body is made up of water. Milk and eggs are composed of 86 and 74 per cent of water, respectively. It also helps to dissolve other foodstuffs, and helps to carry them through the digestive canal. Water, through perspiration and otherwise, relieves the body of waste material. Through perspiration it aids in equalizing the temperature of the body.

The Carbohydrates, the starches and sugars, have two functions:

1. To provide heat energy to the body. (Carbon, hydrogen, and oxygen, of which they are composed, are good heat producers.)
2. To provide fat. Since the composition of carbohydrates and fats is so similar, little change is necessary to convert a carbohydrate into fat. Every farmer knows that starches and sugars are good fatteners.

The Fats, often defined as concentrated carbohydrates, have the same function as the carbohydrates. In cold regions more fats are fed because they furnish more heat. A pound of fat furnishes $2\frac{1}{4}$ times as much heat as a pound of carbohydrates.

The Proteins build bone, muscle, connective tissue, horn, hoofs, skin, and hair. The protein foods are the only source of the protein in the body. Proteins supply nitrogen, which cannot be supplied by the carbohydrates. Protein feeds make for growth, vigor, quality of skin, and hair, and are essential to milk and egg production and work. (Fig. 41, p. 98.)

The Ash Elements in foodstuffs form bony tissues, help the blood, and aid digestion. The ash elements are important, but are not usually considered in figuring the nutritive ratios of feeding stuffs.

Food Requirements of Animals. — Food requirements vary with different conditions of work and temperatures; a few statements are applicable generally. The best physiologists teach us that the human body needs about eight times as much carbonaceous materials as protein substances. Agriculturists tell us that the following are the food requirements of different animals under the different conditions given:

	Part Protein to Carbohydrates in Nutritive Ratio for Different Animals under Different Conditions
Horses at light work	1 : 7.0
Horses at heavy work	1 : 6.0
Milch cows giving milk	1 : 6.8
Fattening steer	
First period	1 : 6.8
Second period	1 : 5.5
Third period	1 : 5.2
Fattening swine	1 : 5.5
For egg production	1 : 4.8
For growing fowls	1 : 4
For fattening chickens	1 : 7.5

Finding the Nutritive Ratio. – The nutritive ratio of a feed is found by multiplying the digestible fats by $2\frac{1}{4}$, adding the digestible carbohydrates, and dividing the result by the digestible proteins. To illustrate, corn has this composition: Fats 4.6 per cent, carbohydrates 67.8 per cent, protein 7.5 per cent.

Then the N. R. of corn $= \frac{4.6 \times 2\frac{1}{4} + 67.8}{7.5}$ or 10.4

or the nutritive ratio of corn is 1 : 10.4. Likewise the nutritive ratio of any feed or food may be found.

Balancing a Ration. — A milk cow requires a ration whose nutritive ratio is as 1 : 6.8. Since the N. R. of corn is 1 : 10.4, it is evident that it contains too much carbohydrate material. Therefore if corn is fed, some feed that contains more protein must be added. Alfalfa is richer in protein than corn. Let us see what the N. R. of the following ration is.

	Fats	Carbo-hydrates	Protein
10 lb. alfalfa hay $= \frac{1}{10}$ of 100 lb., or	.09	3.90	1.06
5 lb. corn $= \frac{1}{20}$ of 100 lb., or	.23	3.40	.37
20 lb. corn silage $= \frac{1}{5}$ of 100 lb., or	.14	3.00	.22
Total	.46	10.30	1.65

$$\text{N. R.} = \frac{.46 \times 2\frac{1}{4} + 10.30}{1.65} = 6.8$$

or the N. R. of the above ration is 1 : 6.8.

A balanced ration is one in which the protein, carbohydrates, fats, and ash materials are fed in proper proportion. The needs of the animal, of course, must be taken into consideration in balancing a ration.

Summary. — The question of properly and economically feeding farm animals is one of the most difficult and important farm problems. A careful study of the result desired will be a help in providing the best feeds. The feed requirements of animals vary with work and conditions. Thus a horse at heavy work requires more protein than one that is doing light work. The feeds should be properly balanced so that the correct nutritive ratio is provided. (See Exercises below.)

LABORATORY EXERCISES

1. To Find the Cost of Rations. — Find the cost per ton, and per one hundred pounds, of each of the feeds fed to at least three kinds of animals.

Also find the number of pounds of each of the feeds fed to some farm animal, and find the cost of the ration for one day.

2. Comparison of a Few Feeds. — Compare closely the composition of alfalfa and bran; silage and alfalfa; corn and wheat; milk and skim milk; tankage and cottonseed meal. Compare the feeding value of each pair of feeds suggested.

CHAPTER X

THE HORSE

Importance of Horses. — The value of the horses in the United States is greater than the value of cattle, sheep, and swine combined. The number, value per head, and total value of all horses, all cattle, swine, and sheep follows:[1]

	Number in U. S.	Average Value	Total Value
Horses, mules, asses, and burros	24,148,580	$108.59	$2,622,180,170
All cattle	61,803,866	24.26	1,499,523,607
Swine	58,185,676	6.86	399,338,308
Sheep	39,644,046	4.44	232,841,585

From this table it may be observed that the value of all horses is about one-half billion dollars greater than the value of all cattle, swine, and sheep.

Contrary to the opinion of some, horses and mules have not decreased in numbers the last five years. According to the United States Yearbooks of Agriculture, there were an average of 21,179,000 horses and mules in the United States during the

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this Chapter are:

Two draft and two light horses to judge; a saddle horse; and a five foot measuring tape.

[1] *1910 Census Report.*

five years from 1907 to 1911 inclusive, and for the five years 1912 to 1916 inclusive there were 21,769,000 horses and mules in the United States. This shows that there are more horses and mules in the United States now than ever before. Below is a list of the states in which is found the largest number.[1] They have more than half of all the horses and mules in the United States. Can you give a reason for this?

Graph 6. The leading states in horse and mule production.

A Few Essentials in Judging Horses. — A good judge of horses must be a close observer, quick to see deviations from a correct conformation. He must know the different breed characteristics, and be able to tell the age of a horse, capable of detecting blemishes and unsoundnesses of horses, and of passing judgment upon the above points. Discussions of the things which will enable the pupil and farmer to improve themselves in putting a proper estimate on horses follow.

[1] *United States Yearbook of Agriculture.*

The Parts of a Horse. — The skeleton of a horse is the framework upon which the conformation, action, and other important features of a horse largely depend. Each type has features that are distinctive; for instance, the draft horse has a larger frame

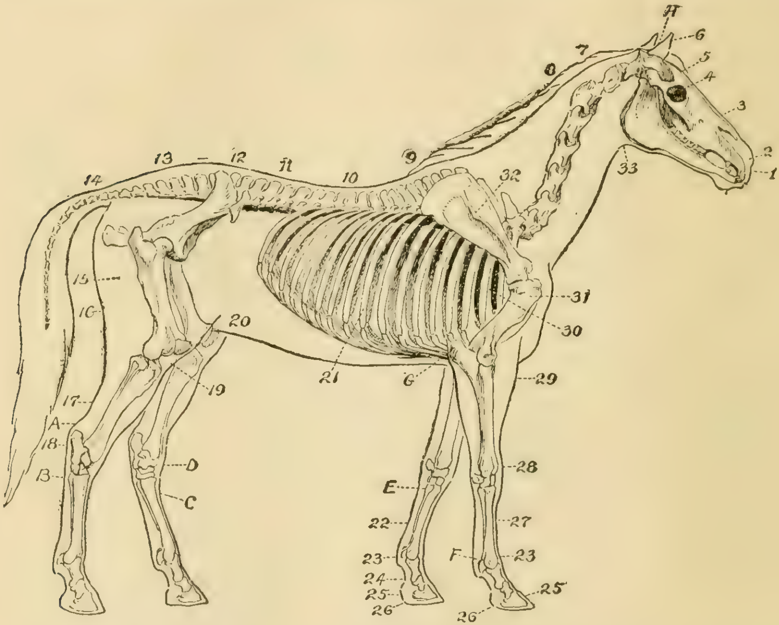


FIG. 45. — The parts of a horse.

1. Muzzle; 2. nostrils; 3. face; 4. eye; 5. forehead; 6. ear; 7. neck; 8. crest; 9. withers; 10. back; 11. loin; 12. hip; 13. croup; 14. tail; 15. thigh; 16. quarter; 17. gaskin or lower thigh; 18. hock; 19. stifle; 20. flank; 21. ribs; 22. tendons; 23. fetlocks; 24. pastern; 25. foot; 26. heel of foot; 27. cannon; 28. knee; 29. forearm; 30. chest; 31. arm; 32. shoulder; 33. throat latch; *A*. thoroughpin; *B*. curb; *C*. bog and blood spavin; *D*. bone spavin; *E*. splint; *F*. windgall; *G*. cappel elbow; *H*. poll evil.

and the bones are heavier. The pasterns are generally shorter and thicker than are the pasterns of the light horse.

The form of the skeleton affects the action. There are three or four important points considered in action; namely, length of stride, elasticity, trueness, and energy of action. Length of stride is to some extent dependent upon the length and obliqueness of shoulder and pastern. Straight shoulders and pasterns give the horse a short stride, with heavy concussion, conducive to blemishes. Elasticity and springiness are impossible with a straight shoulder and pastern. Trueness of action is dependent, to a large degree, upon the attitude of the legs. If the legs are straight, the action will be straight and true.

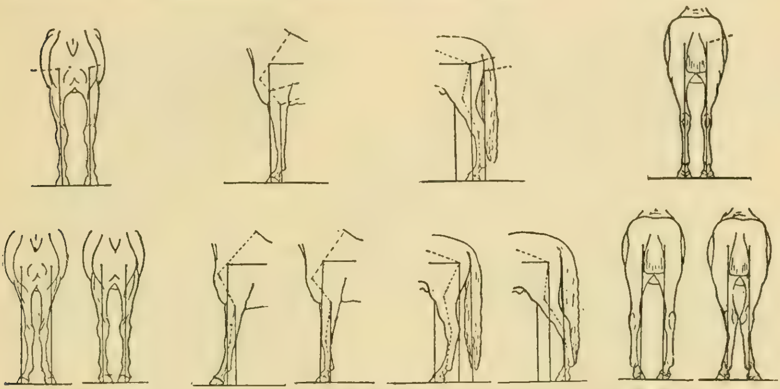
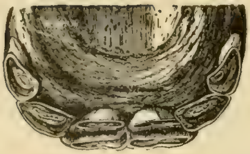


FIG. 46. — The upper four pictures show correct conformation that gives strength and trueness of action; the lower pictures illustrate incorrect conformation, which is conducive to poor action.

If from the front the knees are in or out, or if the front feet set in or out, the action cannot be straight and true. Also if the hocks are in, as they often are, and the rear feet are out, the action will be untrue. The action of a horse is largely dependent upon the conformation of the skeleton.

How to Tell the Age of a Horse. — Horses have two sets of teeth, a temporary and a permanent set. The temporary teeth make their appearance during the first and second months of the colt's life. They are small, very white, and soft. They change as follows: The middle incisors come out when the colt is two and one-half or three years old, and the permanent ones



Lower front teeth at three years of age. Two center permanent teeth up.

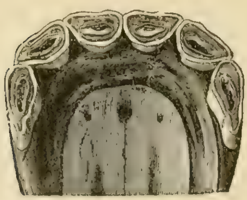
Lower front teeth at four years of age. Four center permanent teeth up.

Lower front teeth at five years of age. All permanent teeth up.

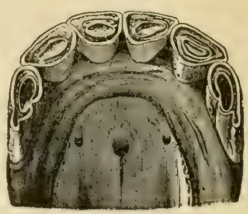
Lower front teeth at six years of age. Cups out in center pair.

Lower front teeth at seven years of age. Cups out of intermediate pair of incisors.

Lower front teeth at eight years of age. Cups all out.



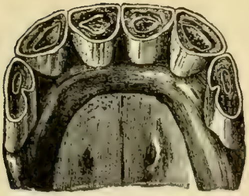
Upper front teeth at nine years of age. Cups out of center pair.



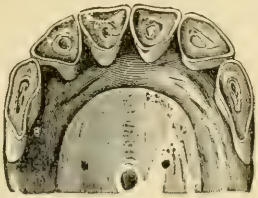
Upper front teeth at ten years of age. Cups out of intermediate pair.

Fig. 47.

take their place. The intermediate incisors above and below disappear when the horse is three and one-half or four years old, and permanent ones take their place. At four and one-half or five years the corner incisors disappear, and the permanent ones take their place. At five, the permanent teeth are all present and the horse is said to have a full mouth. The permanent teeth are larger, darker in color, and of a harder texture than the milk teeth. To tell the age of a colt under five years notice



Upper front teeth at eleven years of age. Cups all out.



Upper front teeth at twenty-one years of age. Note the triangular form of the teeth.

Side view at five years of age.

FIG. 48.

which temporary incisors are gone, and which ones are still present.

To tell the age of a horse after he is five, observe the disappearance of the cups in the teeth. The cups in the teeth of the lower jaw disappear first. The cups in the middle two lower incisors are gone when the horse is six years old; the cups in the intermediate lower incisors are gone at seven; and the cups of the lower corner incisors are gone at eight.

The cups in the upper jaw disappear from the middle, intermediate, and corner incisors at the ages of nine, ten, and eleven years, respectively. The exact time at which the cups of horses' teeth disappear depends upon the texture of the teeth, the kind of feed, and the disposition of the horse. At twelve the horse has a smooth mouth. After twelve the age of a horse cannot be accurately told. Harper says,[1] "After a horse has passed the twelfth year, a year or two matters little. Much depends on the individuality of the animal, as some animals are worth more at fifteen than others at twelve. The value of a horse should then be determined from general appearances and activity rather than upon age." (See Exercise 1.)

Blemishes, Unsoundness, and Diseases of Horses. — Blemishes are defects which do not interfere with the functioning of the part affected. Unsoundnesses do interfere with the functioning of the part affected. A wire cut may be a blemish only, because it may not interfere with the action of the horse. But a ringbone, sidebone, curb, and similar defects do interfere with the proper functioning of the parts affected, and are therefore called unsoundnesses. A disease irritates parts of the body, so that the horse is sick. Distemper, bots, heaves, and colic are diseases. We shall study the most important blemishes and unsoundnesses.

Defective Vision. Horses are often totally blind. This defect may be easily observed by looking at the horse's eye and watching the horse walk, for a blind horse will lift its feet higher than is natural.

Defective Hearing. Some horses are hard of hearing. Such a horse does not respond when spoken to, and will use its eyes unduly, and the ears are usually held rigidly.

Poll Evil appears between the ears over the poll. It is due to bruises of the poll, often caused by standing in a stable that has a low ceiling. The poll is bruised and becomes sensitive. The horse suffering from poll evil does not like to be bridled, because any touch on the poll is painful. This defect can usually be remedied by preventing irritation to the poll.

[1] Harper: *Animal Husbandry for Schools.*

Fistulæ are collections of pus, as indicated in Fig. 49. This defect, like poll evil, is caused by a bruise. Often horses in rolling bruise the withers on a stone or hard soil and fistulæ result. They should be opened at the lowest point possible, and washed out with a three per cent carbolic acid solution or some other good disinfectant.

FIG. 49. — Fistulæ.

Sore Shoulders are usually caused by an ill-fitting collar. A horse having shoulders that are 20 inches long and a bearing surface of 2 inches wide, has a total of 80 square inches of bearing surface. If a collar fits well, and the horse pulls 2000 pounds, there is a weight of 25 pounds on each square inch. But if the collar is too long, all the weight of the load is borne on the shoulder point, or about 8 square inches. Then the weight and pressure on each square inch is 250 pounds, and causes sore shoulders. A well-fitting collar will prevent this.

Sweeny is also a defect on the shoulder. The muscles over the shoulder blade shrink, and the remaining muscles apparently grow fast to the bone. It is difficult to lift the skin over the region affected.

Capped elbow, occasionally called shoe boils, may be caused by the horse hitting the elbow with the shoe of the rear foot upon lying down. Capped elbow does not interfere with the action of the horse.

Splints, bony deposits at the end of the splint bones, generally occur on the inner front cannon and sometimes near the tendon. Near the tendon a splint interferes with the horse's action much more than a splint on the inner front cannon.

Scratches appear on the rear of the pastern. Scratches are a chapped condition of the skin, and are caused by the horse's standing in unclean, muddy, wet stables. Give the horse a clean stable, wash the parts affected, first with soap, and then with clean, well-boiled, salt water.

Ring Bones and *Side Bones* are due to a bony deposit and occur just above the top of the hoof, generally on the front feet. There are two forms of side bones, high and low. Ring bones grow nearly all the way around the hoof, and side bones grow on the sides only.

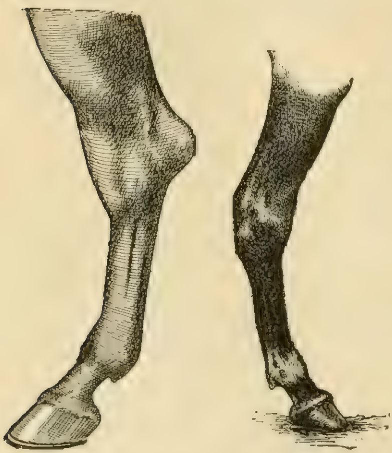


Fig. 50. — A capped hock and a curb.

Quarter Cracks and Sand Cracks. Quarter cracks appear at the rear quarter of the foot, and sand cracks appear on the front part of the hoof. Corns and thrush are other blemishes of the feet.

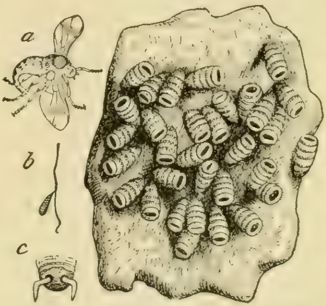
Blemishes and Unsoundnesses of the Hock are the most common defects in horses. A *capped hock* is an enlargement and thickening of the skin of the hock. A *curb* is a bony deposit that appears about three or four inches below the hock and is more serious than a capped hock. *Thoroughpins* appear between the tendon and the bone, just above the hock. Thoroughpins are knot-like in shape, and movable. *Bone spavins* appear on the inner lower point of the hock and may be seen from the front of the horse. *Bog spavins* are soft swellings made by the deposit of oil of the joint and appear in the natural depression on the inner and front part of the hock.

Wind Puffs occur just above either the front or rear fetlocks.

Distemper is a bad cold of a horse. It is very contagious; horses suffering from it should be isolated, and not permitted to drink or eat with the other horses. Distemper may usually be cured by keeping the horse in clean, dry, warm, sunshiny quarters, and feeding it carefully.

Heaves is a disease of the lungs in which the air sacs become distended and the muscles around the sacs lose their power to control exhalation. Air escapes from the lungs suddenly and loudly.

Bots are due to the bot fly which deposits its eggs on the front cannon of the horse, where they hatch. They cause an itching sensation and the horse bites them off and swallows them. The larvæ remain in the stomach of the horse for about nine or ten months, securing their food from the inner lining of the stomach. The best way to combat bots is to destroy the eggs while on the cannon by wetting well with kerosene or some disinfectant. (See Exercise 2.)



Courtesy of Orange Judd Co.

FIG. 51. — Bots in stomach. At right young bots attached to stomach wall. *a*. female bot fly; *b*. the bot; *c*. magnified head of bot.

Every effort should be made to keep the horse free from blemishes, unsoundnesses, and diseases of all kinds. With care one may protect the horse so that bruises and sprains will be prevented.

Draft Horse Type. — Draft horses are large, compact, and heavy. When fat, they weigh from 1600 to 2300 pounds. The weight of draft horses affects the price. Heavy draft horses bring more per pound than light draft horses. In 1893 a Chicago firm found the average prices for the weights as follows: [1]

[1] Craig: *Judging Live Stock*.

Average Weight	Average Price	Cents per Pound
1400	$155.87	$0.111
1450	159.15	0.109
1500	169.15	0.112
1550	176.56	0.114
1600	176.62	0.110
1650	208.64	0.126
1700	212.89	0.125
1750	236.14	0.126
1800	258.33	0.135

It will be seen from this table that horses weighing 1800 pounds brought more than $100 more than horses weighing 1400 pounds. Weight is an important factor in draft horse values.

The importance of quality of bone, skin, and hair of a draft horse can hardly be overemphasized. Roughness of bone, showing blemishes and unsoundnesses, is a bad condition. The leg should be flat and wide, with well-defined tendons. The skeleton of a draft horse is better covered than that of a light horse, and therefore blemishes are often difficult to detect. Sound texture of bone and foot are desirable points. A good foot is essential to any horse. The old saying, "no foot, no horse," is correct. A sound, tough-textured, good-sized, concave, solid foot is essential in a draft horse. The legs and feet should be straight from the front and the back. A well-sloping shoulder and well-sloping pastern are essential. A long, regular, true elastic walk is the essential gait of this type of horse. (See Exercise 3.)

The Draft Horse Breeds. — *The Percheron* horse originated in La Perche, France. All horses used in France for breeding purposes are examined by Government veterinarians, and are classified as follows:

FIG. 52. — A Percheron type, showing the conformation, intelligence, temperament, and countenance desirable in a Percheron horse.

Courtesy of Hale Pub. Co.

FIG. 53. — A Percheron mare, showing the breed characteristics, form, and color that are most typically Percheron.

1. Approved horses are the best, and the owners are given a bonus yearly of $60 to $100 as a subsidy, by the national government.

2. Subsidized horses are the next best, and owners of this class of horses are given a bonus of about $60 yearly.

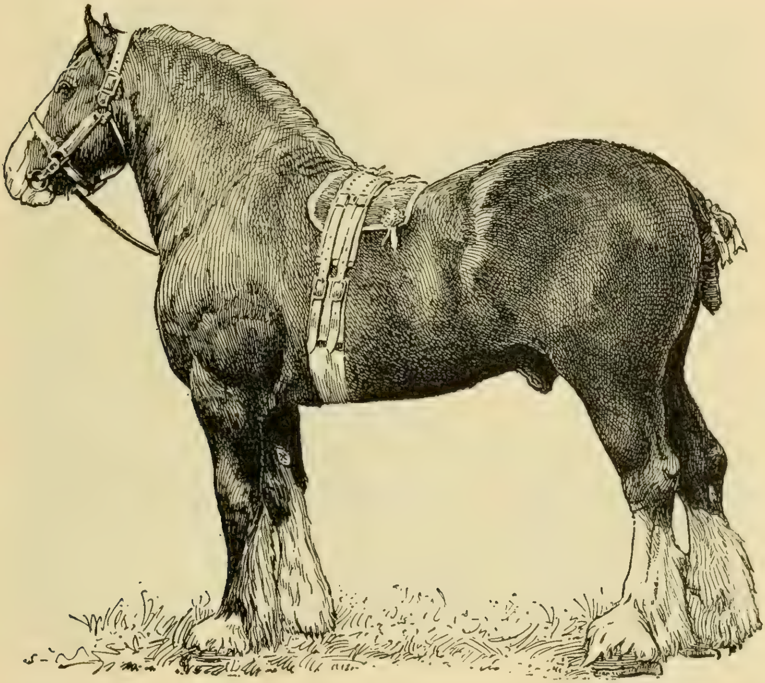


FIG. 54. — Baron's Pride. Said to be the greatest Clydesdale sire in the world. Shows the conformation, sloping shoulders and pasterns, short back, and a distribution of white points that stamp this breed.

3. Authorized horses belong to the poorest class, and are permitted to be used as breeding stock, but are considered mediocre horses, — and their kind is discouraged. Such government support as the above helps in building up a definite type of animal.

Percheron horses have been imported in large numbers into the United States, and are found chiefly in Illinois, Iowa, Ohio, Indiana, Michigan, Wisconsin, New York, Pennsylvania, and Minnesota.

FIG. 55. — A Shire stallion, showing the most approved type combining size, weight, conformation, draft, and color typical of this breed.

Percheron horses have definite breed characteristics. They are usually black or gray in color, $15\frac{1}{2}$ to 17 hands high, weighing from 1600 to 2100 pounds. They have a strong conformation and are noted for their constitution and endurance. They generally have excellent feet, excellent heads and necks, and in every respect are fine horses. For a combination of constitution, endurance, feet, speed, and strength, they have few equals and no superiors. (See Exercise 4.)

The Clydesdale horse has been developed by Scotch breeders along the Clyde River in Scotland. Though they are of mixed origin, since about 1850 they have been kept pure. Clydesdale horses are now found chiefly in Germany, Russia, Sweden, Argentine Republic, and the United States.

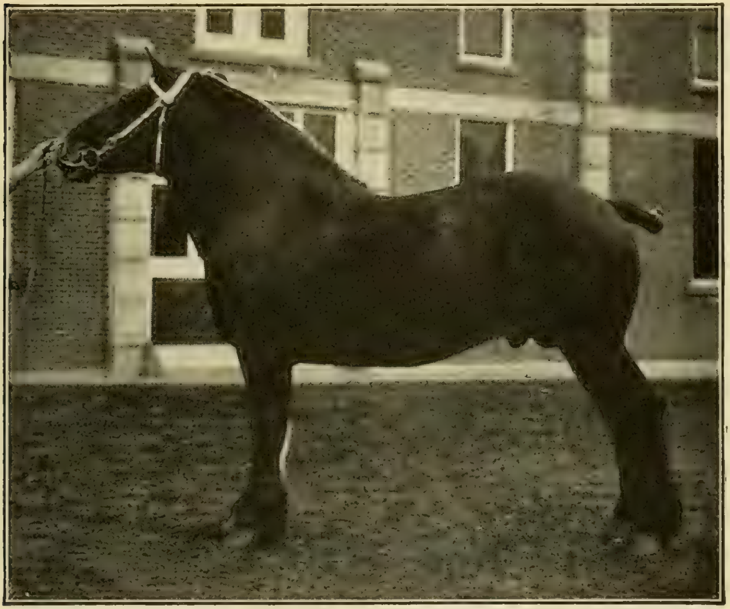


Fig. 56. — Belgian draft horse.

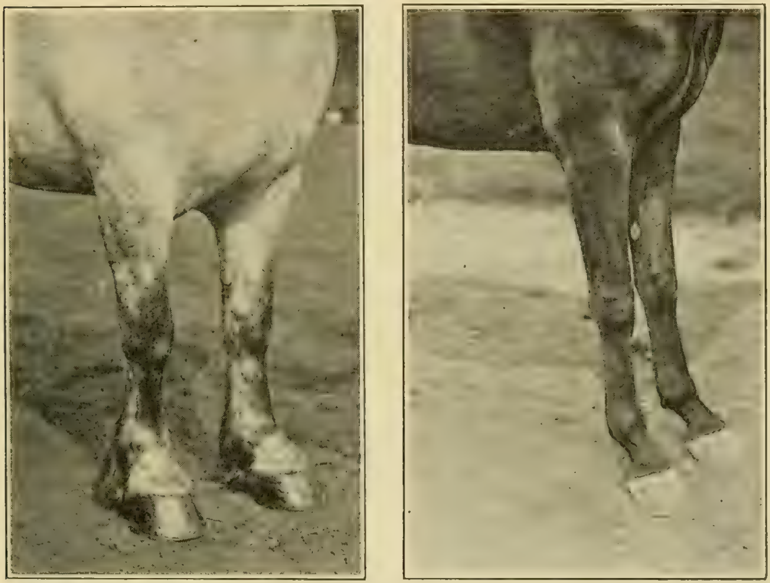
The Clydesdales are typical draft horses, being about 16 to $16\frac{1}{2}$ hands tall and weighing from 1600 to 2100 pounds. They are usually bay and brown in color, with often one or more white feet, and sometimes a white-blazed face. Their shoulders and pasterns are oblique and help to give them good action. The feet, bone, and action are emphasized by the Scotch breeders. The ribs of the Clydesdale horses are often comparatively short.

This makes for a body that lacks depth. The action of the Clydesdale is unsurpassed by other breeds of draft horses. Some people object to their lack of length of rib, and to their hairy fetlocks.

Fig. 57. — A Hackney coach horse.

The English Shire horse is the draft horse of England. It is a large horse equaled only by the Belgian horse in weight. These horses weigh, when fat, from 1800 to 2400 pounds. They are generally black, bay, or gray in color, with white markings on the forehead and on the legs below the knee. The Shire is a strong, massive draft horse. They are found mainly in English-speaking countries. There are some Shires in the United States.

The Belgian is the largest of all the draft breeds. Figure 56 is a fair representation of the Belgian type.



Courtesy of the Agricultural Extension Department, Purdue University.

FIG. 58. — Strength and speed. Note width of breast, and short straight pasterns of the one in contrast to light and long oblique pasterns of the other one.

The Suffolk Punch horse originated in England. They are chestnut in color, and the smallest of the draft breeds.

Coach Horses. — Coach horses range from 15 to $16\frac{1}{2}$ hands high, and weigh from 1000 to 1500 pounds. The German Coach, the Hackney, and Cleveland Bay of England, and the French Coach represent the coach breeds. The German Coach is the

Courtesy of the Show Horse Chronicle, Lexington, Kentucky.

FIG. 59. — Rex McDonald 833, — an American saddle horse, showing the beautiful form, the stylish carriage of head and tail, and the intelligence of this breed.

largest and the Hackney the smallest of this type. The Hackney is known for its high knee and hock action. The principal gait of the coach horse is the trot.

Light Horses. — Light horses comprise the English Thoroughbred, American Saddle horse, the Standard Bred horse, the Arabian, and Orloff Trotter. The Thoroughbred is the English running horse. The American Saddle horse is either a three- or five-gaited horse. The Standard Bred horse is bred for speed. These horses trot or pace. The Standard Bred horse and the American Saddle horse furnish much entertainment at State Fairs. (See Exercises 5 and 6.)

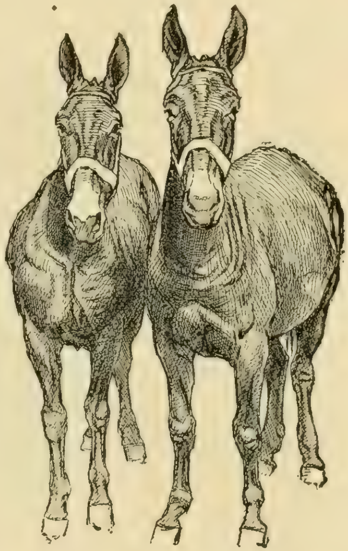


FIG. 60. — A matched mule team. Note the fine, gentle, docile countenances of these mules. They are superior and safe workers.

The Market Classes of Mules. — There are five market classes of mules. (1) The plantation mules are of two kinds, the sugar plantation mule and the cotton mule. Sugar plantation mules are 15 to 17 hands tall, and weigh 1100 to 1500 pounds. They are better than other mules in quality, style, and action, and bring the highest prices. The cotton mules range from $14\frac{1}{2}$ to $15\frac{1}{2}$ hands, and weigh from 850 to 1100 pounds. They have medium-sized bones, are compact, and of good style. (2) The lumber mules range from $15\frac{1}{2}$ to $16\frac{1}{2}$ hands, weigh from 1250 to 1600 pounds, and possess more ruggedness and bone than do the sugar mules. (3) Railroad mules are the same height as lumber mules but weigh a little less. Quality and action are essential points of this mule. (4) Levee mules are about the same as railroad mules, but possess a little more substance, and can do harder work. They are used as draft animals. Soundness and working ability are emphasized. (5) The mining mules are from $12\frac{1}{2}$ to $14\frac{1}{2}$ hands, and weigh about 700 to 900 pounds. They must possess rather heavy bones and be rugged in order to do the work in the mines.

Prices vary, but the mining mules and cotton mules are generally the lowest-priced mules; mules belonging to the other classes have a ready sale and bring good prices.

Care and Management of Horses. — Occasionally horses' teeth do not wear down evenly, and a little filing will take away the uneven sharp edges left on the upper corner incisors.

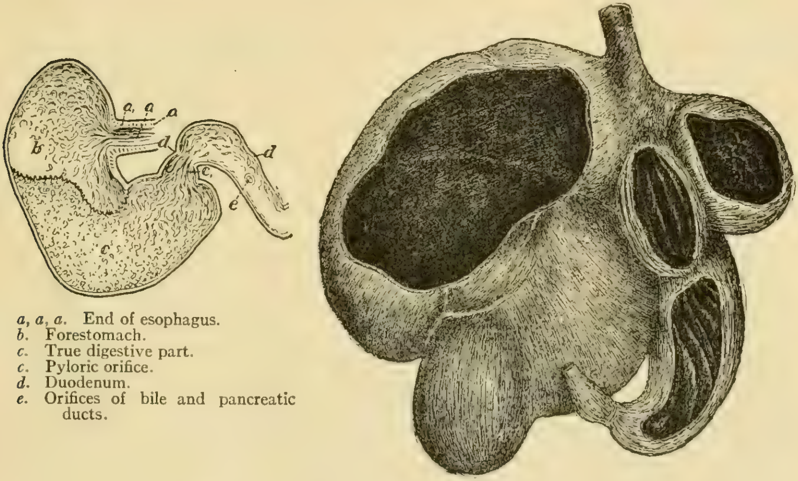
Horses should not be exposed to a cold brisk wind, or left out in the cold when they have been driven hard. Blanketing the horse will prevent disease, and protects the horse somewhat against extreme cold temperatures.

The feet of a horse need constant attention if it is being worked. Dry hoofs should be oiled, and shoes should be carefully put on and renewed frequently. The entire length of the horse's foot grows out in from 3 to 14 months. At the rear, where the foot is short, it grows out in 4 months. At the front the entire length is repaired by new tissues in about 12 to 14 months. Since the foot is larger near the bottom than at the top of the hoof, and since the hoof grows quite rapidly, shoes should be taken off, and refitted to the foot. Poor action and blemishes are often due to poor shoeing. It is better to fit the shoe to the foot than the foot to the shoe.

Horses should be groomed in the morning and at the close of the day. Grooming has other values than merely improving the appearance of the horse. Brushing off the perspiration at the close of the day improves the condition of skin and hair, and reduces the chances of the horse's becoming chilled.

Training Horses. — Colts should be handled very early in life, and may be made gentle. They may be taught to stand over, back, or move forward. A few simple things taught the colt saves a lot of energy later and secures better results.

When a young horse is being trained to work, it should be hitched beside a well-trained, easily controlled, sensible horse.



a, a, a. End of esophagus.
b. Forestomach.
c. True digestive part.
c. Pyloric orifice.
d. Duodenum.
e. Orifices of bile and pancreatic ducts.

FIG. 61. — A simple and a compound stomach.

The early training of a colt is important, for then he forms habits which stick to him afterward. For illustration, if a colt is allowed to start as soon as or before the driver gets into the wagon, the habit will be hard to overcome. But, on the other hand, if he is trained to stand until the driver says go, this habit will remain with him always. It is for this reason that a few simple things should be taught a horse when he is being trained. Horses will do what you ask them to do, but first they must be taught what is wanted.

Feeding Horses. — The digestive organs of different farm animals vary in capacity. Horses and swine have one stomach, while the ruminants, cows, sheep, and goats have several stomachs. The picture on the preceding page will give an idea of the difference.

The capacities of the digestive organs of the different animals as given by Harper are as follows: [1]

LENGTH OF INTESTINES AND CAPACITY OF STOMACH OF FARM ANIMALS

	CAPACITY QUARTS		TOTAL QUARTS	LENGTH FEET OF INTESTINES
	Stomach	Intestines		
Horse	19.0	204.8	223.8	98.1
Cow	266.9	109.8	376.7	187.2
Sheep	31.3	15.4	46.7	107.3
Hog	8.5	20.5	29.0	77.1

It will be observed from the table that the horse and hog have smaller digestive organs, and for this reason their food must not be so bulky as the feed of cows and sheep.

A few rations for work horses weighing 1250 lb. will be in order here:

Oats	12.0 lb.
Timothy hay	13.0 lb.

Corn	10.8 lb.
Oats	8.0 lb.
Timothy hay	10.0 lb.
Oat straw	5.0 lb.

Oats	10.0 lb.
Corn	5.0 lb.
Hay	15.0 lb.

Corn	5.0 lb.
Oats	5.0 lb.
Bran	5.0 lb.
Timothy hay	10.0 lb.

[1] Harper: *Animal Husbandry for Schools.*

The nutritive ratio of one or two of these rations should be figured according to data given in the preceding chapter on Feeds and Feeding.

Summary. — In judging a horse it is important to know the age, and to be able to detect any unsoundnesses. The formation of the skeleton determines largely the action, shape, constitution, and endurance of the horse. The draft horse must be able to walk well; the coach horse must trot well; and light horses must be able to perform at different gaits. The early training of a colt is important, for the habits horses learn in their youth remain with them. Proper feed and care increase the usefulness of a horse. A horse can hardly be expected to do his best unless he has a good driver, and a well-fitting harness.

LABORATORY EXERCISES

1. **Examine the Skeleton Formation of the Horse.** — (*a*) In the draft horse, note the large frame; size and strength of the bones; and the short, thick pastern. Note the lightness of frame and the length of the pastern of the coach horse. Study the action, noting the length of stride, elasticity, trueness, and energy. How does the light horse differ from the coach horse, and the draft horse? (*b*) With a plumb line, made by tying a little rock or a piece of lead to a string, study the skeleton of a horse, as to straightness from the shoulder point, and buttock, and also from the sides.

2. **Tell the Age of a Horse.** — Examine several horses and tell their ages. From what teeth can you tell the age of horses under nine years? Over nine years? What points are observed on the lower front teeth of a horse three years old? Four years old? How can one tell the age of a horse under five years? How can one tell the age of a horse after he is five years old? After he is nine years old? After what age is it impossible to tell accurately the age of a horse?

3. **Location of Blemishes.** — With a horse before you, tell where blemishes are located, and the character of each.

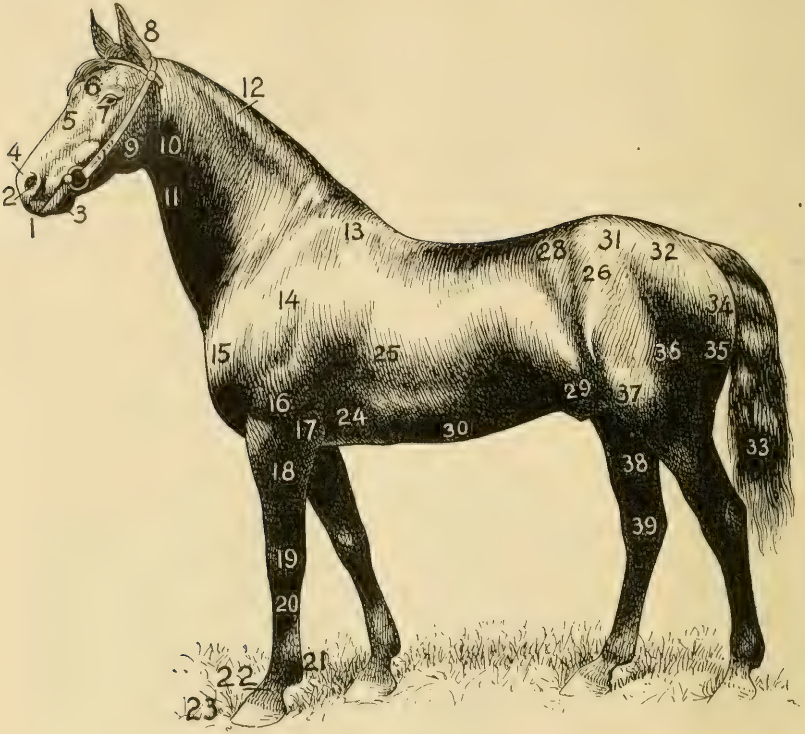


FIG. 62. — Parts of a horse.

1. Mouth.
2. Nostril.
3. Chin.
4. Nose.
5. Face.
6. Forehead.
7. Eye.
8. Ear.
9. Lower jaw.
10. Throat latch.
11. Windpipe.
12. Crest.
13. Withers.
14. Shoulder.
15. Breast.
16. Arm.
17. Elbow.
18. Forearm.
19. Knee.
20. Cannon.
21. Fetlock.
22. Pastern.
23. Foot.
24. Fore flank.
25. Heart girth.
26. Coupling.
27. Back.
28. Loin.
29. Rear flank.
30. Belly.
31. Hip.
32. Croup.
33. Tail.
34. Buttock.
35. Quarters.
36. Thigh.
37. Stifle.
38. Lower thigh.
39. Hock.

4. Measurements of a Draft Horse and a Light Horse. — Take measurements with a tape of the following points of a draft horse and a light horse, and record in the following table.

To make these measurements accurately you will need to study the parts of the horse shown on the opposite page. On Figure 62 indicate the distances in the table that are to be measured, and practice until you can locate the points at once. How many of the parts mentioned on Figure 62 can you locate correctly without the aid of the figure numbers?

	Draft		Light	
1. Length of head from lips to poll				
2. Length of neck from poll to withers				
3. Height at withers				
4. Height from withers to elbow				
5. Distance from elbow to ground				
6. Length of shoulder				
7. Length of arm				
8. Length of forearm				
9. Length of cannon				
10. Distance around cannon				
11. Distance from fetlock to ground				
12. Angle of front pastern				
13. Girth measure				
14. Length of back from withers to hip				
15. Length from shoulder to buttock				
16. Length of croup				
17. Length of gaskin				
18. Distance from hock to ground				
19. Height at croup				
20. Angle of hind pastern				
21. Width through breast				
22. Width over hips				
23. Weight				

5. To Score a Draft Horse. — Use the following score card in judging several draft horses:

SCORE CARD FOR HORSES — DRAFT

SCALE OF POINTS	PERFECT	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED
1. General Appearance — 35 points									
Age, estimated — years — actual . . .									
Height, in hands									
Weight, estimated — lb. — actual . . .	8								
Form, low, massive, drafty, symmetrical .	6								
Quality, bone flat, tendons defined, skin and hair fine	6								
Color, according to breed	1								
Action, step elastic, long with energy, trot regular	6								
Attitude, members vertical	5								
Temperament, good disposition, docile .	3								
2. Head and Neck — 5 points									
Head, proportionate size, broad forehead, straight profile, clear-cut features . .	1								
Muzzle, fine, nostrils, large, lips, thin and even	1								
Eyes, full, clear, bright, and intelligent .	1								
Ears, short, clean, fine, and directed forward	1								
Neck, well muscled, arched, throat clean with long, even collar line and well carried	1								
3. Forequarters — 20 points									
Shoulders, long, extending into back, collar line smooth, and having a large bearing surface	3								
Arm, relatively short, well set back, muscled	1								
Forearm, vertical, wide, heavily muscled .	2								
Knees, clean cut, strongly supported . .	3								
Cannons, vertical, tendons well defined, 9–10 inches long, free from blemishes . .	2								
Fetlocks, wide, thick, clean, free from wind puffs	1								

SCORE CARD FOR HORSES — DRAFT (*Continued*)

Scale of Points	Perfect	Student's	Corrected	Student's	Corrected	Student's	Corrected	Student's	Corrected
Pasterns, angle 45 degrees, not too long, showing strength	2								
Feet, even sized, large, horn dark colored, sole concave, bars strong, heels wide apart, frog large	6								
4. Body — 10 points									
Chest, ribs well sprung, deep, showing constitution, half the height of horse	3								
Breast, broad, deep, and muscular	1								
Ribs, long, round curvature, well sprung	2								
Back, short, straight, muscular, broad	2								
Loin, wide, short, closely coupled	1								
Underline, long, and flanks low	1								
5. Hind Quarters — 30 points									
Hips, level, wide, and smooth	1								
Croup, wide, long, fairly level	4								
Tail, set high and well carried	1								
Thighs, well muscled	3								
Quarter, heavily muscled and well descended	2								
Gaskin, medium, straight, wide, well muscled	3								
Hocks, clean cut, large, straight, free from blemishes	6								
Cannons, 11–12 inches long, clean	2								
Fetlocks, wide, clean, strong	1								
Pasterns, angle of 60 degrees, free from puffiness	2								
Feet, well set, concave soles, heels high, well apart, and of a good texture	5								
Total	100								

6. To Study a Saddle Horse. — If there is a saddle horse in the community, have the owner bring him to school and let him demonstrate the gaits of a saddle horse. A three-gaited horse must go the walk, trot, and canter. A five-gaited horse goes the following gaits in addition: racks and paces, or foxtrots, a running walk or a slow pace.

7. Score a Light Horse according to the Following Score Card:

Scale of Points	Perfect	Student's	Corrected	Student's	Corrected	Student's	Corrected	Student's	Corrected
1. General Appearance — 43 points									
Age, estimated									
Height, estimated	4								
Weight, estimated	4								
Form, symmetrical, high, light, indicative of good action	4								
Quality, bone fine, tendons defined, skin and hair fine	8								
Action, quick, step long, true, and regular, trot rapid and even	15								
Attitude, members vertical	4								
Temperament, lively, energetic, intelligent, docile	4								
2. Head and Neck — 5 points									
Head, lean, clean cut, well-defined features, carried high, profile straight	1								
Muzzle fine, nostrils large, lips thin and even	1								
Eyes, full, bright, and intelligent	1								
Ears short, alert, well carried	1								
Neck, well fitted to head, slightly arched, clean, large windpipe	1								
3. Forequarters — 19 points									
Shoulders, oblique and well set back	2								
Arms, short, well set back	1								
Forearms, long, 12–13 inches, well muscled, and clearly defined	2								
Knees, clean cut, wide, deep, well supported	3								

Scale of Points	Perfect	Student's	Corrected	Student's	Corrected	Student's	Corrected	Student's	Corrected
Cannons, 10–11 inches long, tendons, well attached and defined	2								
Fetlocks, free from puffiness	1								
Pasterns, long, sloping	2								
Feet, horn dense, concave sole, fair size, frog, large and elastic, heels, wide apart	6								
4. Body — 8 points									
Chest, higher than for draft horses, should show constitution	2								
Withers, clearly defined in driving horses, coach horses less	1								
Breast, high and projecting	1								
Ribs, long and well sprung	1								
Back, fair length, well muscled	1								
Loin strongly joined to hips	1								
Underline, long, fairly straight	1								
5. Hind Quarters — 25 points									
Hips, more prominent	1								
Croup, wide, long, muscular, and horizontal	3								
Tail, set high, well carried, long, full, and fine	1								
Thighs, 15–16 inches long, stifle, deviated outward	3								
Buttock, heavily muscled	1								
Gaskin, 14–15 inches long, well muscled, wide	2								
Hocks, clean, 3 inches deep, straight	4								
Cannons, 11–12 inches long, tendons, well defined	2								
Fetlocks, clean, no wind puffs	1								
Pastern, long, sloping	2								
Feet, even sized, concave sole, heels far apart, tough textured	5								
Total	100								

CHAPTER XI

BEEF CATTLE

Importance of Beef Cattle. — The total number of cattle in the United States in 1910 according to the last census was 61,803,866. Of this number 20,625,432 were dairy cows, leaving 41,178,434 other cattle used for beef production. The value of all cattle exclusive of the dairy cows was $1,273,287,300. The value of all cattle per head was $24.26.

Beef cattle are distributed throughout the United States, but about forty-eight per cent are found in the North Central States and Texas. The map (Fig. 63) shows the distribution of all cattle exclusive of dairy cattle. (See Exercise 1.)

Reasons for Beef Production. — Beef cattle are produced primarily for four classes of people, — the breeders, the feeders, the retail butchers, and the consumers; and the real purpose of beef production is to furnish food for man. In judging cattle the purpose for which they are to be used should be considered. The butcher considers small bones important, because a small-boned animal gives a higher per cent of dressed carcass. The feeder wants a steer that will put on a maximum amount of beef with the minimum of feed. In judging breeding stock, breed characteristics, conformation, quality, and temperament

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

A beef cow to show the beef cuts; and a Shorthorn, Hereford, and Angus cow to judge.

can hardly be overemphasized. The points of excellence held by the breeder, feeder, butcher, and consumer should be kept in mind when judging.

Characteristics of Beef Cattle. — Beef cattle are low, compact, rectangular, and heavy. They are "bricklike" in form. The top line and under line are almost straight and parallel. The

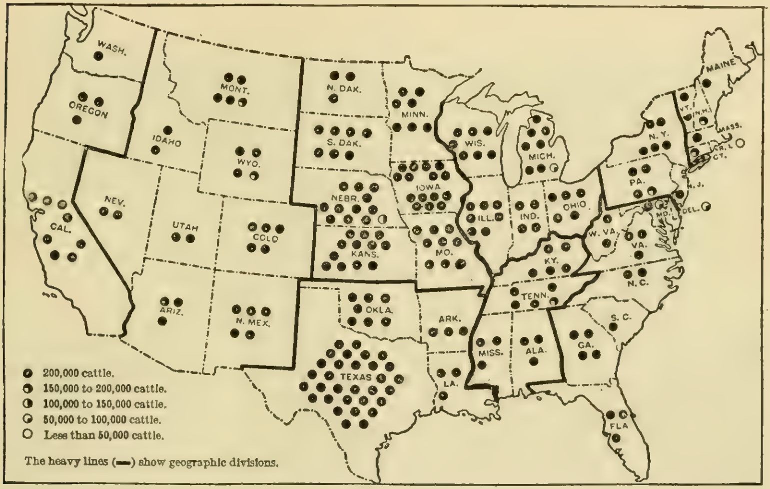


FIG. 63. — Number of beef cattle on farms, by states, April 15, 1910.

back is broad and the body is deep. The quarters are fleshy and well descended. The body is blocky. Roughness is to be avoided.

The head is a good index to the body characteristics. A steer with a wide head, large box-shaped muzzle, and large nostrils is usually a good feeder. Large nostrils show breathing capacity. The ears should be medium in size, should not be coarse, and should show quality. If horns are present, they should be of fine texture, and rather small. A steer with these head characteristics is usually compact, blocky, a good feeder, and will dress out, when well finished, a high per cent of edible dressed meats.

On the other hand, a steer with a thin long face, a thin narrow forehead, a small muzzle, small nostrils, large coarse ears, and long rough oversized horns, is generally unprofitable. The

Courtesy of the Agricultural Exension Department, Purdue University.

FIG. 64. — A typical beef type; bricklike in conformation from side, front, and top view.

features of the head are correlated with similar features in the rest of the body. (See Figures 64 and 65.)

The Valuable Cuts. — The picture (Fig. 66) shows the way a steer is cut for the retail beef trade. It is taken from Farmers' Bulletin, No. 711, and shows the Chicago retail dealer's method of cutting beef. It should be studied because it shows where beef cattle ready for slaughtering should be well formed and finished. The region from which the porterhouse steak, prime of rib, and sirloin cuts are taken is important. A broad, well-finished back is a sign of a great amount of meat in the region of these valuable cuts. There are some "cuts" which are actually worth less after the steer is slaughtered than they were when the steer was alive.

A steer of good quality, that is of fine bone, skin, and hair, well

Courtesy of the Agricultural Extension Department, Purdue University.

FIG. 65. — An inferior feeder.

finished and evenly, firmly, and smoothly fleshed, weighing 1200 pounds, will dress out about 800 pounds (about $66\frac{2}{3}\%$), and of this about 700 pounds of meat can be eaten. Careful judging of beef cattle and a close study of the score card will aid a great deal in placing proper estimates upon the different sections of a beef type. (See Exercise 2.)

The Beef Breeds. — All the typical beef breeds have the characteristics pointed out in the above paragraphs. They vary slightly in different sections of the country, in temperament, in color, in milk production, and in other minor points. For a more extended discussion refer to other texts, and especially to *Types and Breeds of Farm Animals*, by C. S. Plumb. The most important breeds of beef cattle are Shorthorns, Herefords, Aberdeen Angus, and Galloways.

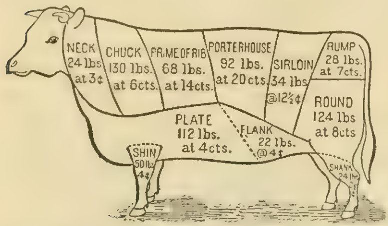


FIG. 66. — Picture of a 1200-pound beef steer, showing cuts and their relative value, according to a large packing concern.

1. *Shorthorn Cattle.* a. *History.* The origin of the Shorthorn cattle is as mixed as are the people of England. The native Celts, the Romans, Anglo-Saxons and Jutes, and the Normans, all brought cattle that served to lay the foundation of the Shorthorn breed. However, not until about 1775 to 1875 were the Shorthorns developed into a well-defined breed. The following men developed slightly different types of Shorthorns as follows:

	BORN	DIED	TYPE
Thomas Bates	1775	1849	Dairy-beef type
Chas. Collings	1749	1836	Beef type
Robt. Collings	1750	1820	Beef type
John Booth	1789	1857	Beef type
Richard Booth	1788	1864	Beef type
Amos Cruickshank	1808	1895	Beef type

These were the men who started the real history of the Shorthorn cattle. All of these men did their work in England except Amos Cruickshank, who was in Scotland.

Although Shorthorn cattle were imported into the United States as early as 1783, the Ohio Importing Company, organized in 1833, was the most important agent in introducing Shorthorn cattle into the United States. The first importation included nineteen head. In 1836, forty-three animals, including those that were imported and their offspring, were sold at pub-

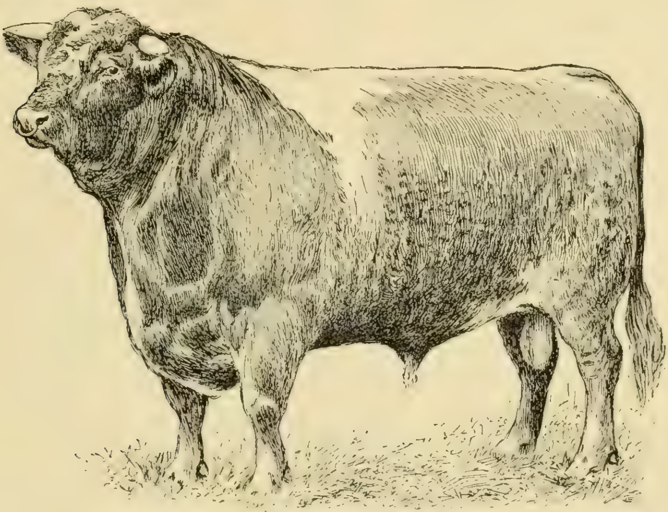


FIG. 67. — A Shorthorn type, showing conformation and head characteristics which stamp this breed.

lic auction for $34,540, an average of $803.25 per head. The Shorthorn characteristics were so excellent that they were soon distributed throughout the country.

No other breed has been used as much as the Shorthorn in crossing and grading up native cattle. The entire West, and the South American countries, have been materially benefited by mating native stock with Shorthorns. The pure-bred sire produced an animal that dressed out a higher per cent of carcass, had shorter horns, had a better disposition than the native cattle, and was more easily handled. The rapid elevation of good characteristics as a result of crossing was a splendid financial investment. Such opportunities in breeding up herds, though not so numerous as formerly, are still present. Ordinary farm herds may be improved a great deal by mating with animals of the same breed, that are pure bred, and of the proper conformation.

b. *Characteristics.* In England three types of Shorthorns were developed; namely, the beef type, the dairy type, and the dairy-beef type (dual purpose). Each type has a different conformation in accordance with its purpose. In the United States, the beef type is more commonly found, because our agricultural conditions are somewhat different from those of England. In England the dairy type is common, and the English people depend largely upon the Shorthorn cow for their milk supply. "At the London Dairy Show, from 1894 to 1904 inclusive, the first place in both milk production and fat production was won in every case by a Shorthorn, competing against Jerseys, Guernseys, Ayrshires, Red Polled, and crosses."[1]

Shorthorns are red, white, and roan. A mixture of red and white is roan. Some breeders have placed more emphasis upon color than upon other points. This is a mistake, for color is a matter of secondary importance. Beef-producing qualities should be placed first. The Shorthorns rank first among the beef breeds in udder development and in milk-producing ability. They may occasionally be criticized in being slightly rangy and in having prominent shoulders. They may be regarded as the largest of the beef breeds. The males weigh from 1800 to 2400 pounds, and mature cows from 1400 to 1800 pounds. (See Exercise 3.)

[1] C. H. Eckles: *Dairy Cattle and Milk Production.*

2. *The Hereford.* a. *History.* Hereford cattle originated in the county of Hereford, England. Their origin is somewhat obscure, and according to the opinions of some authors the Hereford is the oldest of the beef breeds. But, like the Shorthorn breed, it was not until about 1723 that the Hereford breed was developed with definite breed characteristics.

Henry Clay, in 1817, became the first importer of Hereford cattle into the United States. From 1840 to 1860, a great many

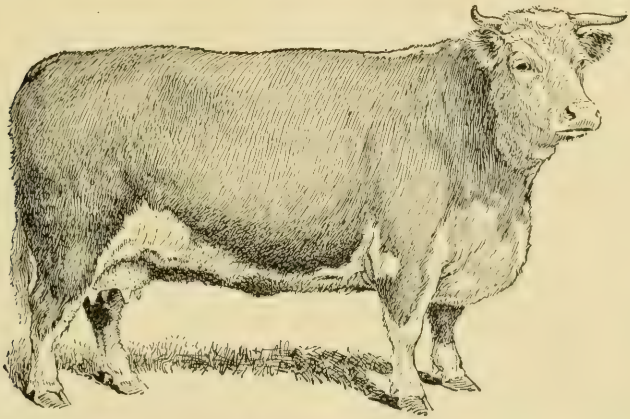


FIG. 68. — A Hereford cow, showing the conformation, color, markings, and head characteristics desirable in the breed.

were brought to America. Because the Hereford cattle are superior rustlers, they have been used much in crossing with native Western cattle. Although Herefords have not been used as much in crossing on native cattle of North and South America as have the Shorthorns, it may be said that in the last decade their popularity has steadily increased, and that their good qualities are becoming realized more and more by ranchmen.

b. *Characteristics.* The Herefords are typical beef-producing cattle. They are not quite as large as the Shorthorn breed.

The color is red, with a white head, and the white extending over neck and along the underline. Six white tips may often be seen in the individuals of this breed. They have a quiet, docile disposition. In milk production they rank low, and are often criticized on this point.

The distinguishing characteristics of the Herefords are, (1) prepotency, or power of transmitting definite breed characteristics, (2) early maturing qualities, and (3) grazing attributes. Where Hereford cattle have been crossed with other breeds, Hereford markings usually crop out in the offspring. Their vigorous constitution is often transmitted when crossed with other cattle. This is partly due to the fact that in spring of rib they are unequaled. Hereford cattle mature early and are, therefore, superior in economical meat production. They are good grazers, and as rustlers in stalk fields, pastures, and on the range where feed is scarce, they are unexcelled.

3. *The Aberdeen Angus.* a. *History.* The Aberdeen Angus originated in the counties of Aberdeen, Kincardine, and Forfar, Scotland. The first printed reference to this breed was made in 1797.

The Angus cattle were first introduced into the United States in 1873, when George Grant of Victoria, Kansas, imported three bulls. From 1875 to 1885 small numbers of Angus were imported into different sections of the United States and Canada. Large numbers are found in the "corn belt" states, and they are widely distributed throughout Europe.

b. *Angus Characteristics.* The Angus cattle are black, polled, and are of a typical beef conformation. They are not quite as large as the Shorthorn breed. Their bodies are more cylindrical than are the bodies of either the Shorthorn or Hereford breeds. Compactness is a strong feature of the breed. In quality, which refers to desirable features of bone, skin, and hair, they are unexcelled. It is for this reason, along with their splendid conformation, that they dress out as high a percentage of carcass as any breed. The Angus cattle are good grazers and feeders, and are unsurpassed in quality of flesh produced. For beef production,

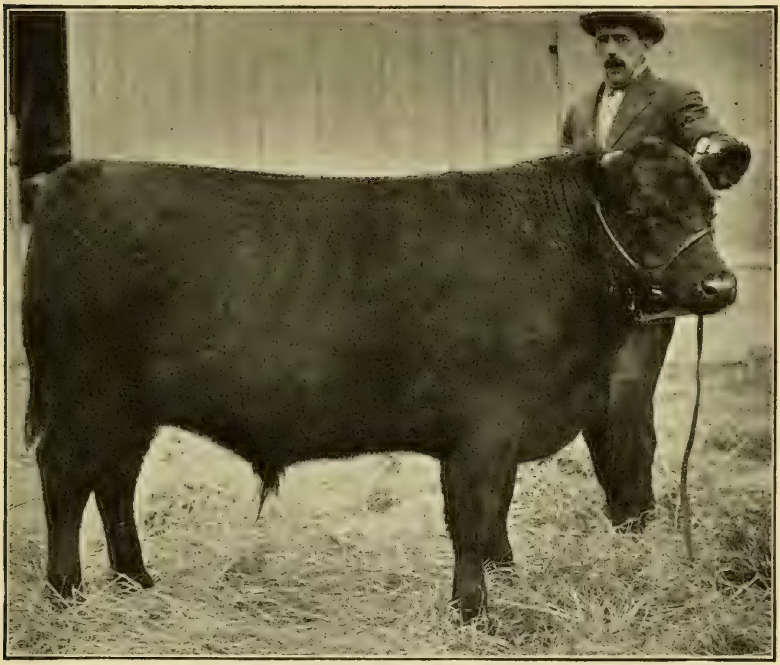


FIG. 69. — The Aberdeen Angus steer. An example of a fine beef type.

meeting the market demands of the commission houses, and in show ring competition, the Angus breed ranks high.

4. *Galloways*. a. *History*. The Galloways came from Scotland. Their origin is more or less obscure; the name is from the province of Galloway in the southwestern part of Scotland. At first the cattle of Galloway were horned, and not until about

1789 did "polled" cattle appear. In 1862 the Galloway Herd-book Society was organized. In America an organization to improve the Galloways was perfected under the title of "The American Galloway Cattle Breeders' Association," in 1882. The Galloways are now mainly distributed in Scotland and America.

b. *Characteristics*. The Galloways are black, hornless, and covered with a heavy, curly coat of hair. Hardiness and strength of constitution are characteristics of the breed. They are well adapted to a cold, rigorous climate. Because of their hardiness and rustling qualities, they are popular on the Western and Northwestern ranges. The breed has been criticized for lack of spring of rib, late maturity, and for slow response to feeding. These points are being overcome to a large extent by selective breeding. (See Exercise 4.)

Management of Beef Cattle. — The number of beef cattle per one thousand people in the United States has decreased from 660 to 450 between 1900 and 1910. The reasons for this decrease are:

1. The ranges of the West are being plowed up.
2. Farmers can often get more cash out of the sale of their crops.
3. Tenant farmers are frequently unable to stock the rented farms.
4. Growing cities have increased the demand for milk and its products.

Economic Production of Beef. — In producing beef more economically three points must be considered:

1. Relation of age to economic gains.
2. Relation of age to cost of fattening.
3. Influence of degree of finish upon gains.

1. *Relation of Age of Cattle to Economic Gains.* — The tabula-

FIG. 70. — A typical Galloway heifer. Note color, conformation, and long hair that stamp this breed.

tion of the findings by the Ontario Agricultural College shows the amount of gain in weight at different ages and the amount of food required.

RELATION OF AGE TO ECONOMIC BEEF PRODUCTION

	FIRST YEAR	SECOND YEAR	THIRD YEAR
	Pounds	Pounds	Pounds
Daily gain	2.2	1.2	1.0
Total gain	785	456	350
Feed per one hundred pound gain milk calf used	492		
Concentrates	159	480	689
Hay	184	777	776
Succulent feed	314	1928	2637
Digestible nutrients per one hundred pound gain	315	875	1183
Water drunk daily	27	43	47

This table shows that the first year the calf made a gain of 2.2 pounds a day; the second year, 1.2; and the third year, 1.1 pounds a day. If the feed per one hundred pound gain is studied, some interesting points are brought out. The total digestible nutrients required to produce one hundred pounds gain was 315 pounds during the first year, 875 pounds the second year, and 1183 pounds the third year. The steer weighed 1588 pounds when slaughtered.

We should not conclude from this table that it is more economical to sell the steer when he is a year old; but it should cause us to study the relation of age to economic gains.

2. *Relation of Age to Cost of Fattening.* — With 153 head of cattle, the Ottawa Experiment Farms found the results shown in the following table:

Rate and Cost of Gains for Fattening Steers of Various Ages

	Average Weight at Beginning	Average Daily Gain	Average Cost of One Hundred Pounds Gain
	Pounds		Dollars
Calves	397	1.8	$4.22
Yearlings . . .	833	1.6	5.31
Two-year-olds .	1011	1.8	5.62
Three-year-olds .	1226	1.7	6.36

This table indicates that calves weighing 397 pounds put on one hundred pounds gain at a cost of $4.22, and that it required $6.36 worth of feed to put an equal weight on three-year-old steers, weighing 1226 pounds.

3. *The Influence of the Degree of Finish upon Gains.* — The Kansas Station found the following regarding the amount of gain required to produce one hundred pounds of gain:[1]

	Grain for One Hundred Lb. Gain	Increase of Feed Required
Up to 56 days the steers required	130 lb. of grain	
Up to 84 days the steers required	807 lb. of grain	10 %
Up to 112 days the steers required	840 lb. of grain	15 %
Up to 140 days the steers required	901 lb. of grain	23 %
Up to 168 days the steers required	927 lb. of grain	27 %
Up to 182 days the steers required	1000 lb. of grain	37 %

From these data we learn that feeders find that as they approach the finishing period of fattening cattle for market it is more difficult to secure gains in weight. The results of these experiments indicate that it costs heavily to thoroughly fatten

[1] *Kansas Bulletin, No. 34.*

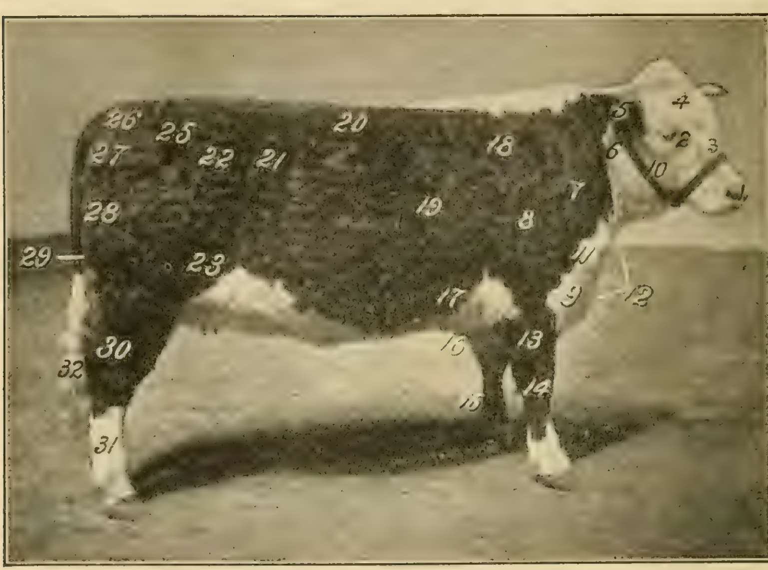


Fig. 71. — Points of the beef cow.

1. Muzzle.
2. Eye.
3. Face.
4. Forehead.
5. Ear.
6. Neck.
7. Shoulder vein.
8. Shoulder.
9. Brisket.
10. Jaw.
11. Breast.
12. Dewlap.
13. Arm.
14. Shin.
15. Fore legs.
16. Chest.
17. Fore flank.
18. Crops.
19. Ribs.
20. Back.
21. Loin.
22. Hip.
23. Hind flank.
25. Rump.
26. Tail-head.
27. Pin bones.
28. Thigh.
29. Twist.
30. Hock.
31. Shank.
32. Tail.

the steer. The importance of selling at the earliest possible date is plain from the table.

Summary. — For producing beef economically, the typical beef breeds are superior. They dress out a higher per cent of dressed carcass, and make gains with less feed than do scrubs or dairy types. The important beef breeds are the Shorthorn, Hereford, Angus, and Galloway. In judging beef cattle, the region of the valuable cuts should be given preference, though all other points are important. Grass lands, corn silage, and some grains aid in raising calves economically. Getting cattle to market at an early age reduces the cost of production. Securing cattle of better conformation, economical feeding, and marketing are important topics for the beef cattle raiser.

LABORATORY EXERCISES

1. Cattle Survey of District. — Have pupils take a census of all cattle not dairy cattle of the district. Record as follows:

Name of Farmer	Kind of Cattle	Number

2. Location of Beef Cuts. — Locate on a live animal the beef cuts. Number them in the order of their value.

3. To Score Cattle. — Score all beef breeds if possible according to the following score card.

Beef Cattle — Score Card

Scale of Points	Perfect	Student's	Correction	Student's	Correction	Student's	Correction	Student's	Correction
1. General Appearance — 26 points									
Age, estimated — years, actual — years									
Weight, estimated—lb., actual—lb., score according to age	6								
Form, straight topline and underline, deep, broad, low, medium length, symmetrical, compact, standing squarely on legs	8								
Quality, bone of fine texture, fine skin, silky hair, clearly defined features and joints, mellow touch	6								
Condition, thick even covering of firm flesh especially in regions of valuable cuts, indicating finish, light in offal	6								
2. Head and Neck — 8 points									
Muzzle, good size, lips thin, nostrils large and well apart, jaws wide	2								
Face, short, broad, profile straight	1								
Forehead, broad	1								
Eyes, large, full, clear, bright	1								
Ears, well carried, fine, medium size	1								
Neck, thin, short, throat clean, dewlap slight	2								
3. Forequarters — 12 points									
Shoulder vein, full, smooth	2								
Shoulders, smoothly covered with firm flesh, compact	6								
Brisket, broad, full, breast wide	2								
Legs, straight, short, strong, wide apart, forearm full, shank fine, feet sound	2								
4. Body — 32 points									
Chest, deep, broad, girth large, foreflank full	4								
Crops, full, thick, even with shoulders	5								
Back, broad, straight, medium length; thickly, evenly, and firmly fleshed	7								

BEEF CATTLE — SCORE CARD (*Continued*)

SCALE OF POINTS	PERFECT	STUDENT'S	CORRECTION	STUDENT'S	CORRECTION	STUDENT'S	CORRECTION	STUDENT'S	CORRECTION
Ribs, deep, well sprung, closely set, thickly, evenly, and firmly fleshed	7								
Loin, broad, straight, thickly, evenly, and firmly fleshed	7								
Flanks, full, low	2								
5. Hindquarters — 22 points									
Hips, smoothly covered, proportionate width	3								
Rump, long, level, width well carried back, thickly, evenly, and firmly fleshed	5								
Pin bones, wide apart, not prominent	1								
Tail, fine, tapering, medium length	1								
Thighs, deep, wide, well descended, and fleshed	4								
Twist, deep, broad, well filled	6								
Legs, straight, short, strong, shank smooth, feet sound	2								
Total	100								

4. Comparison of Beef Breeds. — Describe in a two hundred fifty word paper the outstanding characteristics and contrasting features of the different beef breeds.

CHAPTER XII

DAIRYING

Importance of Dairying. — According to the United States census for 1910, there were 20,625,000 dairy cows in the United States, which produced 5,814,000,000 gallons of milk. The total value from dairy products in 1909 was $596,000,000. This does not include the milk and cream used on the farms, which would approximate closely, or probably exceed, the above figure. Wing states that, in 1900, the average production per cow was 3600 pounds of milk, equivalent to about 150 pounds of butter fat. This milk at $1.25 per hundredweight, or 25 cents per pound butter fat, would yield $45.00 or $37.50 per cow, respectively.

Comparative Value of Dairy Products for 1909

Corn	$1,438,000,000
Poultry	750,000,000
Wheat	657,656,000
Dairy products	596,000,000
Oats	414,000,000

The importance of milk as a food for man can hardly be estimated, both because of its extensive use and also because it

Note to the Teacher: The materials needed to do the Laboratory Exercises at the close of this chapter are:

Dairy cows at different times; an eight bottle closed Babcock Tester (open testers are inaccurate and dangerous); the necessary glassware and chemicals needed to make the Babcock Test; samples of whole milk and skimmed milk.

contains the food nutrients in a better proportion than any other one food. Milk is a well-balanced food.

More attention will be given to dairying as the population becomes denser. The cities consume large quantities of milk and milk products. Consequently the farmers of the territory surrounding the city devote much of their time to dairying, and, where shipping facilities are good, the demand for milk is so great that it is often shipped as much as two hundred miles or more to market. (See Exercise 1.)

The Advantages of Dairying. — In thickly populated countries and near cities where land is high priced, nearly all farmers give up their land to dairying, truck gardening, and poultry raising. On the islands of Jersey and Guernsey, land is said to rent for $60.00 to $70.00 per acre, and in Holland, where land cannot be bought for less than $1500 to $2000 per acre, dairying is the main occupation. Land near our American cities valued at from $400 to $1000 per acre is used largely for dairying.

Dairying is advantageous because it aids in maintaining soil-fertility. The average amount of solid and liquid manure voided in a year by a thousand-pound dairy cow is about 12 tons. It is stated that such manure contains fertilizing materials (plant food) the value of which is $2.74 per ton. Upon this basis the value of the fertilizer materials voided by a cow in a year is $32.88. However, the amount of manure voided is almost in direct proportion to the amount of milk produced; a good cow consumes more feed, and hence voids more manure. It is a well-known fact that dairy farms become more productive as this type of farming is continued. When butter fat is sold from the farm, very little soil fertility is removed. The table below will give a comparison of the fertilizing constituents in feeding stuffs and animal products.

FERTILIZING CONSTITUENTS IN FEEDING STUFFS AND ANIMAL PRODUCTS [1]

	Fertilizing Constituents in 2000 Lb.			Fertilizing Value per Ton
	Nitrogen	Phosphoric Acid	Potash	
Dent corn	32.4 lb.	13.8 lb.	8.0 lb.	$6.85
Wheat	39.6	17.2	10.6	8.43
Timothy hay	19.8	6.2	27.2	5.20
Red clover hay	41.0	7.8	32.6	18.72
Animal products				
Fat ox	46.6	31.0	3.6	9.96
Fat pig	35.4	13.0	2.8	7.10
Milk	11.6	3.8	3.4	2.43
Butter	2.4	0.8	0.8	0.57

From this table it may be observed that if a ton of butter fat is sold, only 57 cents' worth of soil fertility is removed from the farm; while if an equal amount of dent corn be sold, $6.85 worth of soil fertility is removed.

The dairy cow, of all farm animals, is the most economical producer of human food; that is, a dairy cow produces more human food in proportion to the feed fed than any other animal.

HUMAN FOOD PRODUCED BY FARM ANIMALS FROM ONE HUNDRED POUNDS OF DIGESTIBLE MATTER CONSUMED [2]

	Marketable Product Pounds	Edible Product Pounds	Animal	Marketable Product Pounds	Edible Product Pounds
Cow (milk)	139.0	18.0	Poultry (eggs)	19.6	5.1
Pig (dressed)	25.0	15.6	Poultry (dressed)	15.6	4.2
Cow (cheese)	14.8	9.4	Lamb (dressed)	9.6	3.2
Calf (dressed)	36.5	8.1	Steer (dressed)	8.3	2.8
Cow (butter)	6.4	5.4	Sheep (dressed)	7.0	2.6

[1] Henry and Morrison: *Feeds and Feeding.*

[2] Jordan: *The Feeding of Animals.*

This table shows that with 100 lb. of feed the dairy cow produced 18.0 lb. of edible food for man; more than that produced by any other farm animal. The table deserves close study.

Eckles and Trowbridge, of the Missouri Station, have furnished the following data on the point that the cow is a very economic human food producer as compared to a beef steer.

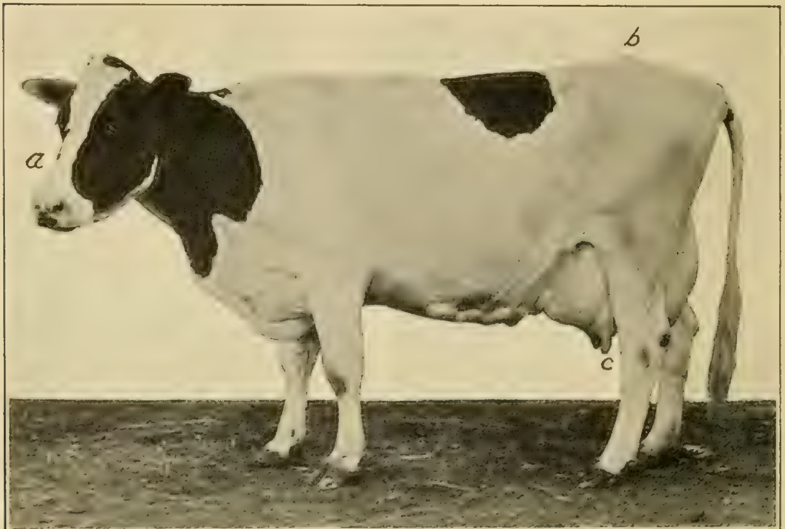
	Averages of Cows Producing 6000 Lb. Milk	18,405 Lb. Milk	Steer Weight 1250 Lb.
Proteids	187	552	172
Fat	200	618	333
Sugar	300	920	
Ash	43	128	43
Total	730	2218	548

It took the dairy cow one year to produce 2218 lb. of human food, while the beef steer produced only 548 lb. in about two years. The cow producing 6000 lb. milk, produces 730 lb. of edible dry matter in a year. The sugar in milk is worth as much per pound for human food as ordinary sugar.

Five Essential Points of a Good Dairy Cow. — In order that the value of a dairy cow may be rightly judged, the amount of her feed should be known, her milk should be weighed and tested for butter fat. It is not always possible to decide upon these points, so we must know what characteristics to look for in a cow which shows milk-producing capacity. There are five points that are essential to a good dairy cow. These are:

1. A good constitution.
2. Capacity for food.
3. Proper temperament.
4. Good blood circulation.
5. Milk-producing ability.

1. *Constitution* is indicated by a strong, large girth, broad head, box-shaped muzzle, and large, well-distended nostrils. A thin-chested, narrow, long-headed animal has not a good constitution; an animal that has very small nostrils cannot take in large volumes of air, which is essential to a long life. The average economic productive period of a dairy cow is 6 to 7 years.



Courtesy of the Agricultural Extension Department, Purdue University.

Fig. 72. — Wedge shape as seen from the side.

An extraordinary milk yield for one or two years is not sufficient. A cow with a good constitution will be valuable from 2 to 5 years longer than a cow with a poor constitution.

2. If a cow is to be profitable, she must have a large *capacity for food.* Capacity for food is indicated by a large barrel and a long body. A cow with a short body and a small stomach girth measure cannot consume large quantities of food or produce

much milk. A cow measuring 34 inches from withers to hips, 74 inches around the heart girth, and 88 inches around the barrel, has one and one-half times the capacity that a cow has that measures 30, 65, and 75 inches, respectively, in the same points. Short-ribbed, slab-sided, short-bodied cows can consume only small amounts of feed, and therefore can produce only small amounts of milk.

Courtesy of the Agricultural Extension Department, Purdue University.

Fig. 73. — Wedge shape as seen from above and behind.

3. *Dairy temperament* is essential to a good dairy cow. A cow with such a temperament is angular, triple wedge-shaped, and lacks flesh. A dairy cow that is well fleshed is not transforming enough food into milk, but is converting a lot of it into meat. This kind of cow is a beef-producing cow. The most economical milk producers are angular and skinny. They have prominent hip bones, poorly covered ribs, and well-defined vertebræ. The best milk-producing cow is triple wedge-shaped; that is, from a side view she shows less depth of body at the front than she does at the rear. Secondly, viewed from front, she shows more width at hips than she does through the breast and chest. Thirdly, as we look downward and backward over the withers, the third wedge-shaped con-

formation may be seen. This type of cow is the best milk producer. This type has arisen because certain organs of the dairy cow perform more work than others. The digestive, milk-secreting, nervous, and circulatory systems are extremely active, and are therefore greatly developed.

Courtesy of the Agricultural Department, Purdue University.

FIG. 74.—Wedge shape as seen from the front.

In selecting cows for milk production, the type of cow here described is very important. It must be remembered, however, that not all cows of this type are good milk producers. Every cow is an individual when we come to consider the amount of milk that she can be made to give. A cow of good type may be a poor milk producer, but, in general, the best milk producers are cows from the best type. Profitable dairying requires, first, that cows of the right type be selected, and second, that every cow be tested to find out her milk-producing capacity. If, then, the cows that produce little are disposed of, a good producing herd can be secured.

To show the relation of dairy temperament and dairy form to economy of milk production, Haecker of the University of Minnesota divided cows into four groups according to type. The returns of different types are as follows:

ECONOMY OF MILK PRODUCTION OF DAIRY AND BEEF TYPES

Types	Number of Animals	Average Live Weight	Dry Matter Consumed			Feed Cost of 1 Lb. Fat
			Daily	Daily per 1000 Lb. Live Wt.	Per Pound Fat	
		Pounds	Pounds	Pounds	Pounds	Cents
Beef type . .	3	1240	20.8	16.7	31.3	17.5
Less beef type	4	945	20.4	21.0	26.4	15.1
Spare, but lacking depth of body . . .	3	875	20.0	23.0	25.5	14.6
Dairy type .	12	951	21.9	23.6	21.2	12.1

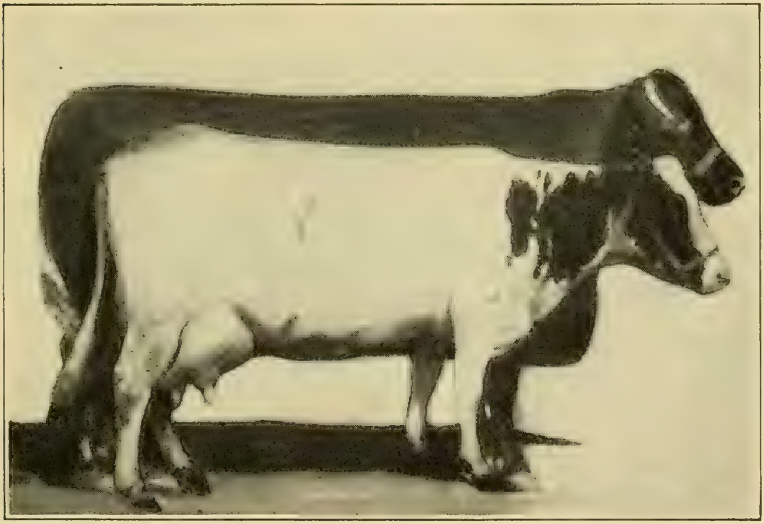


FIG. 75. — Beef and dairy type in outline. Compare their conformation and function.

It will be observed that the cows of a beef type and beef temperament produced butterfat at a cost of 17.5 cents per pound, and that the dairy type produced an equal amount of butterfat at a cost of 12.1 cents per pound.

4. *Circulation.* Just how the cow digests foods and converts it into milk is a topic too complicated to present here. Food must be transformed and conveyed by the digestive and circula-

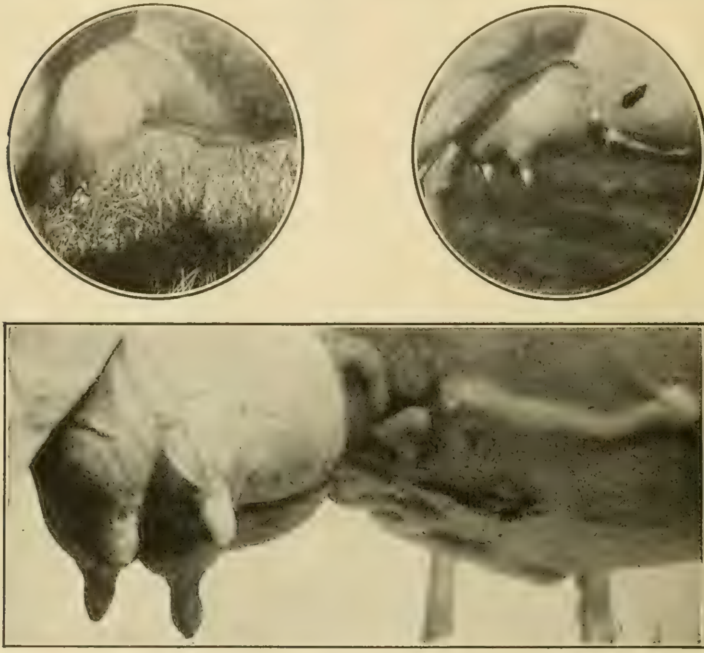


FIG. 76. — Examples of well-developed milk veins.

tory systems before milk can be produced. "Good blood circulation is shown by a network of veins on the udder; and by the size and number of the milk wells or holes in the abdomen through which these blood vessels pass, carrying the blood on its return to the lungs to be purified and to be pumped back again. Large milk wells also indicate good blood circulation.

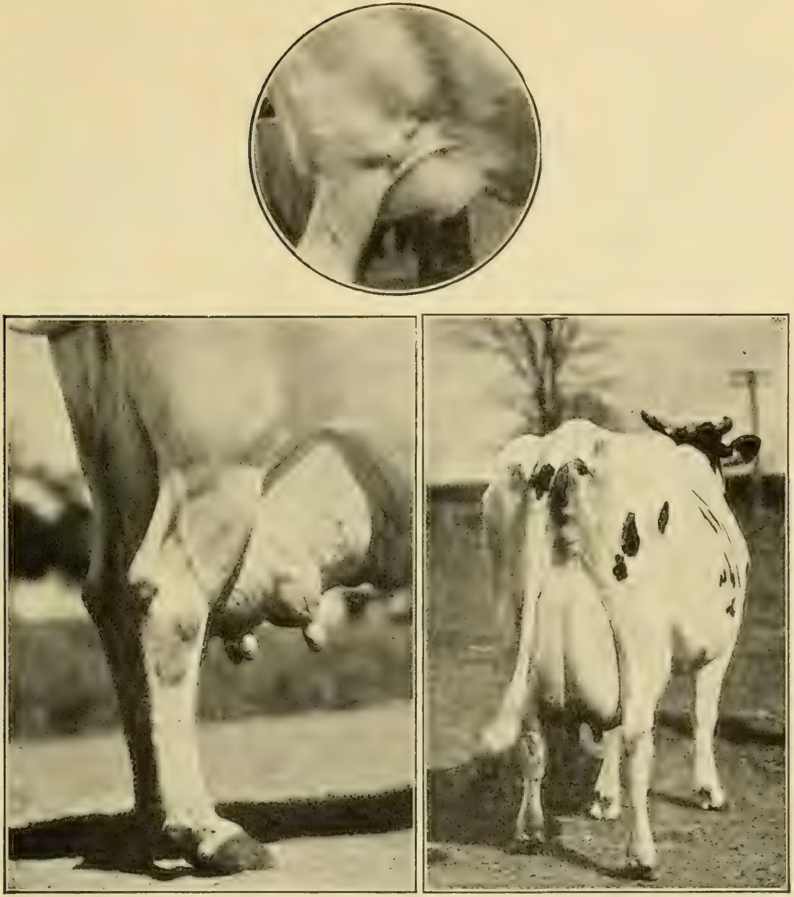


FIG. 77. — Example of well-formed udders. Note network of veins.

" Cows with small, short, straight milk veins, and only two small wells, show either that the blood circulation is small and sluggish, or that the nutrients are being conveyed to some other part of the body to be converted into some product other than milk and butterfat."

5. Two factors which are essential to *milk-producing ability* are the proper form and texture of the udder. The udder should be large, wide, long, and fairly deep, but well held up, extending well up between the thighs and well to the front. An udder that lacks width and length but is deep is not well formed. It should be evenly quartered and symmetrical; the teats should be of proper size, and evenly and well placed.

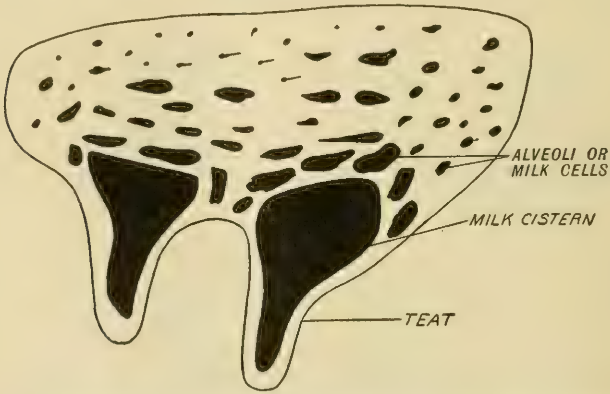


FIG. 78. — A cross section of a cow's udder, showing the milk cistern, and milk cells. The size and number of openings in the udder determine its texture.

The udder is supposed to manufacture all the constituents in milk except water. Butterfat, casein, and sugar are all formed in the udder. It must have, therefore, a great deal of interior milk-producing surface. There must be large milk cisterns, and a large number of milk cells, as indicated in the above figure. When these milk cisterns and milk cells are large and numerous, thousands in number, the empty udder is soft, pliable, elastic, and collapsed. It has great capacity for work and expansion, during the production of the milk. Hard, beefy udders have small milk cisterns, few and small milk cells, and their shape after milking is nearly the same as before.

Constitution, capacity, temperament, circulation, and ability — these are, first of all, essential to milk production. Other points of equal importance, such as feeding, care, and management, cost to produce milk, housing, and aids to the highest milk production are discussed in later paragraphs. (See Exercises 2 and 3.)

The Major Dairy Breeds. — The major dairy breeds are the Jerseys, Guernseys, Holstein-Friesians, and Ayrshires.

1. *Jerseys.* a. *Origin and History.* The Jersey cattle are native to the Channel Islands, which are in the English Channel between England and France. Although the Jersey breed traces back many years, their real history dates back from about 1763 to 1789. Since then their purity as a breed has been protected by law. In 1789, an act was passed that no cattle could be imported into the Island of Jersey unless they were to be slaughtered within 24 hours after their arrival.

The Island of Jersey is about 11 miles long and 9 miles wide, and contains about 39,580 acres. From ten to twelve thousand cattle are kept upon it, however, or about one cow to every 2.2 acres of land.

In 1850, some Jersey cows were brought to Hartford, Connecticut. Since then many Jerseys have been imported into the United States, and now they are the most popular of all the dairy breeds because of their efficiency in producing rich milk, and because the American Jersey Cattle Club has advertised the good points of the breed. Large dairies of Jersey cattle are found in the United States, France, Canada, England, and Australia.

b. *Characteristics.* The Jersey is the smallest of the main dairy breeds, weighing from 850 to 1000 pounds. They are fawn-like in color, with occasional white spots. The muzzle, tongue, and switch are generally black. They are usually considered the best dairy type, being angular and wedge-shaped. Their dairy temperament is, with few exceptions, typical of a perfect

FIG. 79. — A pure-bred Jersey cow. A good example of the Jersey type in conformation, type, and color.

dairy cow. This is shown by the fact that the Jersey seldom becomes fleshy when producing milk, for all of the food consumed is transformed into milk. The Jerseys, as a breed, are more sensitive and nervous than other breeds. When properly handled they become gentle, but when any unusual thing happens they are easily frightened. If Jerseys are not accustomed to them, the lives of children may be endangered by going into a lot where there are Jersey cattle.

The Jersey is a poor producer of beef. Their ability to make gains is comparatively low, and their ability to dress out a high per cent of carcass is still less.

c. *The Jersey as a Milk Producer.* The Jersey breed is not the most economical producer of quantity of milk. But they will produce more butterfat with the same amount of feed than any other breed. From a large number of butterfat tests, the following averages have been found for the breeds named:[1]

	Solids	Butterfat Test
1. Jersey	14.70	5.6
2. Guernsey	14.71	5.3
3. Devon	14.50	4.6
4. Shorthorn	13.38	4.4
5. Ayrshire	12.61	3.6
6. Holstein-Friesian	11.85	3.4

Jersey milk is rich, of a deep yellow color with large butterfat globules. Milk with large butterfat globules creams easily.

The Jersey is a persistent milker and as a family cow it has scarcely an equal. A few yearly records of the leading Jerseys follow:

[1] Cornell Experiment Station.

Name of Cow	Pounds Milk	Pounds Butterfat
Sophie 19th of Hood Farm . . .	17,557	999
Spermfield Owl's Eva	16,457	993
Eminent's Bess	18,782	962
Jacoba Irene	17,253	952

(See Exercises 4 and 5.)

2. *Guernseys.* a. *Origin and History.* The Guernsey cattle were developed on the Island of Guernsey, another of the Channel Islands group just off the coast of France in the English Channel. The Island of Guernsey is about nine and one-half miles by six miles, and contains about 12,500 acres. Upon this island are kept 5000 to 8000 cattle.

It is stated upon good authority that one hundred years ago the Guernseys and the Jerseys were almost the same in color and size. The purity of the Guernsey like the Jersey breed is now protected by law.

Guernsey cattle were not introduced into the United States in large numbers until 1880. To-day the Guernseys are found extensively in New York, Massachusetts, Wisconsin, Pennsylvania, and some of the other leading dairy states.

Although the Guernseys have been widely distributed, they are found only in small numbers in the United States, England, and Canada. Plumb says in his book, *Types and Breeds of Farm Animals*, that it has never been clear to him why the Guernseys have not attracted more attention in the United States. "It is a dairy breed of the highest merit, as repeated tests have shown; yet it is quite limited in development and does not seem to get much foothold in some of our greatest dairy states, especially in the Mississippi Valley."

b. *Guernsey Characteristics.* In general appearance the cattle

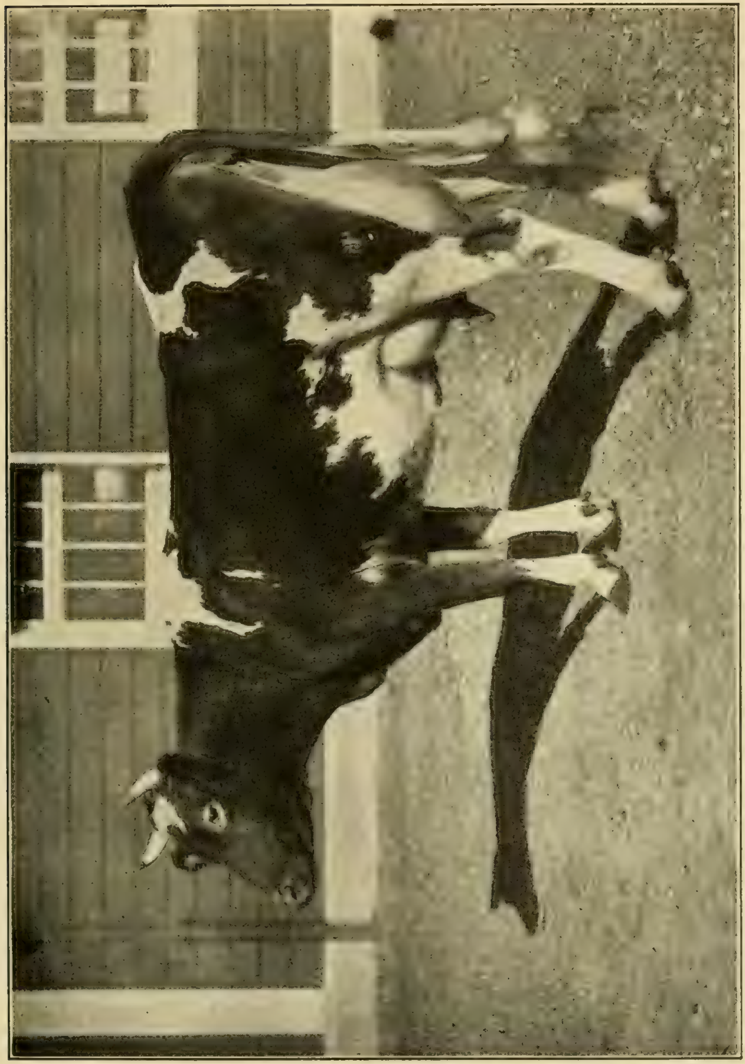


Fig. 80. — Pure-bred Guernsey cow. Record, 18,458 pounds milk, 907 pounds fat, in one year as a four-year-old.

of this breed are about 100 pounds larger than the Jerseys, have coarser bones and features, and are nearly perfect in dairy type. Their color ranges from an orange to a lemon fawn, with white markings. The udder of the Guernsey is somewhat larger than that of the Jersey, is well held up, and extends further to the front. The skin secretions are very yellow.

The cattle of this breed are slower and not so nervous, excitable, and irritable in temperament as the Jerseys.

c. *Dairy Characteristics.* The Guernsey cattle are persistent milkers, and in quality of milk produced they rank a close second to the Jerseys. Their milk is very yellow and has large fat globules. The butter made from Guernsey milk is very yellow.

The records of a few leading Guernsey cows follow:

Name of Cow	Pounds of Milk	Pounds Butterfat
Murne Cowan	24,008.0	1098.18
May Rilma	19.673.0	1073.41
Spotswood Daisy Pearl	18,602.0	957.38

3. *The Holstein-Friesian.* a. *Origin and History.* The native home of the Holstein cattle, as they are usually called in the United States, is Holland, in the province of Friesland. For over 2000 years they have been bred there, and are therefore the oldest breed of cattle. From the ninth century to the present day, Holland has been a great producer and exporter of milk, butter, and cheese.

A few Holstein cattle were imported into New York as early as 1795. They were not imported in large numbers until 1861. In 1873 the first Holstein Association was formed, known as the Holstein Herd Book Association, and in 1879 the Dutch Friesian Association was formed. These two were fused in 1885 under the

FIG. 81. — Pure-bred Holstein cow, "Missouri Chief Josephine." Record, 26,861 pounds of milk, 741 pounds of butterfat in one year. A fine specimen of the Holstein breed.

name Holstein-Friesian. Although the Jersey breed was introduced into the United States first, and enthusiastically advertised, the Holstein cattle are at present largely used in the leading dairy states, namely, Wisconsin, New York, Pennsylvania, Michigan, Illinois, Missouri, and Ohio.

b. *Holstein-Friesian Characteristics.* In general appearance the Holstein cattle are not so typically a dairy form as are the Jerseys, but approach slightly the beef type. They are the largest dairy breed, males weighing from 1800 to 2000 pounds and females from 1200 to 1600. There has been and is a tendency toward the development of Holstein cattle resembling the dairy type. This has been due largely to the opinions of judges passed on Holstein cattle at fairs. The color is black and white, varying in different localities. American breeders generally prefer cows with more than one-half white. The udder of the Holsteins is large, U-shaped, and usually very deep but not extended. The Holstein cattle are docile, gentle, and easily handled.

c. *Dairy Characteristics.* The Holstein cattle, as a breed, produce quantity of milk more economically than do the cows of any other breed; that is, with a given amount of feed they will produce more milk than any other cattle. The milk of the Holstein cattle is lighter in color, and contains less fat than the milk of other breeds of cattle. The small butterfat globules in Holstein milk do not rise to the top as easily nor as rapidly as the large butterfat particles in Jersey and Guernsey milk. It is for this reason that milk from Holstein cows sustains a greater loss of butterfat in the skim milk than the milk from other breeds, especially where the gravity system of creamage is used. Machine separation is usually efficient even if the fat globules are small.

Since the butterfat from the Holstein is lighter in color than that of the Jerseys and Guernseys, the cream and butterfat from this breed is also lighter. Some people think that a light-colored butter is not rich, and will not pay so high a price for it as for darker butters. Holstein cattle, because of the large quantity of milk produced and also because the fats and the solids not fat are well balanced, are well adapted to the condition in which milk is retailed to the consumer. Holstein milk is easily digested because the butterfat globules are small and expose more surface to the digestive fluids. Holstein milk is better suited for children's use than the milk produced by other cattle, for the reasons that the butterfat particles are smaller on the whole and the total solids in the milk are usually less, making the milk easily digestible. The popularity of Holstein milk is increasing, especially where whole milk is wanted for family use.

Fig. 82. — Showing the comparative sizes of small and large fat globules. Fat globules range from $\frac{1}{25,000}$ to $\frac{1}{1,500}$ inch in diameter.

d. *Methods of Handling Dairy Cattle in Holland.* Much of the country of Holland is below the level of the sea, which is held back by extensive dikes and embankments. The land is well drained and very fertile; although it is seldom sold, it is valued at from $1200 to $2000 per acre. The fertile soil of Holland produces a luxuriant growth of grass and hay, on which the cattle graze from May to October. The people of Holland very rarely feed grain to their cattle. This diet of grass and little grain is probably the reason why Holstein cattle give such a large quantity of milk and why the cream is not so rich in butterfat.

From October to May the cows are kept in a stable adjoining the house, from which doors lead into the stalls. This is the reason that Holstein cattle are so gentle. The stables are kept very clean and sanitary. In summer the cows are not driven home to be milked, but are milked in the pasture, so that the cow will not grow tired. The people of Holland were the first to form associations to test the producing power of cows and to set a standard.

e. *Advanced Registry Official* (A. R. O.). The Babcock Test was invented about 1890 in Wisconsin. New York was the first to make practical use of it. The people of New York began to organize cow-testing associations in 1894 and set up the following minimum requirements for advanced registry for Holstein cows:

2-year-old cow must produce 7.2 pounds fat in 7 days
3-year-old cow must produce 8.8 pounds fat in 7 days
4-year-old cow must produce 10.4 pounds fat in 7 days
5-year-old cow must produce 12.0 pounds fat in 7 days

The above tests were made by qualified men sent out from the experiment stations. Although the test extended only over seven days, it paved the way for the formation of the best types of cow-testing associations in which the tests are made over the entire lactation period.[1]

To sum up, Holstein cows have a vigorous constitution, quiet

[1] The butterfat requirements for the major dairy breeds for A. R. O. are as follows:

	Jersey, Guernsey, and Holstein		Ayrshire		Brown Swiss	
Age	Fat	Per Cent	Fat	Per Cent	Fat	Per Cent
Two . .	250.5	70	214.3	66	222.0	66
Three . .	287.0	80	236.0	73	238.4	70
Four . .	323.5	90	279.0	87	271.4	80
Five . .	360.0	100	322.0	100	304.1	90
Six . . .					337.0	100

The per cent indicates what amount of fat may be expected from a cow during any year of the milking period.

temperament, produce an abundance of milk, are free from disease, and have a good family history.

The records of a few leading Holstein cows follow:

Name of Cow	Pounds Milk	Pounds Butterfat
Duchess Skylark Ormsby	27,761	1205
Finderne Pride Johanna Rue . . .	28,403	1176
Pontiac Clothilde De Kol	25,318	1017
Colantha 4th's Johanna	27,432	998

4. *Ayrshires.* a. *Origin and History.* This breed of Scotch dairy cattle was developed in the county of Ayrshire, Scotland. Although the Ayrshire cattle were mentioned in Scottish literature as early as 1750, not until about 1825 to 1850 did the breed assume definite characteristics. Holsteins, Durhams, and Jerseys were used as the foundation sources of this breed. Ayrshires were imported into the United States as early as 1822, but on account of small teats their popularity decreased and the breed was soon lost. Within recent years a considerable number have been imported, but because of the fact that they were not advertised they have not been extensively used.

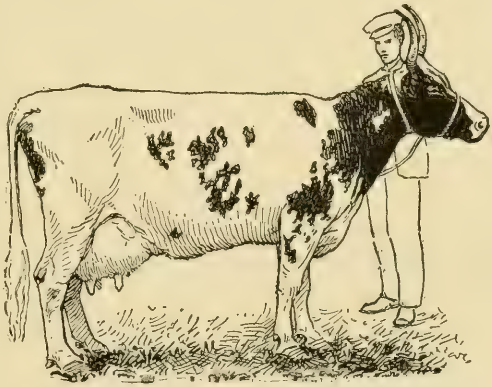


Fig. 83. — An Ayrshire cow, showing the conformation, red and white color, upturning horns, and well-formed udder that stamp this breed.

The Ayrshires are mainly distributed in Scotland, Canada, Australia, the United States, Russia, Norway, and Sweden. They are better adapted than other breeds to severe climates, scant feed, and rough land, and are, therefore, generally found in such places. In the United States they are found in New England and the Ozark Plateau.

b. *Characteristics.* Ayrshire cattle are red, brown, and white in color. They are much larger than the Jerseys but smaller than the Holsteins. They are good milkers, but do not produce as much milk as the Holsteins, nor as rich milk as the Jerseys. It is largely because of their failure to excel in one of these two points that the popularity of the Ayrshires has not been greater. The horns of this breed turn outward and upward and are white with black tips. Their udders are uniform and almost perfect. They are well held up, are wide, and extend well forward on the body. Plumb states that the udder development of the modern Ayrshires presents a higher average perfection of form than does that of any other breed. Their temperament is good.

The milk of Ayrshire cattle contains a great deal of casein. In their native home in Ayrshire the milk is used almost entirely in the manufacture of cheese.

The leading records of the Ayrshires up to the present are as follows:

Name	Pounds Milk	Pounds Butterfat
Auchenbrain Brown Kate 4th	23,022	918
Garclaugh May Mischief	25,328	897
Lily of Willowmoor	22,106	889
Auchenbrain Yellow Kate 3d	21,123	888

(See Exercise 6.)

The Cost of Milk Production. — It is impossible to handle this large topic exhaustively in this small treatment. The discussion here is merely suggestive. Some further points may be worked out by teacher, pupil, and farmer.

Large Production Lowers the Cost. — A cow that yields 3600 pounds of milk per year does not produce milk as cheaply as a cow that produces 10,000 pounds per year. The first figure given is approximately the average production of the dairy cows of the United States.

COST OF MILK FROM COWS PRODUCING DIFFERENT AMOUNTS

POUNDS MILK PER YEAR	COST TO PRODUCE 100 POUNDS OF MILK	COST OF PRODUCING A QUART OF MILK
3,000	$1.70	3.3 cts.
4,000	1.25	2.5
5,000	1.00	2.0
6,000	.83	1.7
7,000	.71	1.3
8,000	.62	1.2
9,000	.55	1.1
10,000	.50	1.0

The assumption that it costs $50.00 to keep a dairy cow for one year is the basis of the foregoing table. We have learned that the dairy type of cow produces milk at less cost than the beef type. The dairy cow is angular, showing that she transforms nearly all the food she eats into milk; the beef cow is fat, showing that she transforms all her food into fat. The cost of milk production is from 25 to 30 per cent less from dairy types than from beef types.

Cows Freshening in the Fall Produce Milk More Cheaply. — It is a well-known fact that cows freshening in the fall produce from 25 to 35 pounds of butterfat more per year than cows freshening in the springtime. This is because the cow has two periods, one in the fall and another in the spring, when the milk flow is large. The increase in butterfat is equal to an increase of from 600 to 800 pounds of milk. This is approximately from one-sixth to one-fifth of the total production. Therefore, if it costs $50 to keep a cow for one year, the cost of milk production will be decreased from about 16 to 20 per cent by cows calving in the fall.

Production Covering a Long Number of Years Lessens the Cost of Milk Production. — The cost of producing calves and heifers until they are 24 months old has been found, by Bennett and Cooper of Wisconsin, with 117 calves to be as follows:

COST OF REARING DAIRY HEIFERS IN WISCONSIN[1]

	COST TO ONE YEAR	COST TO TWO YEARS
1. Initial value of calf	$ 7.04	$ 7.04
2. Feed	24.67	40.83
3. Labor	4.45	7.81
4. Other costs	6.36	13.73
Gross cost	$42.52	$69.81
Credit for manure	3.00	8.00
Net cost	$39.52	$61.41

A cow giving milk only from the time she is 24 to 36 months old would have to produce an extremely large quantity of milk to pay for the cost of raising the heifer, and the cost of keeping the cow during the first years of milk production. But the production of milk over a long number of years reduces the cost of milk production per year. The following table shows twelve years of profitable milk production:

[1] Henry and Morrison: *Feeds and Feeding.*

RECORD OF CYLENE JEWEL (UNIVERSITY OF MINNESOTA COW) [1]

YEAR	MILK Pounds	BUTTERFAT TEST	BUTTERFAT Pounds	LACTATION PERIOD Weeks
1902–03	6,413.6	3.28	210.24	55
1904–05	6,231.3	3.16	197.20	52
1905–06	8,061.9	3.21	258.86	42
1906–07	7,373.9	3.31	244.33	44
1907–08	11,067.8	3.24	358.59	52
1908–09	7,487.3	2.99	224.25	42
1909–10	11,853.8	2.93	346.99	51
1910–11	11,436.0	3.28	375.39	55
1911–12	12,704.7	3.16	402.05	46
1912–13	10,713.1	3.02	323.06	46
1913–14	12,697.9	3.93	499.63	44
1914–15	12,811.1	2.89	370.09	55
Total	118,852.4	38.40	3810.68	584
Average . . .	9,904.364	3.20	317.556	48.66

Keeping accurate records such as the above, does more to put dairying on a sound basis than any other one thing. (See Exercises 7 and 8.)

Treating with kindness, being regular in feeding a balanced ration, providing good, clean, sanitary quarters, supplying plenty of clean, pure, medium warm water, and allowing the cow a reasonable amount of exercise, raising the calves on skim milk, — all aid in the economical production of milk. These topics will be touched in a later discussion.

Composition of Milk and its Products. — As we have said before, milk is of such a composition that it can nourish all tissues of the body more nearly than any other food. For this reason it is the only food for many young animals for about the first

[1] Courtesy of University of Minnesota.

eight months. The tissues of the body are made up of water, mineral matter, fatty tissue, and protein tissue. These are all found in milk in such proportion that every tissue of the entire body may be well nourished. There is no other single food that will sustain life longer. The composition of other foods may well be compared with that of milk, for milk gives a good basis on which the value of other foods may be estimated.

The Average Composition of Milk

1. Water	87.4 per cent
2. Fat	3.7 per cent
3. Casein and albumen	3.2 per cent
4. Milk sugar	5.0 per cent
5. Ash	0.7 per cent
Total	100.0 per cent

According to a Federal law, milk must contain 8.5 per cent of solids not fat, and 3.25 per cent or more fat.

In order that milk may be of the best quality it must be produced by healthy cows under sanitary conditions. The cow, the surroundings, the utensils, and the milker must all be free from dirt and disease. Bacterial life in milk may be destroyed by pasteurization. The germs of tuberculosis, diphtheria, and scarlet fever may be destroyed in this way, also, but it is much better to produce pure milk.

In the modern creamery, milk is skimmed with separators. The skim milk remaining contains all the constituents given in the table excepting the butterfat. Under farm methods of skimming about 0.3 to 0.6 per cent butterfat remains in the skim milk. What is the value of skim milk? W. D. Hoard, editor of Hoard's *Dairyman*, says: "It is well established that one hundred pounds of skim milk will make 5 pounds of growth when fed to pigs weighing from 75 to 150 pounds. Multiply this growth by the price of pork and you have the minimum value of the skim milk. Feed it in conjunction with corn and you add 20 per cent to its value or cash return, all as a result of the combination." [1]

Cream is the part of whole milk which contains a larger proportion of butterfat than the whole milk. According to Federal law, cream must contain not less than 18 per cent of butterfat. Butterfat rises to the top because it is lighter than whole milk. The specific gravity of whole milk is 1.029 to 1.033; water, 1.00; and butterfat, about 0.93.

The amount of cream lost depends upon the system used in skimming. In the shallow pan system, about 20 per cent of the cream is lost. The skimmed milk retains about 0.5 of one per cent of the fat in the whole milk. In the deep-setting system where deep cans are used, only about 0.2 to 0.3 of one per cent of the fat is lost. By the use of centrifugal separators, almost all of the butterfat is taken out of the milk. However, when the skim milk is tested for butterfat, from .02 to 0.5 per cent of butterfat is usually found; sometimes more. Butter has about the following composition:

Butterfat	80 to 88 per cent
Salt	1 to 4 per cent
Water	10 to 16 per cent

Federal law provides that the maximum quantity of moisture in butter cannot exceed 16 per cent. Ordinarily butter has about 82½ per cent butterfat, 14½ per cent moisture, and about 2 to 3 per cent salt. By an act of Congress, May 9, 1902, butter may contain added coloring matter. The best churning temperature ranges from 50° to 60° Fahr. The extreme temperatures for churning are from 46° to 80° Fahr.

A hundred pounds of butterfat will yield about 110 to 120

[1] Wisconsin Buttermaker's Association Report of 1912.

pounds of butter, because of the addition of salt and water. The number of pounds of butter yielded above the number of pounds of butterfat is known as the *overrun*. It is upon the overrun that the creamery man depends mainly for his profits.

The composition of cheese varies a great deal, but the average for full milk is about as follows: water, 34 per cent; fat, 35 per cent; casein, 28 per cent; and salt, 3 per cent. Cheese is an exceedingly nutritious food. Butter excels cheese in flavor, but cheese is a better balanced food. (See Exercise 9.)

The product remaining after the fat and the casein have been taken out of milk is whey. It, also, has some food value for animals.

Feeding for Milk Production. — One of the great problems for the dairyman to solve is the question of converting vegetable feeds into milk. To do this best, he must know the composition of the dairy cow's body, the milk she is to produce, and the digestible composition of feeding stuffs. The price of feeds is an important factor in the economical aspect of milk production. These points can be discussed only in a brief way.

Composition of the Dairy Cow's Body, and of the Milk Produced. — The author was unable to find any statement as to the chemical composition of the dairy cow's body. The composition of a half-fat steer will provide, however, a fair estimate of the approximate composition of the dairy cow's body.

Composition of Half-fat Steer and Milk

	Water	Fat	Carbohydrates	Protein	N. R.
Fat steer . .	54.0	22.6	0.0	17.8	1 : 1.2
Milk	87.4	3.7	8.7	3.2	1 : 5.3

In the production of milk, the body of the dairy cow must be first supported; then, in addition, food must be provided to produce the milk given. The food, if it is to produce the best results, must contain in proper proportions the same constituents that are found in the dairy cow's body and in her milk. It is for this reason that an abundance of water, some carbohydrates, and protein must be fed in order to get the best results from a dairy cow.

Spring Conditions Make Most Milk. Why? — Every farmer welcomes spring. The temperature, the abundance of succulent grass, the moderate exercise, the comfortable surroundings, and the balanced ration, and the drinking of a lot of clean pure water, — all are conducive to the highest efficiency in milk production. There is nothing superior to blue grass, mixed with white clover, for milk production, because the cattle eat an abundance of this feed; it is palatable and contains the food elements which make it a well-balanced ration. Compare the composition of blue grass and white clover with the dairy cow's body and her milk.

Composition of Blue Grass and White Clover

	Water	Fat	Carbohydrates	Protein	N. R.
Blue grass . .	68.4	0.6	14.8	2.3	1 : 7.0
White clover .	78.2	0.5	9.6	3.1	1 : 3.5

It is quite probable that a small amount of concentrates fed along with the blue grass and white clover would increase the milk flow, but not the economical production of milk, except in case of short pastures. In addition to the pasture grass, an abundance of pure, clean, moderately warm water should be provided. These summer conditions are conducive to the highest milk production.

Winter Feeding for Milk Production. — To produce the best milk in winter, summer conditions should be maintained as nearly as possible. The cows should be given an abundance of green, or nearly green, feed, a well-balanced ration, an abundance of water, and comfortable surroundings.

Well-kept silage, sugar beets, and mangel-wurzels furnish a feed that corresponds as nearly as possible to green feed.[1] Silage is one of the principal feeds used by dairymen. Silage gives bulk to the feed, is palatable, causes the cow to eat and drink more, and is probably the cheapest substitute for green feed. Silage, however, is not a balanced feed, because it contains too large an amount of carbohydrates and too small an amount of protein.

COMPOSITION OF CORN SILAGE (FROM WELL-MATURED CORN)

	Dry Matter	Water	Fat	Carbohydrates	Protein	N. R.
Silage . . .	26.3	73.7	0.7	15.0	1.1	1 : 15.1

The nutritive ratio of corn silage is as 1 : 15.1. This shows that it contains too much carbohydrate material in proportion to the protein content. The nutritive ratio of blue grass is 1 : 7.0 and of white clover and blue grass combined is as 1 : 5.3. An equal amount of white clover and blue grass makes an excellent ration for a dairy cow. Its nutritive ratio is right, but the nutritive ratio of corn silage, 1 : 15.1, is too wide.

Bran, red clover, alfalfa, soybean hay, cowpea hay, or cottonseed meal may be used to supply the deficiency of protein in the corn silage.

[1] Read again the paragraphs on silage in the chapter on Corn.

Digestible Composition of Corn Silage and Other Feeds Richer in Protein

	Dry Matter	Water	Fat	Carbohydrates	Protein	N. R.
Silage . . .	26.3	73.7	0.7	15.0	1.1	1 : 15.1
Wheat bran .	89.9	10.1	3.0	41.6	12.5	1 : 3.9
Alfalfa . . .	91.4	8.6	0.9	39.0	10.6	1 : 3.9
Cowpea hay .	90.3	9.7	1.0	33.7	13.1	1 : 2.7
Prime cotton-seed meal .	92.2	7.8	7.9	24.3	33.4	1 : 1.3

It will be seen that the above feeds contain a large amount of protein material. It is this which helps in balancing corn silage as a ration.

The suggestions of a few practical rations will be in order here. For a cow weighing 1000 pounds, producing 25 pounds of milk, testing 4 per cent butterfat, the following rations may be used. If the farmer has not all the feeds suggested, other feeds may be supplied that will furnish the same food constituents.

Digestible Composition of a Ration [1]

	Parts of 100 Pounds of Each	Dry Matter	Fat	Carbohydrates	Protein	N. R.
		Pounds	Pounds	Pounds	Pounds	
Corn silage 25 lb. . .	$\frac{1}{4}$ of 100 lb. .	6.6	.02	3.75	.27	
Clover hay 10 lb. . .	$\frac{1}{10}$ of 100 lb. .	8.7	.18	3.93	.76	
Corn 4 lb.	$\frac{1}{25}$ of 100 lb. .	3.98	.18	2.68	.30	
Bran 4 lb. . .	$\frac{1}{25}$ of 100 lb. .	3.99	.12	1.68	.50	
Totals .	. . . .	23.27	.50	12.04	1.83	1 : 7.3
Requirements	. . . .	30.00	.65	13.00	2.80	1 : 5.3

[1] Henry and Morrison: *Feeds and Feedings.*

From the above it may be concluded that the ration suggested is too low in all of its constituents and that dry matter and protein are especially lacking. The nutritive ratio of the ration is too wide, indicating that a larger amount of protein should be fed.

A few other good dairy rations are given:

Corn silage . . . . 30 lb.	
Bran . . . . 10 lb.	
Cottonseed meal . . 2 lb.	

Corn silage . . . . 30 lb.	
Alfalfa . . . . . . 11 lb.	
Cottonseed meal . . 2 lb.	

Corn silage . . . . . 30 lb.	
Soybean hay . . . . 10 lb.	N. R. 1 : 5.7
Bran . . . . 10 lb.	

When production of milk is considered, regardless of cost, the composition of the ration fed should be right. But when the production is considered from an economical viewpoint, and this is the practical viewpoint, the cost of the feeds making the ration should be carefully figured.

The following method of figuring the price (not the feeding value) of feeds may be suggestive. Current prices should be used in figuring the cost of rations.

Prices of a Few Feeds

Feed	Estimated Cost per Ton	Cost per 1000 Pounds	Cost per 100 Pounds	Cost per Pound
Corn silage	$ 3.50	$ 1.75	$0.175	$0.00175
Clover hay	13.50	6.75	0.675	0.00675
Cottonseed meal . .	30.00	15.00	1.50	0.015
Bran	22.00	11.00	1.10	0.011

(See Exercises 8 and 9.)

Summary. — Dairying is one of our most important farm operations. It is adaptable to high-priced land, enriches the soil, and brings a steady income. The dairy cow is the most economical producer of human food. The Jerseys, Guernseys, Holsteins, and Ayrshires are the major dairy breeds. Every cow must have a good constitution, a good temperament, a good circulation, and milk-producing capacity if she is to be a profitable cow.

A balanced ration at the lowest cost is essential to economic milk production. Conditions similar to those in summer, such as an abundance of palatable, green, well-balanced feed, an agreeable temperature, a moderate amount of exercise, and much water are conducive to the highest milk production.

LABORATORY EXERCISES

1. Local Importance of Dairy Cattle. — Make a survey of the dairy cattle of the school district. Fill out a table somewhat as follows. Leave a permanent record in the school. Assign three or four days before the results are to be reported.

Name of Owner	Breed	Number of Cows	Daily Gallons Milk	Pounds of Milk (Multiply Gal. by 8.58)[1]

2. Comparison of Two Dairy Cows. — Compare two dairy cows from the standpoints of constitution, capacity, temperament, circulation, and ability.

3. Judging Dairy Cows. — Judge according to score card the best types of dairy breeds obtainable in your neighborhood. This exercise will require several hour periods.

[1] A gallon of milk weighs 8.58 pounds.

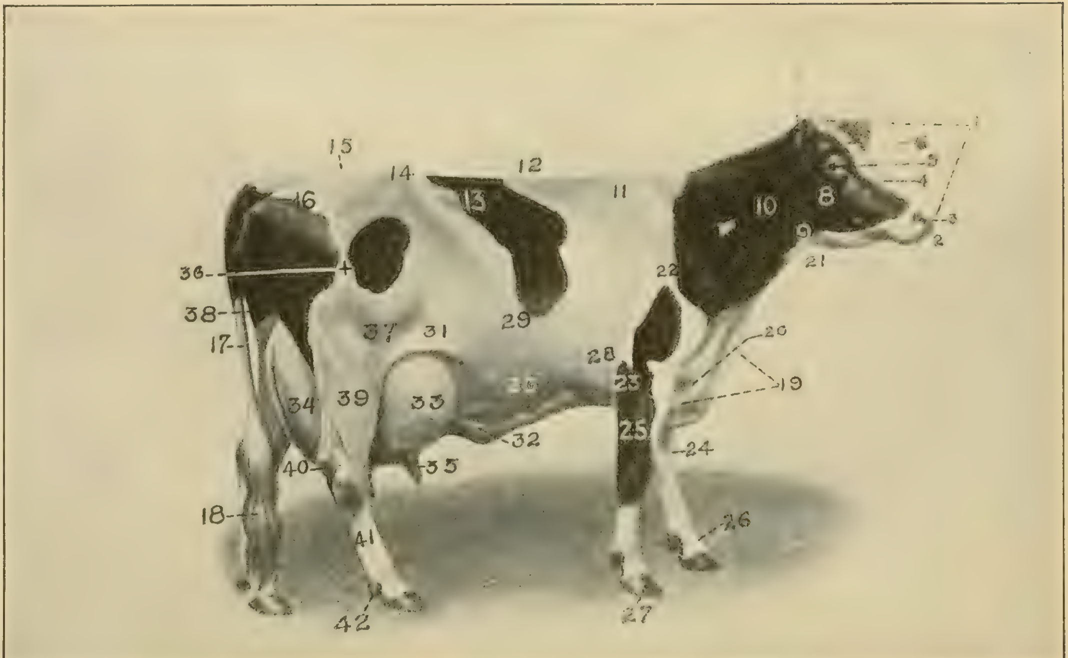


FIG. 84. — Diagram showing points of the cow.

1. Head.
2. Muzzle.
3. Nostril.
4. Face.
5. Eye.
6. Forehead.
7. Ear.
8. Cheek.
9. Throat.
10. Neck.
11. Withers.
12. Back.
13. Loins.
14. Hip bone.
15. Pelvic arch.
16. Rump.
17. Tail.
18. Switch.
19. Chest.
20. Brisket.
21. Dewlap.
22. Shoulder.
23. Elbow.
24. Knee.
25. Forearm.
26. Ankle.
27. Hoof.
28. Heart girth.
29. Side or barrel.
30. Belly.
31. Flank.
32. Milk vein.
33. Fore udder.
34. Hind udder.
35. Teats.
36. Upper thigh.
37. Stifle.
38. Twist.
39. Leg or gaskin.
40. Hock.
41. Shank.
42. Dew claw.

Dairy Cattle — Score Card

Scale of Points	Perfect Score	Score — Female: Student's	Corrected	Student's	Corrected	Student's	Corrected	Student's	Corrected
A. General Appearance — 22 Points									
Weight, estimated....lb.; actual....lb.	1								
Form, wedge shape from front, side, and top	9								
Quality, hair fine, silky; skin mellow, loose, medium, thick, yellow, not fleshy; bone fine	6								
Dairy temperament, angular, not fat, totally inclined to transform food into milk	4								
Disposition, gentle, docile	2								
B. Head and Neck — 8 Points									
Muzzle, broad; nostrils large	1								
Eyes of good size, mild, bright	1								
Face, lean, fine, shapely	1								
Forehead, broad	2								
Ears, not coarse, size, medium, inside yellow	1								
Neck, fine, rather long, well set on shoulders and head; top line slightly curved; throat clean; dewlap light	2								
C. Fore Quarters — 5 Points									
Withers, lean, thin, not rough	1								
Shoulders, light, oblique	2								
Legs, straight, short; shank, fine; feet, well placed	2								
D. Body — 17 Points									
Chest, deep, low, full; girth, large,....inches	4								
Crops, not deeply depressed	1								
Ribs, long, broad, well sprung, wide apart	3								
Back, lean, strong, "spinal processes" well defined	2								
Stomach, deep; girth, large,......inches	3								
Loin, broad, long, level, last rib to hip..inches	3								
Flanks, low, deep from hip down	1								
E. Hind Quarters — 14 Points									
Hips, wide apart	3								
Rump, broad, level; long,....inches	3								
Pin bones (or thurls), high, wide apart	1								
Thighs, thin, roomy, long, well carried	3								
Legs, straight, short, wide apart; shank, fine	3								
Tail, long, fine, reaching hocks, switch good	1								
F. Udder — 34 Points									
Front udder, carried well forward, full, thick, soft, mellow within; quarters, even	12								
Hind udder, full in form, well up behind, good width, mellow, even	10								
Milk veins, large, long, elastic, tortuous	6								
Milk wells, large	2								
Teats, $2\frac{1}{2}$ to 3 inches long, good size, well placed	4								
Total	100								

4. **Language Exercise on Jersey and Holstein Characteristics.** — Write in a brief story the characteristics of the Jersey and Holstein cattle. This may be an exercise in language work.

5. **Making Babcock Test with Babcock Tester.** — With Babcock Tester test several samples of whole milk. (*An eight bottle closed tester is best for school use. Open testers are inaccurate and dangerous.*)

FIG. 85. — Dr. S. M. Babcock, the inventor of the Babcock Test, which aids the dairyman to determine whether a cow is producing butterfat economically.

Directions. — First get a good sample of milk by pouring milk back and forth from one vessel into another several times.

Fill milk pipette up to mark, 17.6 c.c. of milk. Pour the milk into the whole milk test bottle. Then add 17.5 c.c. of sulphuric acid (sp. gr. 1.82); with a whirling motion mix milk and acid thoroughly. Whirl in tester for five minutes. Then fill bottles about up to the base of the neck with warm water. (Temperature about 150° Fahr.) Whirl for three minutes. Then fill bottles well up on the graduations with warm water. Whirl for one minute. Read butterfat test.

6. **Testing Skim Milk and Buttermilk.** — Test some skim milk and buttermilk in the same manner as indicated in Exercise 5.

7. **Finding Value of Milk and Butter Produced by Cylene Jewel.** — Figure the value of the milk produced by Cylene Jewel (page 187) at 20 cents per gallon. Also the value of the butterfat at 30 cents per pound.

8. **Rations of a Dairy Cow.** — Get from your parents or from a neighbor the ration fed to a dairy cow, and figure its cost. Have pupils put these on the board. Correlate such examples with the arithmetic work.

9. **Record of a Dairy Cow for Two Months.** — Keep the number of pounds of milk produced and test of a milch cow for two months. Weigh and test milk produced the first and fifteenth day of each of two months. Keep your record.

CHAPTER XIII

SWINE PRODUCTION

Wild Swine. — It is reported upon good authority that there were about twenty species of wild hogs. The wild boar is probably the immediate ancestor of our domestic swine. He was tall, slender, deficient in sides and rear quarters, and had heavy shoulders. The wild boar had at least three means of protection: he was a fleet runner; his long tusks were good fighting implements; and his skin and hair were heavy.

Courtesy of Orange Judd Co.

Fig. 86. — Wild boar — ancestors of all modern breeds of swine.

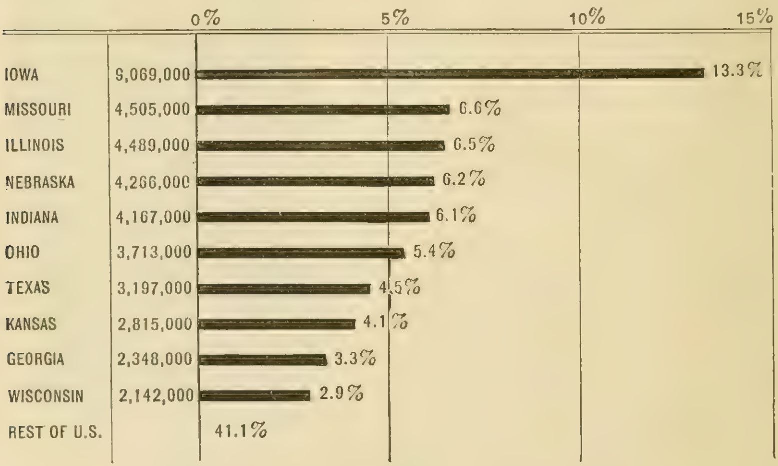
Wild hogs liked moist, damp, warm places best. They sought places near streams where the underbrush was dense, where herbs, roots, insects, and refreshing waters abounded. "Root, hog, or die," was a natural act of the wild hog. By rooting, they secured the foods they needed, — roots, herbs, insects, and worms. Domestic hogs likewise root up the pasture to secure the food they crave and need. Corn-fed hogs will root up the entire pasture in the spring to get worms and roots. These furnish an additional amount of pro-

Note to the Teacher: The materials needed to do the Laboratory Exercises at the close of this chapter are:

Hogs of different breeds to score.

tein substance, which aids in building up bone, muscle, and tissue. Swine that are fed a well-balanced ration will usually not root up large areas.

The Swine-producing States. — While hogs are produced in every state of the United States, the states of the "corn belt" are the ones that furnish the surplus of swine products. The ten leading swine states, in numbers and percentage of swine produced for one year, are as follows:[1]



GRAPH 7. The leading states in swine production.

About 59 per cent of all the hogs produced in the United States are raised in the above ten states. The average number of hogs per farm in Iowa is 35, and in other states it ranges from that down to less than one per farm.[2] (See Exercise 1.)

Advantage in Pork Production. — 1. The first advantage of pork production is the rapidity with which swine multiply.

[1] Data for 1916, taken from *United States Year Book of Agriculture.*

[2] 1910 census.

Sheep, cattle, and horses have usually less than one offspring per year. From ten to fourteen pigs are frequently produced in a year from one pair of hogs.

2. Hogs require less feed to produce a hundred pounds of meat than do other farm animals. From 500 to 600 pounds of corn, or its equivalent, will produce 100 pounds of pork, while in the case of a steer it requires from 1000 to 1100 pounds of corn to produce 100 pounds of beef, and from 800 to 900 pounds of feed to produce 100 pounds of mutton. However, sheep and cattle consume feeds of a different nature, and for that reason may make more economic gains.

3. Hogs dress out a higher percentage of carcass, as shown by the following comparison:

Animal	Per Cent Dressed Carcass
Swine	70–77
Steers	60–66
Sheep	50–55

4. A fourth advantage in pork production arises from the fact that swine consume large quantities of feeds that otherwise would be wasted. In the cattle feed lots, hogs eat the corn that the steers leave. From 150 to 300 pounds of hogs may profitably follow a thousand-pound steer that is on a full-fed corn ration. On the dairy farm, skim milk, buttermilk, and whey are excellent feed for swine. Insects and the grass and roots along streams and fences are eaten by swine.

5. A fifth advantage in pork production is that instead of hauling from 500 to 600 pounds of corn to market only 100 pounds of pork need be hauled.

6. The fertility of the soil may, by proper farm management, be maintained where hogs are raised. (See Exercises 2 and 3.)

Economic Pork Production. — Young pigs put on more weight with less feed than do old large hogs. This is shown in the table below, which tabulates average results at American Experiment Stations, where more than 2200 hogs were fed in over 500 feeding trials. In order to balance the ration in these trials, skim milk and whey were provided as a part of the feed. Six pounds of skim milk and twelve pounds of whey were counted equivalent to one pound of concentrates.

Relation of Weight of Pigs to Feed Used and the Amount of Gains Made by Pigs of Different Weights

Weight of Pigs	Actual Average Weight	Number of Animals Fed	Average Feed Eaten per Day	Feed Eaten Daily per 100 Lb. Live Weight	Average Gain per Day	Feed per 100 Lb. Gain
Pounds			Pounds	Pounds	Pounds	
15–50 . .	38	174	2.2	6.0	0.8	293
50–100 . .	78	417	3.4	4.3	0.8	400
100–150 . .	128	495	4.8	3.8	1.1	437
150–200 . .	174	489	5.9	3.5	1.2	482
200–250 . .	226	300	6.6	2.9	1.3	498
250–300 . .	271	223	7.4	2.7	1.5	511
300–350 . .	320	105	7.5	2.4	1.4	535

From the above table, 174 pigs that weighed on an average of 38 pounds put on 100 pounds of gain with 293 pounds of feed; and 105 hogs, weighing on an average 320 pounds, put on 100 pounds of gain with 535 pounds of feed. Why such a large difference? Because it requires more feed to maintain a 320-pound hog than it does to maintain a 38-pound pig. Since young hogs make greater gains with less feed than do older hogs, the practice has become quite general in recent times to market hogs when they are from six to eight months old, and weigh from 175 to 225 pounds.

A second factor in reducing the cost of pork production is an "All Year Hog Pasture." Such a plan was most excellently suggested by Mr. Sam Jordan when County Farm Advisor of Pettis County, Missouri.

ALL YEAR HOG PASTURE

LOT I — THREE ACRES Sow to rye early in the fall. Pasture from about Dec. 15th to the last of May. Plow under and sow to soybeans. Pasture soybeans as soon as they begin to ripen, until all are eaten.	**LOT III — TWO ACRES** Sow to rape about May 1st. Pasture from last of June to middle of August, when hogs are put back on Lot II. Pasture again when hogs are done with soybeans on Lot I, until rye is ready on Lot II.
Water Tank	
LOT II — THREE ACRES Sow oats and rape in early spring, to be pastured when hogs are removed from the rye on Lot I until last of June. Pasture again from middle of Aug. until soybeans are ready. Remove hogs to soybean field, Lot I, and plow and sow rye. This rye may be pastured from Dec. 15 to following spring.	**LOT IV — TWO ACRES** Permanent pastures of blue grass and white clover or alfalfa. This is to be used as a reserve for such times as other lots might not be ready or could not be used.

"This ten acres," Mr. Jordan says, "should carry from 50 to 75 grown hogs, depending on the quality of the soil, the season, and the supplementary feed. If this plan is followed and about a half-grain ration fed, pork can be produced for about one-half of what it can be produced when nothing but grain is fed. If we can sell hogs for 8 cents per pound and it costs 8 cents a pound to produce them, we had better stay out of the hog business." [1]

The advantages of the "All Year Hog Pasture" are:

1. It reduces the cost of pork production about half.

2. It improves the fertility of the soil.

3. It provides a well-balanced ration and keeps the hogs in the best of health condition.

4. Because the soil has been cultivated and the hogs are shifted from pasture to pasture, the soil does not easily become contaminated. (See Exercise 4.)

A third factor in economic pork production is properly balancing the ration. The picture (Fig. 87) shows that corn alone does not support the tissues of swine, because it does not provide enough protein. When skim milk and wheat middlings were added, the necessary amount of protein was fed, the ration was balanced, and as a result the pigs did better.

Courtesy of Orange Judd Co.

FIG. 87. — Protein is very important. The larger two were fed skim milk and wheat middlings with corn; the smaller two were given corn only.

In the "corn belt," it is generally believed that pork cannot be produced without corn. This opinion is not supported by the conditions under which the wild hogs lived in the forests of Europe, Asia, and Africa, when they ate herbs, roots, worms, snakes, insects, and grew fairly well. However, when a well-balanced ration is provided, pork is produced more cheaply.

If corn or wheat products are fed, some linseed oil meal, tankage, skim milk, ground alfalfa hay, soybeans, or cowpeas will help to balance the ration. A few simple rations follow:

[1] Sam Jordan: *All Year Hog Pasture.*

1. Corn . . . . 3 parts
2. Skim milk . . . . 5 parts

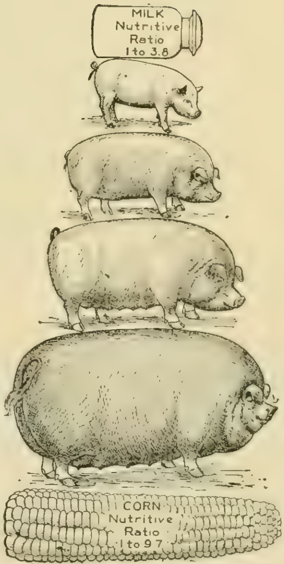
1. Corn . . . . 14 parts
2. Tankage . . . . 1 part
3. Shorts . . . . 2 parts

1. Corn . . . . 6 parts
2. Alfalfa . . . . 1 part

1. Corn
2. Pasture grasses
3. Skim milk

A fourth factor in economic pork production is improving the herd. The razorback is a thing of the past, because he does not dress out a high per cent of pork; nor does he fatten economically. The picture (Fig. 89) illustrates the difference between a razorback and a half-pure breed.

The razorback is a scrub, and will sell slowly for scrub prices; the half breed sells more readily, and for better prices.



Courtesy of Orange Judd Co.

FIG. 88. — From milk to corn. As the animal grows, the ration widens. The cut shows a valuable lesson regarding feeding the swine. The same lesson holds true for the feeding of other live stock.

Types of Swine. — There are two types of swine; namely, the lard and the bacon types. The bacon type is comparatively narrow over the back, the quarters are somewhat smaller, but the sides are deep and long. From the bacon type we have breakfast bacon, which, in many places, is the highest priced cut. The finest bacon is intermingled with a great deal of lean. This is the kind of meat generally exported, because it satisfies foreign trade. The people of England are especially fond of breakfast bacon.

Courtesy of Orange Judd Co.

FIG. 89. — How breeding improves the stock, — a half-pure breed and a razorback.

Hogs of the lard type have broad backs, full quarters, and short legs. They have the greatest capacity to put on fat, and represent, therefore, the best conformation for maximum pork production. The disposition of the lard types is slow, sluggish, and lymphatic. They put on fat readily and often become too fat, especially for show purposes. Judges at State Fairs, and elsewhere, should discount hogs that carry a surplus of fat. Hogs should be judged in accordance with their purpose. Breeding stock should be in good living condition, and hogs for the market should be reasonably fat. (See Exercise 5.)

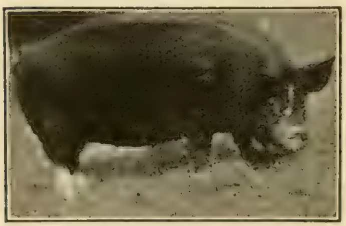


FIG. 90. — The Berkshire. Lard type.

Breeds of Swine. — 1. *Berkshire* hogs came from Berkshire County, England, and are now widely distributed. In England, the Berkshires are not quite so broad-backed, but in the "corn belt" they soon become typical lard hogs. Berkshires have short, dished faces, their ears are short and stand erect, and their bodies are long and deep, but not quite so wide as those of some other breeds. Their backs are slightly arched. The color of the Berkshires is black, with five or six white points. Generally the head, feet, and tail are partially white.

The Berkshires are excellent feeders and fatteners, are of fine quality, prolific, and are very adaptable to a wide range of climatic conditions.

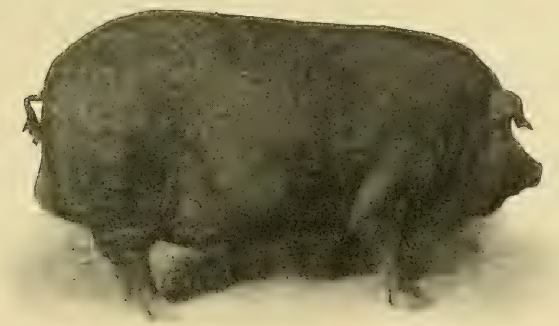


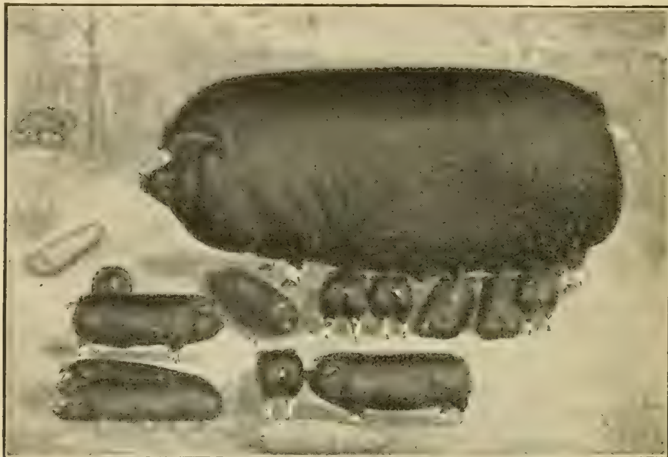
FIG. 91. — The Poland China. Lard type.

2. The *Poland China* hogs originated in the Miami Valley of Ohio from 1816 to 1840. They are very compact, close to the ground, and typical of the lard type. They are black, with white feet, tail, and face. White elsewhere on the body does not show impurity of blood. The face is straight, and the ears break at the upper third.

The chief adverse criticism on the breed is their lack of prolificacy. However, it has been found that the average of one thousand eighty-six Poland China litters was 7.45 pigs each.[1]

[1] Plumb: *Types and Breeds of Farm Animals.*

The strong points of the Poland China breed are their early maturing, and their feeding and fattening qualities. They are widely distributed and a very popular breed in America.



Courtesy of Orange Judd Co.

Fig. 92. — Poland China pigs.

3. The *Duroc Jersey* pig originated in the state of New York. In 1872, the National Swine Breeders' Convention practically set the essential characteristics that this breed was to possess. Hogs of this breed are a solid red, ranging from a dark cherry red to a lighter red.

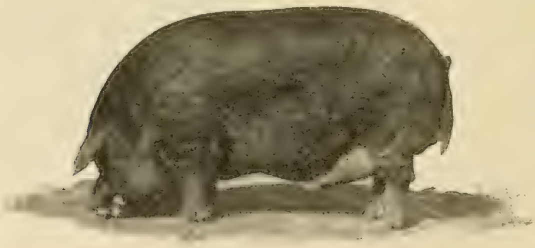


Fig. 93. — The Duroc Jersey. Lard type.

They are in body conformation essentially the same as the Poland China breed. They rank well with the other lard hogs in per cent of dressed carcass. A well-finished 100-pound pig will dress out 72 pounds or seventy-two per cent, and a 300-pound hog well finished will dress out about 237 pounds or seventy-nine per cent.

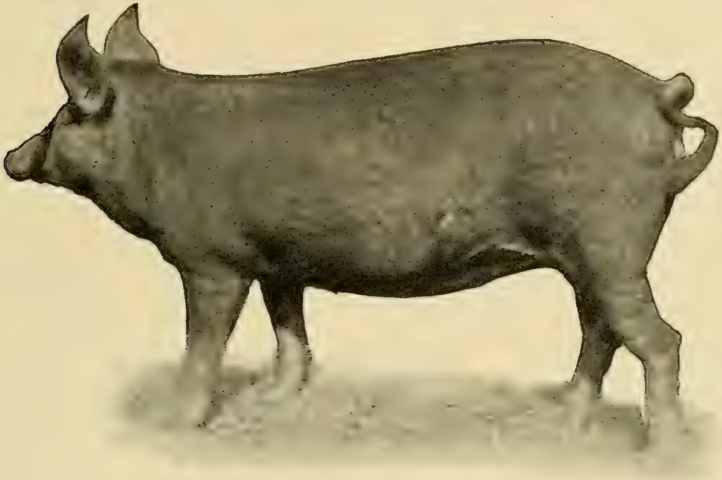


FIG. 94. — The Tamworth. Bacon type.

CLASSIFICATION OF SWINE

1. Lard Types:
   1. Berkshire 2. Poland China 3. Duroc Jersey 4. Chester White
2. Bacon Types:
   1. Yorkshire 2. Tamworth 3. Hampshire

Prevention of Hog Diseases. — Hogs that are healthy have a strong resistance to disease. They may be kept healthy by providing clean quarters and clean water, and by feeding a balanced ration. If every cell and tissue of the body is well fed, the hog keeps strong and vigorous, and disease finds no fertile field or weakened organs in which to develop. On the other hand, if hogs are not fed a well-balanced ration, some parts of the cells are not properly nourished. These cells become weakened, and disease germs soon overtake the weakened parts. Strong, healthy hogs are seldom sick.

Hogs should be kept free from worms and lice, because they reduce the vitality of the hogs. When herds are infested with worms, it is well to use six grams of santonin and four grains of calomel per one hundred pounds of live weight. This may be fed in slop after hogs have had no feed for about twenty-four to thirty-six hours. Lice may be destroyed and kept away by dipping hogs every six or eight weeks in the summer season. A concrete vat filled with crude oil furnishes one of the cheapest and best dips. Spraying hogs with a good disinfectant will also do away with lice.

Hogs will not need treatment often if they are provided clean, sanitary quarters. The saying " dirty as a hog," has no application in the hog kingdom. The hog does not like filthy and unclean quarters, and if man will do his part in maintaining clean quarters, the hog will be healthy, free from lice and worms. Under healthful conditions the maximum growth and thrift in hogs may be secured. (See Exercises 6 and 7.)

Hog Cholera. — Hog cholera causes an annual loss of about $65,000,000 in the United States. This disease is caused, like many other diseases, by a small germ which remains unidentified up to the present time. These germs may be carried by man, mice, dogs, crows, pigeons, sparrows, and on wagons. Hogs that get sick should be isolated and put into a pen that is covered with netting, so neither mice nor sparrows can get in. All hogs that die of cholera should be burned, and the hog-quarters thoroughly disinfected. A good disinfectant is fresh air-slaked lime. It should be used freely on the floors of hog houses and over the ground of pens and feed-lots. After two or three days the lime may be scraped together and hauled out into the fields. Other disinfectants may be occasionally used to advantage.

"An ounce of prevention is worth a pound of cure," applies more forceably to hog cholera than to almost any other disease. However, when all measures of prevention have failed, then remedies must be used. Calling in a veterinarian, or the Farm Advisor, when the disease first appears is most economical. Vaccination, if needed, should be administered early.

In all contagious diseases, whether of animals or of man, it is common courtesy to one's neighbors to put up a sign. Whenever hog cholera exists, the sign to be posted is "Hog Cholera Here." Putting up such a sign is a neighborly act.

Summary. — Raising and selling hogs is so profitable that they are frequently called "mortgage lifters." Early maturity of swine lessens the cost of producing pork. A well-balanced ration also reduces the cost of production; the use of forage crops is almost indispensable in successful swine husbandry. Providing clean quarters, keeping the hogs healthy and vigorous, and feeding carefully, are large factors in preventing disease. The economic production of swine deserves our careful study and attention.

LABORATORY EXERCISES

1. Hog Survey of the District. — Have pupils take a survey of the district, finding the breeds and numbers of hogs and their value. Fill out an outline similar to the following one and keep in your permanent notebook.

HOG SURVEY OF THE DISTRICT

FARMER'S NAME	HOGS	VALUE	PIGS	BREED	TOTAL VALUE

2. Pork Yield from Forty Acres of Corn. — If five and one-half pounds of corn will produce one pound of pork, how many pounds of pork may be produced from 40 acres of corn yielding 27.5 bushels per acre?

3. Figuring the Profits of Feeding Corn. — If the hogs in the above problem sell for $7\frac{1}{2}$ cents per pound, and corn is worth 1 cent per pound, or 56 cents per bushel, how much will the farmer make from tilling such 40 acres of corn?

4. To Study the Amount Saved from Hogging Down Forty Acres of Corn. — If it costs 4 cents per bushel to have corn gathered or husked, how much can a farmer save by "hogging down" 40 acres of corn yielding the average produced in the United States, namely, 27.5 bushels per acre?

5. Construction of Miniature Hog Houses. — Have pupils make miniature hog houses out of pasteboard, and have them discuss the essentials of a good hog house.

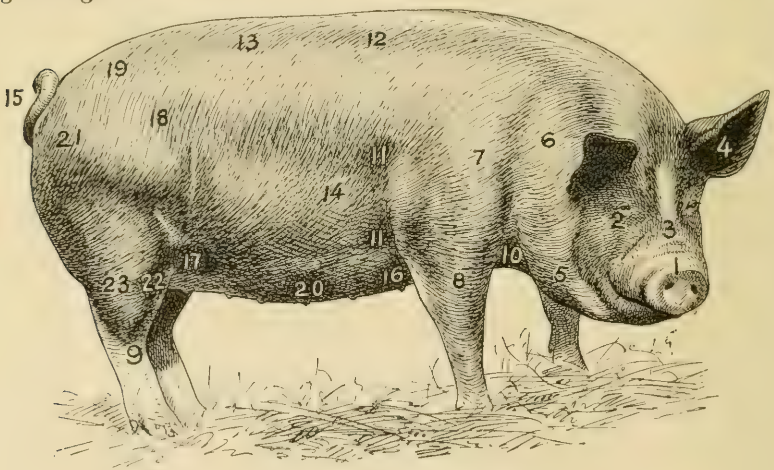


FIG. 95. — Points of the pig.

1. Snout.
2. Eye.
3. Face.
4. Ear.
5. Jowl.
6. Neck.
7. Shoulder.
8. Fore leg.
9. Hind leg.
10. Breast.
11. Breast line.
12. Back.
13. Loin.
14. Side.
15. Tail.
16. Fore flank.
17. Hind flank.
18. Hip.
19. Rump.
20. Belly.
21. Ham.
22. Stifle.
23. Hock.

6. Score Hogs according to the Following Score Card.

Lard Hogs — Score Card

Scale of Points		Breed							
1. General Appearance — 34 points									
Weight according to age	4								
Form, arched back, straight underline, smooth, compact, medium length, standing squarely on legs	10								
Quality, hair smooth and fine, bone medium size, clean, strong, and refined	10								
Condition, indicating health and high capacity for dressed carcass	10								
2. Head and Neck — 8 points									
Snout, medium length, not coarse . . .	1								
Face, short, broad	1								
Eyes, clear, not sunken, free from wrinkles	1								
Ears, carried according to breed, fine medium size	1								
Jowl, full, firm, free from wrinkles . . .	2								
Neck, thick, short, smooth to shoulder .	2								
3. Forequarters — 12 points									
Shoulders, broad, deep, smooth, compact at top	8								
Breast, wide, deep, breast bone advanced .	2								
Legs, straight, short, strong, pasterns strong	2								
4. Body — 32 points									
Chest, deep, wide, large girth, fore flank full	4								
Sides, deep, broad, full, thickly and evenly fleshed	6								
Back, broad, strongly arched, well fleshed	10								
Loin, wide, strong, and well fleshed . .	10								
Flank, straight, full, and low	2								
5. Hindquarters — 14 points									
Hips, wide apart, smooth	2								
Rump, long, level, wide, evenly fleshed .	2								
Ham, deep, wide, full, well fleshed . . .	8								
Pasterns, strong, straight, upright . . .	2								
Total	100								

7. An Essay-writing Contest on Hogs. — Pupils may be given an "Essay-writing Contest" on one of several topics in connection with the study of swine. Such topics as these may be used, "Origin and Improvement of the Hog," "Feeding Hogs," "Money in Hogs," "Treatment of Diseases of Hogs," "How to Produce Cheaper Meat," "Time of Year to Raise Hogs in Order to Make the Most Money out of Them."

CHAPTER XIV

SHEEP

It is generally believed that the Argali of Asia, and the Musimon of the islands of Crete and Cyprus, are the real parents of our domestic sheep. The Argalia is found on the plains and the mountain sides of Asia, and the Musimon is still found on the islands of Corsica and Sardinia in the Mediterranean Sea. Both of these wild types have been crossed with our domestic breeds and the progeny easily becomes domesticated.

Fig. 96. — The Musimon, one of the wild ancestors of our domestic sheep. Had little wool, and some mutton.

The habits and instincts of the wild sheep are still found in our domestic breeds. (1) Wild sheep sought the highest places, partly because they were dry and partly to escape their enemies.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

At least two sheep to judge.

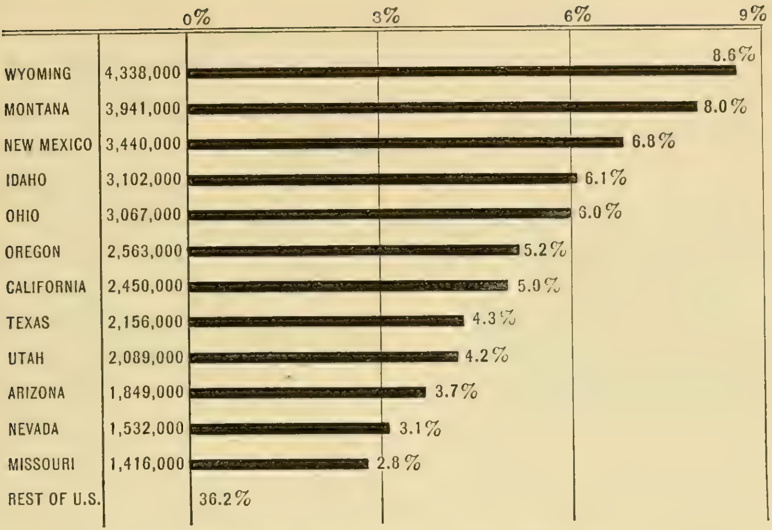
Domestic sheep will also seek the highest places to fold for the night. (2) Sheep do not like to go into stables or cross streams, but they will follow a leader. Shepherds make use of this instinct to drive sheep across a stream and into a stable. After one has gone, the rest will follow. (3) When sheep are excited, they stamp the earth with a front foot, a signal to the herd of approaching danger. (4) Sheep, and especially lambs, have a great play instinct. They jump stumps, low straw stacks, or play around open ditches. If a barrel is set up, and two boards leaned against the barrel, lambs will run up one board and down the other, seemingly in great amusement. (5) Sheep eat weeds in a very strange way. One weed is not eaten down by one sheep, but each sheep of the herd takes a nibble as it passes until the weed is eaten. Sheep can graze the turf closely because their upper lip is split, and because they have sharp incisors. Sheep are called "Plant Scavengers," because they eat about nine-tenths of all the weeds and shrubs found in pastures; horses and cattle will touch less than half of them. Sheep also graze steep hillsides where cattle and horses cannot go. (See Exercises 1 and 2.)

Importance of Sheep. — According to recent reports,[1] there were 52,447,000 sheep in the United States, worth, on an average, $4.40 per head. The income from these sheep is about one-third as much as the income from poultry. (See Exercise 3.)

Sheep States. — Although sheep are found to some extent in every state of the United States, they are mainly raised in the rolling sections of the West. The following twelve states are the leaders, producing about 64 per cent of the entire sheep crop.[2] Wyoming, Montana, and New Mexico produce almost 25 per cent of all the sheep produced in the United States.

[1] 1910 census.

[2] Data for 1916, taken from the *United States Yearbook of Agriculture*.



GRAPH 8. The leading states in sheep production.

Classification of Sheep. — Sheep are classified as wool sheep and mutton sheep. However, typical mutton-producing sheep will produce some wool, and vice versa. Sheep are divided into the following classes:

Fine Wool Breeds:

1. American Merino. 2. Delaine. 3. Rambouillet.

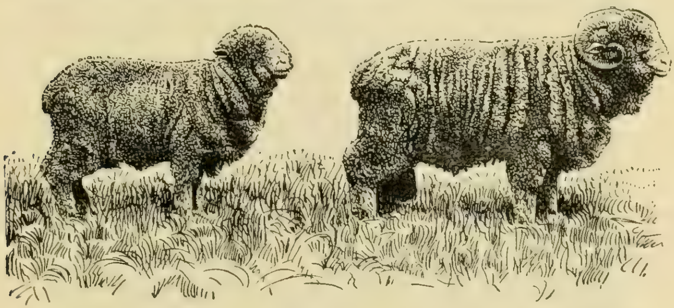


FIG. 97. — A pair of American Merinos, — examples of the fine wool type.

Medium Wool Breeds:

1. Southdown.
2. Hampshire Down.
3. Shropshire Down.
4. Oxford Down.
5. Suffolk Down.
6. Dorset Horn.
7. Cheviot.

Shropshire ewe. Shropshire ram.

FIG. 98. — Examples of medium wool type.

Long Wool Breeds:

1. Lincoln.
2. Leicester.
3. Cotswold.

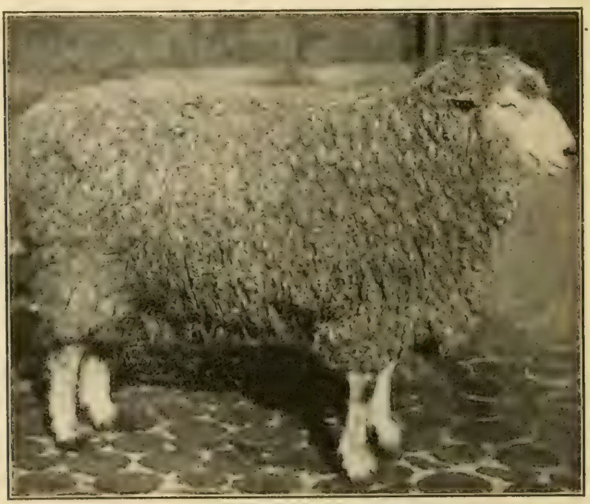


FIG. 99. — Lincoln ram. An example of a long wool type.

Some Facts about Sheep [1]

	Native Home	Color of Points	Length of Wool	Diameter of Wool	Weight of Fleece	Weight of Sheep	Per Cent Dressed Carcass
			Inches	Inches	Pounds	Pounds	
American-Merinos	America	White	$2-2\frac{1}{4}$	$\frac{1}{1194}$	12–25	100–150	50.7
Delaine	United States	White	3–5	$\frac{1}{1194}$	10–20	100–150	50.7
Rambouillet	France	White	3–4	$\frac{1}{1194}$	10–15	150–185	50.7
Southdown	England	Gray	2–3	$\frac{1}{865}$	4–8	123–175	55.3
Cotswold	England	White	8–14	$\frac{1}{605}$	10–14	200–265	54.2

(See Exercise 4.)

The fleece of the Merinos is short and very fine, but is very dense on the body. By *density* is meant the number of fibers that grow on a square inch. The wool of the long wooled types is not so dense, is thicker in diameter, and much longer. The wool from the fine wool breeds is made into the finest woolen fabrics; the wool from the medium wool breeds is made into heavier woolen clothes; and the wool from the long wool breeds is made into carpets, rugs, and other coarse woolen articles.

Sheep, in the North Central States, are raised mainly for their meat. The fleece, weighing about 8 pounds, being worth about 25 to 30 cents per pound (or about $2), pays for the keep of the sheep. The lamb sold for meat weighs usually from 75 to 100 pounds, bringing about 7 or 8 cents per pound (worth $7.50). The latter is the main purpose of sheep production in many parts of the United States.

Shelter for Sheep. — In dry regions sheep need little more than open sheds for protection, but in damp, cold regions they need closed sheds and barns, for when the fleece becomes thor-

[1] Harper: *Animal Husbandry for Schools.*

oughly soaked, 5 or 6 days are necessary to dry it out. Under such conditions the sheep take pneumonia, colds, and other diseases, and need additional feed and care. The wool from fleece that has been soaked is never so good. Keeping sheep dry, therefore, increases the profits of the sheep-raiser.

Lambs More Economical Fatteners. — Professor Shaw, at the Montana Station, in order to determine the relation of age to economical fattening, conducted an experiment with sheep of four ages, and about fifty sheep in each group. The following table gives the results of the experiment:

RELATION OF AGE TO FEED FED AND GAINS MADE [1]

	Average Ration Pounds		Average Weight at Beginning	Average Daily Gain	Average Total Gain	Feed per 100 Pounds Gain in Pounds	
	Barley	Clover Hay				Barley	Clover Hay
			Pounds	Pounds	Pounds		
Lambs . . .	0.7	2.1	63	0.27	23.7	253	763
Wethers One yr. old .	0.7	3.8	95	0.27	23.5	256	1413
Wethers Two yr. old .	0.7	4.1	116	0.28	24.3	248	1469
Aged ewes . .	0.7	2.3	92	0.18	15.6	387	1320

It will be observed that the amount of grain fed was practically the same per one hundred pounds gain in all cases, except in the case of aged ewes, but that only 763 pounds of clover hay was required for the lambs to make 100 pounds gain, as opposed to about 1400 pounds of hay for the other three lots, or a difference of about 700 pounds of hay saved in feeding

[1] *Mont. Bul. No. 35.*

lambs. This at a half cent per pound would be worth $3.50, which is a very large saving in favor of the lambs per hundredweight gain.

Pure-bred Sires. — The use of pure-bred sires, of proper conformation, quality, and disposition, often reduces the cost of mutton production. It is said that the sire is half of the herd. In the first generation he is half; in the second, three-fourths; in the third, seven-eighths, and so on, until the entire flock becomes a very high-grade group. The choice of a good pure-bred sire is very important.

At the University of Missouri,[1] a group of Western ewes were mated to a pure-bred mutton ram, and another group of similar Western ewes were mated to a scrub ram. There were 17 lambs in each lot.[1]

The lot of good lambs averaged 60 pounds when 3 months old, and sold for $7.35 per hundredweight; the scrub lambs averaged 56 pounds when 4 months old, and sold for $4.50 per hundredweight.

Notice the width of neck, body, withers, hips, thickness of quarters, and size of the good lamb shown in Figure 100 on the following page.

Lambing Time. — Lambing time, according to the author's teacher, Professor Kleinheintz, of the University of Wisconsin, is the "Harvest Time" of the shepherd. Then the shepherd must remain with his flock day and night. Ewes should be given separate pens, and weakly lambs should be helped in getting their first meal. Lambs should be kept warm until their bodies become dry; sometimes they must be wrapped in a dry, stove-heated, woolen cloth. The true shepherd is quiet, gentle, kindly, and sympathetic. These qualities are essential to securing the best results with sheep.

[1] *Cir. 65. Advantages from the Use of Pure Bred Ram.*

Docking Lambs. — All lambs should be docked when about ten or twelve days old, in cold weather if possible. The tail is cut off with a sharp knife at the third or fourth joint from the body, where the skin on the under side of the tail begins to be covered with wool. The skin should be slipped as far as possible toward the body of the lamb before cutting. The wound should be disinfected with a 5 per cent solution of carbolic acid, and then covered with pine tar.

Courtesy of University of Missouri.

FIG. 100. — This good 60-pound lamb sold for $7.35 per hundredweight when three months old.

Dipping Sheep. — Sheep may be profitably dipped twice a year, once just after they are sheared and again in the autumn. The coal-tar preparations are probably the best and cheapest dips. The directions for their use are generally printed on the cans. Ordinarily one part of dip to one hundred parts of water is used. Dipping overcomes sheep scab and sheep ticks. According to Farmers' Bulletin, No. 713, sheep scab is caused by a small parasitic mite. The female mite deposits 12 to 15 eggs which hatch in 3 or 4 days, mature in 7 or 8, and begin to lay eggs, the whole life cycle being complete in 12 days. When dipping sheep, care should be taken to have the dip warm, about 100° to 105° Fahr. After the sheep have all been dipped they should be kept in a warm, dry place not exposed to drafts.

Feeding Sheep. — Sheep need feed for both flesh and wool. Corn, mixed with legume hay, is generally fed in the United States as far west as Colorado; farther west wheat or barley is used instead of corn. Lambs weighing from 60 to 80 pounds may be given the following daily ration:

Shelled corn	1.3 to 1.5 pounds
Clover or alfalfa	1.4 to 2.0 pounds

Corn stover, corn silage, corn, and oat straw may furnish the carbonaceous part of the feed. Clover hay, alfalfa, cowpeas, or soybean hay furnish the nitrogenous part of the feed. Sheep need feed for both flesh and wool. Wool is made up of a great deal of nitrogen, and therefore heavy wool producers should be fed a larger proportion of feeds rich in protein than are those that are to produce mutton only.

Summary. — Sheep are principally produced in the Rocky Mountain regions. The production of mutton constitutes about two-thirds of the sheep industry. However, the production of wool is important to the American people. Care and proper management help to make sheep more profitable. Unless sheep are given shelter, proper feed, and are protected from their enemies, the best results will not be secured. Docking, dipping, and starting the lambs properly are necessary for success in sheep production.

LABORATORY EXERCISES

1. Write an essay on "The Grazing Methods of Sheep."

2. Write an argument of one hundred fifty to two hundred words, telling why raising of sheep should be encouraged in your county.

3. Make a survey of the number and kinds of sheep of your school district.

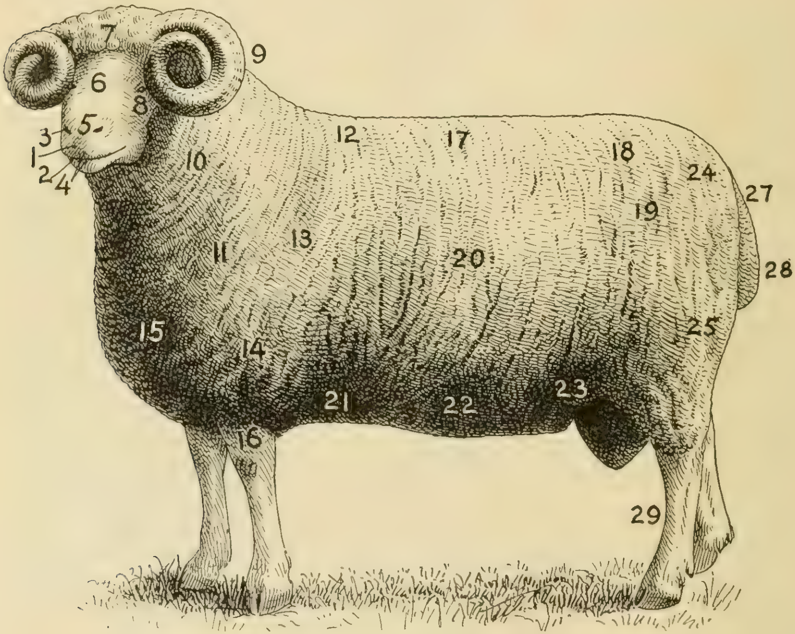


FIG. 101. — Points of a sheep.

1. Muzzle.
2. Mouth.
3. Nostril.
4. Lips.
5. Nose.
6. Face.
7. Forehead.
8. Eye.
9. Ear.
10. Neck.
11. Shoulder vein.
12. Shoulder top.
13. Shoulder.
14. Arm.
15. Brisket.
16. Fore leg.
17. Back.
18. Loin.
19. Hip.
20. Ribs.
21. Fore flank.
22. Belly.
23. Hind flank.
24. Rump.
25. Leg of mutton.
27. Dock.
28. Twist.
29. Hind leg.

4. To Score Sheep.

SCORE CARD — MUTTON SHEEP

SCALE OF POINTS		NAME OF BREED		
Age, estimated — years, actual — years				
General Appearance — 26 points				
Weight, estimated — lb., actual — lb., score according to age	6			
Form, straight topline and underline, deep, broad, low, medium length, symmetrical, compact, standing squarely on legs	8			
Quality, bone of firm texture, fine skin, silky hair, clearly defined features and joints, mellow touch, fleece soft, fine, pure	6			
Condition, thick, even, covering of firm flesh, especially in regions of valuable cuts, indicating finish, light in offal	6			
Head and Neck — 8 points				
Muzzle, good size, lips thin, nostrils large and well apart, jaws wide	1			
Face, short, broad, profile straight	1			
Eyes, large, full, clear, bright	1			
Forehead, broad	1			
Ears, well carried, fine, medium size	1			
Neck, thick, short, throat clean	3			
Forequarters — 10 points				
Shoulder vein, smooth, full	2			
Shoulders, smoothly covered with firm flesh, compact	4			
Brisket, broad, full, breast wide	2			
Legs, straight, short, wide apart; forearm full, shank fine; feet sound	2			
Body — 25 points				
Chest, deep, broad, girth large, foreflank full	4			
Back, broad, straight, medium length, thickly, evenly, and firmly fleshed	7			

Score Card — Mutton Sheep (*Continued*)

Scale of Points		Name of Breed		
Ribs, deep, well sprung, closely set, thickly, evenly and firmly fleshed	6			
Loin, broad, straight, thickly, evenly, and firmly fleshed	6			
Flanks, full, low	2			
Hindquarters — 20 points				
Hips, smoothly covered, proportionate width	3			
Rump, long, level, width well carried back, thickly, evenly, and firmly fleshed	5			
Thighs, deep, wide, well fleshed	4			
Twist, deep, broad, well filled	6			
Legs, straight, short, strong; shank, short but sound	2			
Fleece and Skin — 11 points				
Quality of wool, long, dense, even, well distributed over body	3			
Quality of wool, fine, soft, pure, even, crimp close and uniform	3			
Condition of wool, bright, strong, clean, yolk abundant	2			
Skin, pink color, clear	3			
Total	100			

CHAPTER XV

POULTRY

Origin and History of Poultry. — It is generally believed that our domestic hen originated from the wild jungle fowls which still live in India, Ceylon, and the Philippine Islands. This wild fowl was a game, wary, shy bird, about the size of a pheasant, weighing from a pound to three and one-half pounds. The female jungle fowl usually laid two clutches of eggs a year, each containing from 2 to 15 eggs. These eggs were small and probably weighed from 4 to 8 ounces a dozen.

Fig. 102. — The Aseel fowl, one of the original ancestors of domestic fowls.

The wild fowl was a scratching bird, living on seeds, insects, and vegetation. It could fly some distance, and, after the young were large enough to fly, roosted on limbs of shrubs and trees. It was a game fowl, and its flesh had a wild, undomesticated taste, and

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

The Standard of Perfection, pure-bred fowls of the following breeds: Plymouth Rock, Wyandotte, Rhode Island Red, Orpington, and others. One sample of eggs (twelve eggs make a sample); scales that will weigh to ounces.

did not possess the good eating qualities of the meat breeds of our fowls to-day. Some people prefer the wild flavor, and think that Leghorn chickens have a flavor like that of undomesticated birds.

Fowls were domesticated centuries ago by the Chinese. From China they were distributed through the rest of Asia, Europe, and America.

Up to 1850 little was done to develop and improve poultry breeds. Very primitive methods were used in the poultry industry. Methods of housing, feeding, breeding, and selection were neglected. Scarcely any one attempted to develop his poultry. Two practices greatly hindered its development: (1) The best fowls were slaughtered for table use, and (2) it was generally believed that a mixed flock produced the best results; consequently, no definite varieties were developed. The idea that a mixed flock of fowls are more productive is still held by many, but is not in keeping with the principle, "that for definite purposes, definite varieties are developed."

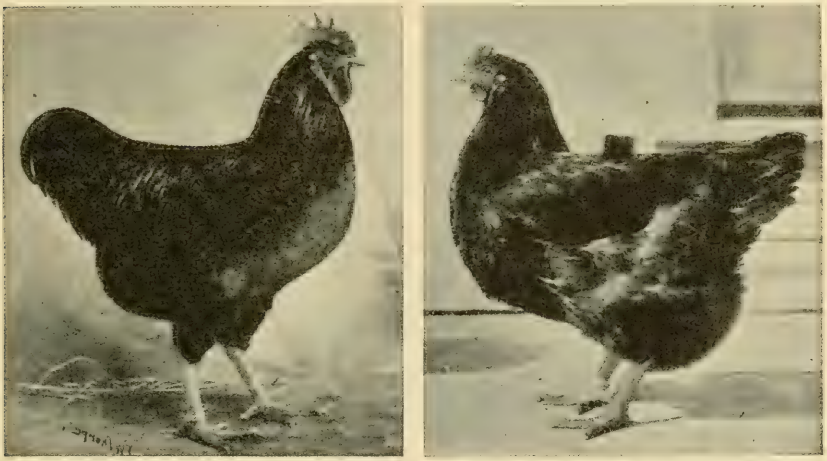
Since about the middle of the nineteenth century, definite breeds have been developed for specific purposes. Factors which have been influential in aiding the development of definite breeds were:

1. The interest of poultrymen in better poultry.
2. Exhibitions.
3. Poultry books and newspapers.
4. Incubators (improved from 1890 on).
5. Instruction.
6. The publication of *The Standard of Perfection*[1] (first copy published 1874).

[1] *The Standard of Perfection* is published by the American Poultry Association, Mansfield, Ohio. (Cost about $2.00.) This book should be placed in every school of our land.

Classes, Breeds, and Varieties of Poultry. — There are twelve classes of poultry. The term "class" refers to the country in which the fowls originated. The twelve classes are: American, Asiatic, Mediterranean, English, Polish, Hamburg, French, Continentals, Games and Game Bantams, Orientals, Oriental Bantams, and Miscellaneous.

In each class there are usually several breeds; for illustration, in the American Class there are the following breeds: (1) Plym-



Courtesy of University of Missouri.

FIG. 103. — Rhode Island Red male and female. The Rhode Island Reds are characterized by a straight back and rectangular appearance.

outh Rocks, (2) Wyandottes, (3) Javas, (4) Dominiques, (5) Rhode Island Reds, and (6) Buckeyes. Every breed has a different shape. Poultrymen frequently say, "shape makes the breed, and color the variety." To illustrate, all Rhode Island Reds are "bricklike" in shape; and all Wyandottes are "ball-shaped." Rhode Island Reds have a long back and body; Wyandottes have a short back and body. Study the illus-

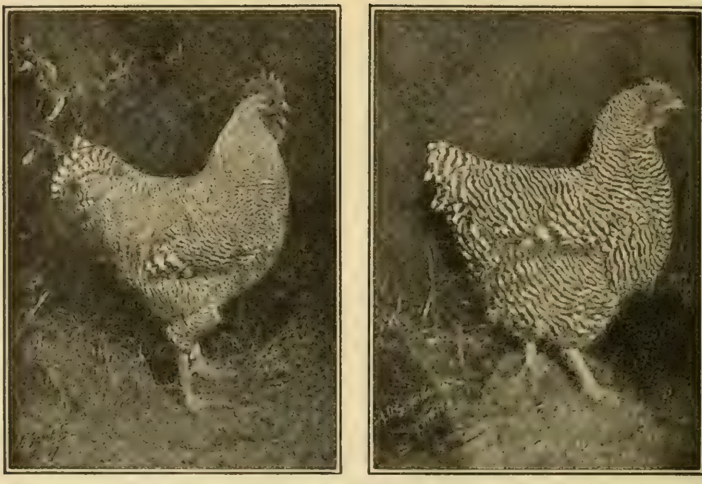
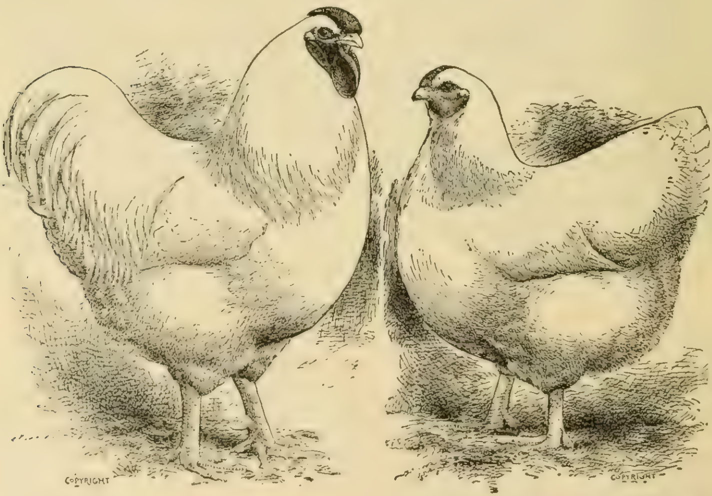


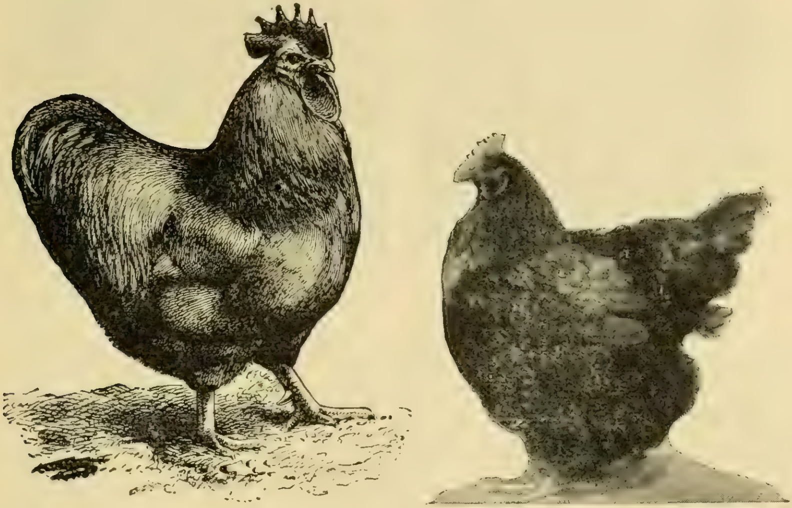
FIG. 104. — Barred Plymouth Rocks. Note the shape of these fowls. Plymouth Rocks are of six varieties, — Barred, White, Buff, Silver Pencila, Partridge, and Columbian. All varieties have the same weight, — cocks $9\frac{1}{2}$ lb., hens $7\frac{1}{2}$ lb.



Courtesy of University of Missouri.

FIG. 105. — Wyandotte male and female. Note their shape. They are ball-shaped and have a Rose comb. All varieties of this breed have the same shape and weight, — cocks $8\frac{1}{2}$ lb., hens $6\frac{1}{2}$ lb.

trations of hens and cocks of each. Hens and cocks of each breed have standard weights. The size, shape, and weights of fowls are closely related. Some people overemphasize color of plumage, but it should be remembered that, while color of plumage is worth while, it is only a matter of secondary importance. If a fowl is to be most productive in egg or meat production, it



Courtesy of University of Missouri.

FIG. 106. — Orpington male and female. While the Orpington has a back similar to the Plymouth Rock, its general appearance approaches that of the Wyandotte.

must have the shape which is consistent with the purpose in mind. A very short back and body are not conducive to the highest egg or meat production. A fowl must have capacity of back and body in order to be a good egg or meat producer. Egg and meat production has been at the basis of the development of most of our breeds of poultry.

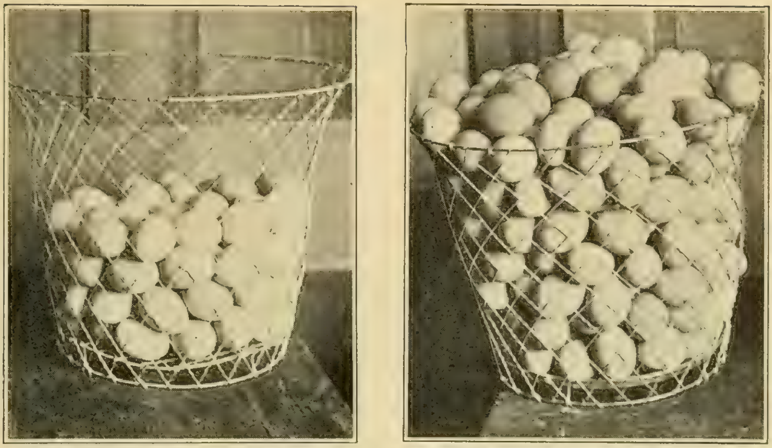
As was stated above, " color makes variety." The Plymouth Rock Breed comprises six varieties, Barred, White, Buff, Silver

Penciled, Partridge, and Columbian. The varieties have different colored plumage. In practically all other respects they are similar. Their shapes are identical. *The Standard of Perfection* gives detailed descriptions of the shapes and colors of all varieties of fowls. (See Exercises 1, 2, 3, and 4.)

FIG. 107. — Single-comb White Leghorns. Note white earlobe, and the snug way they hold their feathers.

Purposes of Poultry. — *Egg and Meat Production.* Three types of fowls have been developed: (1) the egg type, (2) the meat type, and (3) the general purpose type. The Mediterranean Class, of which the Leghorns are a breed, conform most closely to the egg type. The Asiatic Class is generally considered a meat-producing type. The American Class and the Orpingtons of the English Class are of the general purpose type.

Since swine and beef cattle furnish, to a great extent, the meat supply for the American people, chickens are not raised extensively for their meat; although large quantities of poultry are sold annually for meat. The egg production in the United States, on the average, is nearly 60 eggs per hen per year. It is believed the average production could be raised to 120 eggs per hen. Since a dozen eggs, if of fair size, weigh from 24 to 26



60 eggs. What the average farm hen produces. 120 eggs. What she should produce.

Fig. 108.

ounces, and the weight of the average hen is about five pounds, it will be seen that a hen would produce about three times her own weight in eggs a year.

Egg Production[1]

Variety or Name	Number of Eggs	Weight of Eggs in Ounces	Weight of Hen	Weight of Feeds Eaten per Year
			Pounds	Pounds
Plymouth Rock	165	351.45	6.25	91.8
Wyandotte	175	355.25	5.75	74.5
Rhode Island Red	167	374.08	5.98	91.5
Leghorn	165	348.15	3.60	71.3

It will be observed from the above table that the Leghorns produced a greater weight of eggs in proportion to the food con-

[1] Taken from *Bulletin No. 10, Missouri State Poultry Experiment Station.*

sumed than any other breed. However, the conclusion should not be made from the above table that the Leghorns are the best breed. About one-third of the money derived from the sales of poultry products comes from the sale of poultry for meat; and about two-thirds of the income comes from the sale of eggs.

The Characteristics of a Good Fowl. — A good fowl should conform very closely to the standard weight and shape of the

Courtesy of Mountain Grove Poultry Exp. Station.

FIG. 109. — Two chicks of the same age, raised in the same brooder and given the same feed. One is bred from vigorous, healthy stock and the other from stock lacking in vitality.

breed to which it belongs, and have the color of its variety. This shows good breeding or improvement and indicates that its ancestors were pure-bred fowls for at least six generations. A fowl should also show a good constitution. A strong beak, a broad head, a well-formed body, and strong legs indicate a good constitution. A fowl with a thin, peaky, snaky head should be killed for meat. The posture and carriage of a fowl is worthy of consideration. Erectness, pride, alertness, and activity are characteristics of a good fowl. An active fowl is better. "Late to roost and early to rise, makes a fowl healthy, wealthy, and productive." A fowl that is lazy, droopy, and does not hold its feathers and body up snugly is not good. A fowl that works from early morning to late evening is the egg producer. Fowls that remain on the roost late in the morning, go to bed early at night, and sit on the roost a part of the day are drones and unworthy of their keep. The hens that go farthest from the house are usually the best layers.

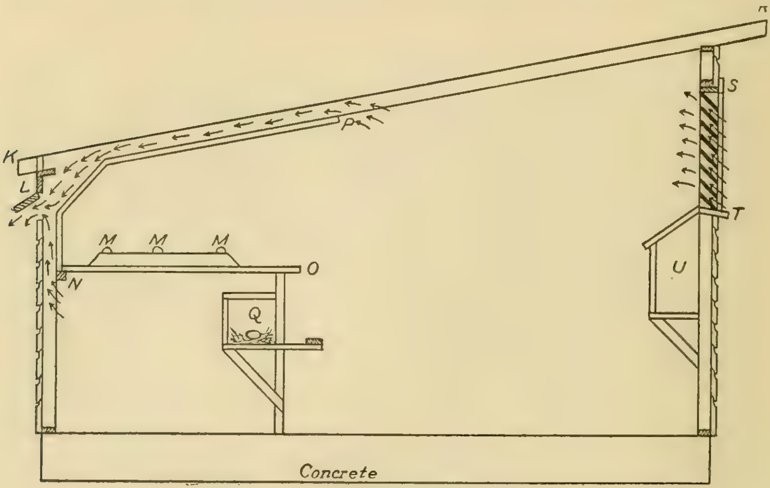
Other points which indicate good qualities in fowls are:

1. Early hatched and early maturing pullets.
2. Early laying pullets.
3. Winter laying hens.
4. Fowls that do not go broody.
5. Late moulting fowls.
6. Fowls with short, worn-down toenails. Long toenails indicate inactivity.

Housing of Poultry. — *The Essentials of a Poultry House.* The essentials of housing poultry are:

1. The house must furnish sufficient room.
2. It should be dry.
3. It should be well ventilated, but free from drafts.
4. Every part of the house should receive sunshine during the day.
5. It should be sanitary and easily cleaned.
6. It should be convenient.
7. It should be economic in cost.
8. It should be enemy proof.

1. Authorities agree that each fowl should have from 3 to 5 square feet of floor space. A house that has 400 square feet of floor space will house satisfactorily about 100 fowls. However, the floor space will vary somewhat with the kinds of fowls; the heavy Asiatics will require more room than the small Leghorns.



Courtesy of Missouri Poultry Experiment Station

FIG. 110. — A cross section of a convenient poultry house. *M* is a roost pole, *O* is the droppings platform, *Q* is the nest underneath, *L* is the back ventilator, *U* is the bin for the grain, *S* and *T* are the front ventilators.

A poultry house that is to serve as a roosting place alone need not be as large per fowl as one that is to serve as a roosting, living, and laying house.

2. The poultry house should be built in a dry place and kept dry. A wet, moist house will be a cold house.

3. The house should be free from drafts, but should be well ventilated. Pure air is as essential to poultry as it is to us, but drafts cause sickness and reduce the strength of the fowls. Means for ventilation should also be provided for when the house is built.

4. The sunlight should, if possible, strike every part of the house daily. The sun's rays keep the house dry and comfortable, destroy germs and lice, and give tone to the fowls. The kind of windows and methods of admitting sunshine are discussed under the topic, "Poultry House Construction."

5. A sanitary house, free from germs, odors, and lice, is essential. All interior fixtures should be movable. The walls should be free from crevices and openings. No hiding places for vermin should be allowed. The manure should be removed frequently.

6. Convenient arrangement of the interior of a poultry house reduces the cost of production. Roosts, nests, feeding hoppers, drinking pans, bins for holding feeds, should be conveniently located for the attendant. These are discussed in the chapter on "Poultry House Construction."

7. Poultry houses should be economically constructed. A house suitable for 100 hens should not cost much more than $50.00 or $60.00. The lumber of old buildings may be used to reduce the cost. Square houses cost less than long houses. A simple house costs less and is better. (See Exercise 5.)

8. Rats, mice, and other animals should be kept out of the poultry house. There is much loss due to rats destroying young chickens. Minks and polecats also lay a heavy tax on poultry production.

Poultry House Construction. — *The Foundation.* There are two kinds of foundations for the sills to rest upon:

1. Wooden posts of hedge, oak, or cedar may be used for the foundation. These posts are set 2 or 3 feet in the ground, and 3 or 4 feet apart. A trench should be dug all the way around these posts, and a fine wire netting, extending 2 to 3 feet in the ground, should be tacked to the posts. This netting will keep out vermin. Brick or rock pillars may be used instead of wooden posts.

2. Cement foundations are put into the soil deep enough to prevent heaving by frost, and should extend 12 inches above the surface of the ground. Cement foundations give greater protection from cold and destructive animals. They are more expensive, but last longer.

Floors. There are three kinds of floors for poultry houses. Each has its advantages and disadvantages, according to conditions:

1. The earth floor is probably the best in places where the soil is sandy and dry, but should not be used in places where the soil is wet. An earth floor is hard to clean; a part of it is taken away at every cleaning, so that it soon becomes lower than the ground outside and the soil water drains into the house.

2. Board floors harbor insects, rats, and mice, are cold, do not last long, and therefore are not to be recommended.

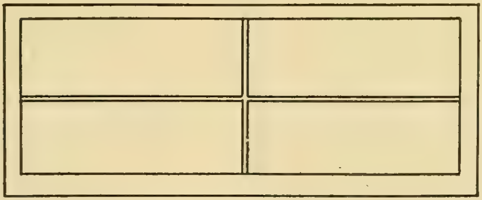
3. Cement floors, if properly made, are the best. In making a cement floor the following points should be observed: First, from 8 to 12 inches of coarse gravel, rocks, or cinders should be packed down to break the capillary movement of soil water, and to keep the house dry. The cement floor should be 8 to 12 inches above the surface of the soil. This will keep the house dry, especially if the soil outside is properly graded. The cement floor is durable and rat-proof, and can be easily cleaned.

Walls. Walls are made of boards, brick, or cement. In most cases boards put on vertically are most satisfactory. Disinfection is difficult where boards are put on horizontally. The inside walls should be smooth. This aids in keeping the house sanitary.

The Height of the House. The height of the poultry house depends upon the type of roof used. Ordinarily in a house with a semi-monitor roof the back should be about 5 feet high and the front about 7. In a house 16 feet wide, with a shed roof, the back should be about 5 feet and the front should be about $7\frac{1}{2}$ or 8 feet high.

Ventilation. Figure 110 illustrates how a house can be well ventilated without drafts. Notice the open shutters in front and the open end at the rear.

Windows. There should be about 1.0 foot of window space to every 15 square feet of floor space. A house that has 400



Windows set horizontally permit the sunlight to shine only over a small portion of the house.

FIG. 111. — Windows set vertically permit the sun's rays to shine over more of the floor space.

square feet of floor space should have about 27 square feet of glass space to the south and have 3 or 4 small windows at the back. Tall windows are better than wide windows, for they admit the sunlight over a greater area.

The windows on the south side should be placed fairly high so that sunlight may strike the remotest corners. See cuts of houses on page 240.

Types of Roofs. There are five types of roofs. From the figures it can be determined when each may be used to advantage. The pitch of roofs should range from a fourth to a third slope.

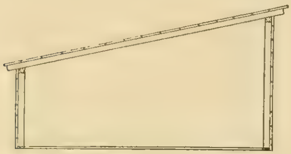


FIG. 112. — This is a shed roof.

FIG. 113. — This is a gable roof.

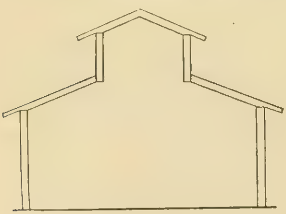


FIG. 114. — This is a monitor type of roof.

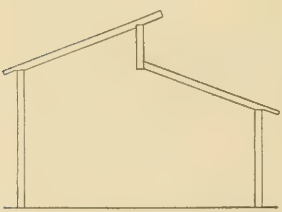


FIG. 115. — Semi-monitor roof.

1. Shed Roof
   - Advantages
     - Turns all the water to the back
     - Admits sunshine to all parts
     - Is the cheapest roof
   - Disadvantages
     - Cannot be used to advantage in a house more than 16 feet deep
2. Gable Roof
   - Advantages
     - Can be used in a wider house
   - Disadvantages
     - Requires two sets of rafters
     - Does not admit a maximum amount of sunlight
3. Monitor Roof
   - Advantages
     - When properly made may give good ventilation and sunshine
     - May be used in a very wide house
   - Disadvantages
     - Requires four sets of rafters
     - Is more expensive
4. Semi-monitor Roof
   - Advantages
     - Admits light into all parts of the house
     - May be well ventilated

5. Combination Roof
   Advantages
      Used in the open-front houses
      Admits sunlight
   Disadvantages
      Is not as good as the semi-monitor

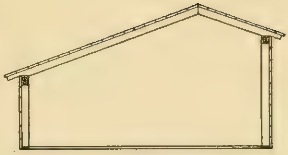


FIG. 116. — Combination roof.

(See Exercises 5 and 6.)

Interior Fixtures in Poultry Houses. — The essential points to consider in putting in interior fixtures are:

1. Cheapness of construction.
2. Convenience to care-taker.
3. Saving of space.
4. Movability.
5. Arrangement so that they may be easily disinfected.
6. Adaptability to the breed of fowls raised.

One or more of these points will be discussed briefly with each interior fixture mentioned.

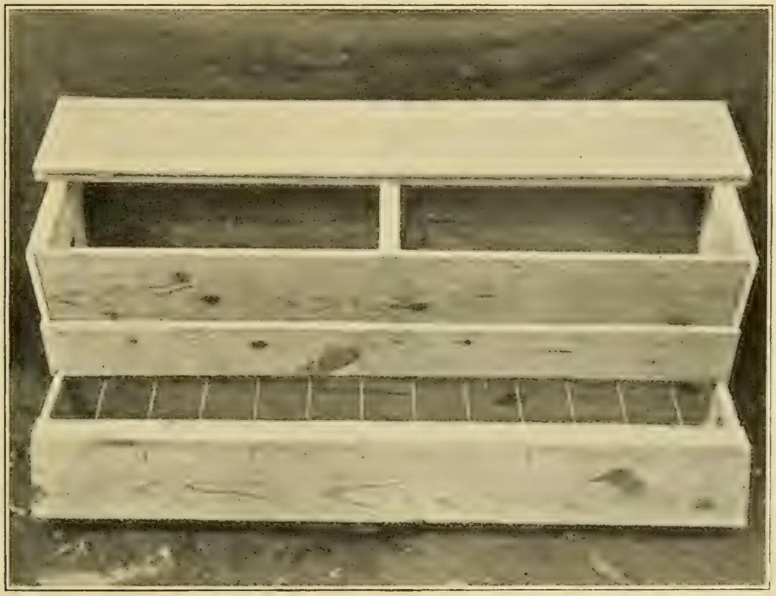
Roosts. If the fowls are to stay in the poultry house overnight, roosts must be provided. Wild chickens roosted on the branches of trees. Round branches are not best suited for fowls to roost upon. An undue pressure is borne on the breastbone of the fowl when roosting on a rounded or edged surface. It is for this reason that crooked breastbones are found in chickens. Roosts are made most economically by using 2 × 3 inch or 2 × 4 inch lumber and slightly rounding the edges. They should be fitted on the sides so that they may be easily removed. A smooth roost aids in keeping out insects and in disinfection. All the roosts should be on one level, for when they are placed slantwise one above the other, like the steps on a leaning ladder, the fowls are constantly pushing each other off in order to get on the upper perch, and are often injured.

The amount of roost space needed depends on the size of the fowls. Small breeds will need about 7 inches of perch room; medium breeds 9 inches; and large breeds from 10 to 12 inches. The rear perch should be about 12 inches from the wall, and the roost poles 14 inches apart. The height of the roosts also depends upon the kind of fowls. Light breeds can fly from a height of 4 or 5 feet without injury, but the perches for large breeds should not be more than 2 or 3 feet from the floor. If a droppings board is used, it should be at least 30 inches from the floor, so that the floor space underneath may be used. Roosts may be fastened to the walls with hinges so that during the day they can be fastened to the roof. This will keep the fowls from roosting during the day in winter time.

Scratching Shed. If during the winter the fowls are to stay in the poultry house in the daytime, a scratching shed will aid in egg production, and keep the fowls in good condition. This shed should have an open front and be 15 × 15 feet. Twelve or fifteen inches of straw, with a little grain scattered through it in this shed, will keep the fowls active, warm, and busy during the cold winter days.

Nests. Fowls like a dark secluded nest for laying, so nests should be placed in the back part of the house. The nests should be movable and should be taken out, aired, and sunned occasionally. The size of the nests depends on the breed, from 10 × 12 to 12 × 14 inches. Trap nests are used when accurate records are wanted. These are made with a door that closes automatically when the hen enters the nest. Where an egg-producing strain is being developed, trap nesting is essential, for accurate records of each hen can then be kept. It is advisable that a slanting board be placed on top of trap nests to prevent fowls from roosting on them.

Feeding Hoppers. Factories have designed many kinds of feeding hoppers, but any farmer can construct them much more cheaply. The capacities of hoppers vary from a few pounds to two or three hundred pounds. They are sometimes made with several compartments.



Courtesy of Mountain Grove Poultry Exp. Station.

FIG. 117. — A dry-mash hopper, four and one half feet long, which holds over 150 pounds of dry mash. The opening through which the fowls eat should be four inches in the clear. Wires are placed across this opening three inches apart to prevent the birds from getting in and also prevent them from flipping the mash out. This shows the top door open ready for filling.

The main advantages of hoppers are:

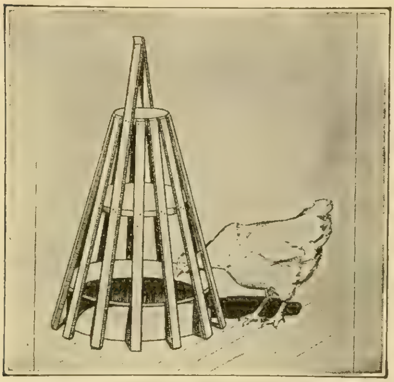
1. They save labor.

2. Where several feeds are provided in the hopper, the fowls may balance the feeds according to individual needs.

3. Where fowls are fed in a flock, shy fowls seldom get enough feed. The feeding hopper supplies their needs. Hoppers should

be economically made, be hung in a well-lighted place, and their capacity range from two to three hundred pounds per hundred fowls. The kinds of feeds used in hoppers will be discussed under feeds and feeding.

Drinking Pans. Drinking pans or buckets should be placed upon platforms about $1\frac{1}{2}$ or 2 feet high. The main consideration is to prevent dust, dirt, and filth from falling into the water. Fresh, pure water is essential to egg production, for about 74 per cent of the egg is water. The water should be pure and fresh, warm in winter and moderately cool in summer.



Courtesy of International Harvester Co.

FIG. 118. — One way to keep the water clean. Fresh, clean, moderately warm water is as essential to egg production as food.

Dust Wallows. Dust wallows should be about 10 inches deep, large, and preferably placed outside of the henhouse in a sunny spot. Dust baths are necessary to kill the lice and mites. Many lice are lost in the dust wallow, and others inhale so much dust into their breathing openings (spiracles) that they die because of lack of air. Equal parts of fine road dust, sand, and ashes make an excellent dust wallow. (See Exercise 7.)

Eggs. — *Importance of Egg Production.* The average annual farm income from eggs, according to the United States Census Report,[1] is $60.57, and from chickens sold, $31.82. Two-thirds of the average farm income from poultry is from the sale of eggs. Egg production constitutes the principal part of the poultry industry; meat production is a by-product. If the

[1] 1910.

estimates are correct that the annual income from poultry is about $750,000,000 in the United States, then the total egg values are approximately $500,000,000. This is about equal in value to the total wheat products. Eggs in many homes pay for groceries and clothes. Many farmers consider poultry products a side line, but, in large numbers of cases, the sale of eggs is the mainstay for general running expenses.

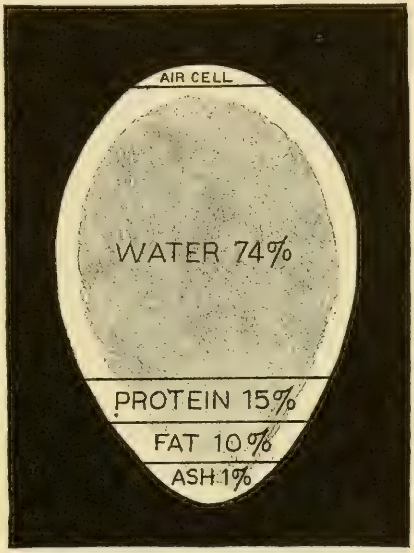


FIG. 119. — The composition of the edible portion of an egg.

Parts of an Egg. An egg is composed of the shell, two membranes beneath the shell, an air sac between the membranes, three layers of the white, the germ, and the yolk. Examine an egg shell to find the two membranes. An egg contains water 66.7 per cent; protein 12.2 per cent; ash 12 per cent; fat 8.9 per cent.

COMPOSITION OF MILK AND EDIBLE PART OF EGGS

	WATER	FAT	SUGAR	PROTEIN	ASH
Milk	87%	3.69%	4.98%	3.5%	0.7%
Eggs	74.0%	10.0%	0.00%	15.0%	1.0%

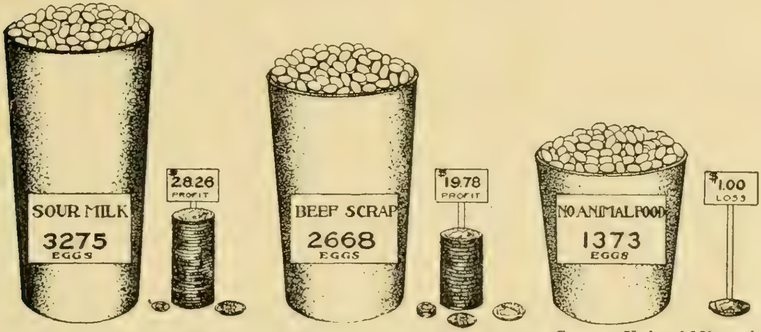
The Building of an Egg. An egg is built in parts. Just as a knife is made a piece at a time, — the blade by one man probably, the part that holds the blade by another, and the handle by still another,— so also is the egg made a piece at a time. There are three essential parts of an egg — the yolk, the white, and the shell. Each part is made in a separate part of the egg-laying organ. The yolk is developed in the ovary; the white (albumen) is laid on the yolk in the first two-thirds of the oviduct; and the shell is built over the white of the egg in the lower third of the oviduct. Each of the three parts of an egg is developed by a specialized organ.

Courtesy of Mountain Grove Exp. Station.

FIG. 120. — Photograph of the egg organs to show the sections where different parts of the egg are made.

The time required to build each part of the egg varies somewhat. But it may be generally stated as follows: All the yolks of the eggs that a fowl is ever to lay, are developed in the growing fowl before it is 5 or 6 months old. These yolks are very small, ranging in size from that of a pinpoint up to the normal size as found in eggs. It was found by an expert examination that these yolks in the grape-like ovary vary in number from 1500 to 3600. It is claimed upon good authority that more yolks are present in the fowl than can ever be laid. When the yolks mature, they pass into the oviduct where the white is laid over the yolk in three layers. The time required to do this is from 6 to 8 hours. The shell is made in from 12 to 24 hours.

Feeding for Egg Production. The egg is a finished product made up of parts. Before a knife can be produced, all the parts must be provided; so, also, in the making of an egg, every part must be provided before there can be an egg. No marketable egg is produced without a yolk, a white, and a shell. Therefore, in feeding for egg production, feed should be provided in such proportions that an equal number of yolks, whites, and shells



Courtesy Univ. of Missouri.

FIG. 121. — Sour milk for chicken feeding.

may be built. To supply feed in such a proportion to a hen as to build 50 yolks, 50 whites, and no shells, would mean no egg production; because no one has ever heard of a case in which 50 eggs having no shells were laid. After the feed for the production of 50 yolks and 50 whites has been supplied, feed that would have built 50 shells would have rounded out man's aid in giving the hen a chance to develop 50 eggs. To be successful in aiding the hen to develop eggs rapidly, one must realize that not all kinds of poultry food are well suited to egg production. Professor C. T. Patterson of the Mountain Grove Experiment Station has worked out the following way of balancing a feed for the maximum egg production. It is a suggestion worthy of our consideration.

An Unbalanced and a Balanced Ration

Feed	Yolks	Whites	Feed	Yolks	Whites
100 lb. corn	255	134	100 lb. corn . .	255	134
100 lb. wheat	243	182	100 lb. wheat . .	243	182
20 lb. oats	39	31	20 lb. oats . .	39	31
20 lb. bran	31	41	20 lb. bran . .	31	41
20 lb. shorts	41	44	20 lb. shorts . .	41	44
20 lb. cornmeal	50	29	20 lb. cornmeal .	50	29
			20 lb. meatscraps	20	221
Totals	659	461	. . . .	679	682

"The above table assumes that one pound of carbohydrates will make $3\frac{1}{3}$ yolks and one pound of protein will make $16\frac{2}{3}$ yolks. This is above maintaining the body where hens are fed all they want."

Grit, oyster-shells, or ground limestone should be provided for the hens, from which they provide material for the egg shells. To each one hundred pounds of the above feed about one and one-half pounds of fine table salt and two pounds of fine charcoal should be added.

Under general farm conditions only two or three feeds will be used. In order to balance a corn ration, common poultry feed, it will prove economic to add one part of meatscraps to ten parts of corn. This will not quite balance the ration, for we will have the following:

	Yolks	Whites
Corn, 100 lb.	255	134
Meatscraps, 10 lb.	10	110
Total	265	244

Therefore slightly more than one-tenth meatscraps should be fed. If skimmed milk is fed, the following may be used as a basis to figure its value: One hundred pounds of skimmed milk will make 22 yolks and 52 whites; and the same amount of buttermilk will make 22 yolks and 65 whites. Figure 121, taken from Bulletin No. 79, Agricultural Experiment Station, University of Missouri, illustrates what feed means in economic egg production.

Market Grades of Eggs. Eggs sold to the country stores should be fresh, clean, *infertile*, uniform in color, shape, and size, and should weigh from 24 to 28 ounces per dozen. All white eggs should be white. All brown eggs should have a uniform shade of brown. Unusually large eggs are undesirable, for they do not fit well into the fillers of egg cases, and are often broken. Eggs weighing 24 ounces are worth about 15 per cent less than eggs weighing 28 ounces. Why produce infertile eggs? Because hens will produce as many, if not more, infertile than fertile eggs, and infertile eggs are not affected by hot weather. Every egg should be covered with a shell of sufficient strength so that it will carry without breaking. (See Exercise 8.)

Preventable Losses in Market Eggs. Circular No. 140 of the Bureau of Animal Husbandry states that the estimated average annual loss of eggs in the United States is about 17 per cent, or $45,000,000. The distribution of causes for these losses is as follows:

	Per Cent
From dirties	2.0
From breakage	2.0
From chick-developed eggs	5.0
From held and shrunken eggs	5.0
From rotten eggs	2.5
From moldy and off-flavored eggs	0.5
Total	17.0

These losses can largely be prevented. Clean nests and daily gathering will prevent dirty eggs. Breakage can be reduced by shipping only eggs with a good shell and of a normal shape and size. Chick development can occur only in fertile eggs. Separating hens and cocks during the season that eggs are produced for the market will secure the production of infertile eggs, the only guarantee against chick development. All mature male birds should be killed, sold, or confined as soon as the hatching season is over. "Swat the rooster" after the breeding season will prevent the loss of many eggs. T. E. Quisenberry, of the Mountain Grove, Missouri, Poultry Experiment Station, states "that the rooster spoils one-half million dollars' worth of eggs a month from June to October each year in Missouri alone." Harry R. Lewis, Poultry Husbandman of the New Jersey Agricultural Experiment Station, says in *Productive Poultry Husbandry*: "There is probably nothing the poultryman can do which would improve the quality of eggs for table use as the production of infertile eggs." To prevent the loss due to heat and evaporation, eggs should be stored in a cool place. The losses due to decay may be partly prevented by marketing eggs twice every week, especially during the summer months.

Preservation of Eggs. Since eggs are produced in greatest numbers in March, April, and May, it is often desirable to preserve some of the surplus supply for use the following winter. One of the cheapest and most convenient egg preservatives for farm use is made by adding one part of water glass (sodium silicate) to nine parts of rain water, well boiled and cooled. This solution is put into ordinary stone jars holding from 12 to 15 dozen eggs. The top of the eggs should be covered by at least two inches of the preservative. It is advisable to cover the jar with oilcloth, or something similar, to prevent evaporation.

The jars should be kept in a place where the temperature is about 60° Fahr. or cooler. Eggs may be kept in excellent condition by this method. The shrinkage of the eggs over a period of 9 months is often as little as one per cent. Preserving eggs is analogous to curing meats, canning fruits, and ensiling corn.

There are many other methods of preserving eggs, among which may be mentioned preservation in limewater and varnishing with vaseline. Eggs preserved in limewater are good, but they have often a disagreeable odor and taste; and to varnish eggs with vaseline takes too much time. If the eggs are fresh and the directions for the use of water glass are followed, the results will be satisfactory.

How to Select Hens that Will Lay. — Housing and feeding, and exercise, are all essential for egg production, but with the best of care and management these will not make all hens lay. Before eggs can be produced, there must be a hen of proper conformation. It has been found by the trap-nest system that some hens will never lay an egg. We have known for some time that some horses are race horses and others are draft horses. We also know that the most economic milk-producing cows have a dairy conformation, but it has only been recently known that a laying hen differs as much from a non-layer as a dairy cow differs from a beef-producing cow. Walter Hogan,[1] author of the Hogan Test, has discovered the characteristics that indicate egg production. To him we are indebted for the following established facts regarding egg-producing capacity (after all other factors have been provided):

1. *The measurement of the fowl* from the rear of the breastbone

[1] *The Call of the Hen*, by Walter Hogan, published by *The American School of Poultry Husbandry*, Mountain Grove, Mo., will be found helpful in poultry study.

to the pelvic bone is very significant. If the distance is only one finger's width, the fowl will lay very few eggs; but if it is 5 or 6 fingers' width, the capacity of the fowl for egg production is greater.

The yearly egg yield of fowls with one-finger capacity, and varying thicknesses of the pelvic bones, are shown in the following table:

One-Finger Capacity (Abdomen)

Thickness of Pelvic Bone	One-Finger Capacity
$\frac{1}{16}$ inch	36
$\frac{1}{8}$ inch	32
$\frac{3}{16}$ inch	28
$\frac{1}{4}$ inch	24
$\frac{5}{16}$ inch	20
$\frac{3}{8}$ inch	16
$\frac{7}{16}$ inch	12
$\frac{1}{2}$ inch	8
$\frac{9}{16}$ inch	4
$\frac{5}{8}$ inch	0

2. The egg-producing capacity depends on the *thickness of the pelvic bone*, which includes the skin, muscles, and gristles. A thin pelvic bone indicates high capacity for egg production; but a heavy, thick pelvic bone indicates a low capacity, as is indicated by the above table. For illustration, a hen having one-finger capacity and a pelvic bone $\frac{1}{16}$ inch thick would be capable of producing 36 eggs the first laying year, provided all other factors for egg production were correct. But if she had a one-finger capacity and her pelvic bone was $\frac{5}{8}$ inch thick, she would be incapable of producing any eggs.

The table on page 253 combines the main points of the Hogan Test. Every boy and girl of our land should study it and be able to apply it.

The Relation of Thickness of Pelvic Bone and Capacity to Egg Production when Condition is Good

Thickness of Pelvic Bone	One-Finger Capacity	Two-Finger Capacity	Three-Finger Capacity	Four-Finger Capacity	Five-Finger Capacity	Six-Finger Capacity
						With Nervous Temperament
$\frac{1}{16}$	36	96	180	220	250	380
$\frac{1}{8}$	32	87	166	205	235	265
$\frac{3}{16}$	28	78	152	190	220	250
$\frac{1}{4}$	24	69	138	175	205	235
$\frac{5}{16}$	20	60	124	160	190	220
$\frac{6}{16}$	16	57	110	145	175	205
						Slow Temperament
$\frac{7}{16}$	12	42	96	130	160	190
$\frac{1}{2}$	8	33	82	115	145	175
$\frac{9}{16}$	4	24	68	100	130	160
$\frac{5}{8}$	0	15	54	85	115	145
						Bilious Temperament
$\frac{11}{16}$		6	40	70	100	130
$\frac{3}{4}$		0	26	55	85	115
$\frac{13}{16}$			12	40	70	100
$\frac{7}{8}$			0	25	55	85
$\frac{15}{16}$				10	40	70
						Lymphatic Temperament
1				0	25	55
$1\frac{1}{16}$					10	40
$1\frac{1}{8}$					0	25
$1\frac{3}{16}$						10
$1\frac{1}{4}$						0

The capacity of any hen for egg production can be determined almost accurately from this table. To illustrate, a hen having a pelvic bone $\frac{1}{16}$ inch thick, and having a 5-finger capacity, will yield 250 eggs per year, when properly cared for. Temperament will affect the egg yield to some extent.

3. The width between the pelvic bones is also indicative of egg production. If there is very little space between the pelvic bones, the chances for egg production are few; but if the pelvic bones are wide apart, greater productivity is indicated.

4. The condition of the fowl raises or lowers chances for egg production. Condition is indicated by the covering of the keel of the breastbone. If the breastbone is well covered with flesh, the fowl is in good condition, which indicates, if all other factors are the same, high egg production. But if the breastbone is poorly covered, a lower yield of eggs may be expected than is indicated by the above numbers.

FIG. 122.—A hen of this type seldom is a good layer. She is inactive and has become so fat because she can't lay.

5. A broad, medium long, or long back is essential to large egg production. Fowls with narrow, short backs have not enough room for the digestive organs, heart, and lungs, and liver. Fowls with baggy bodies are not the best egg producers. The fat hen has a large deposit of fat in the abdomen, causing the abdomen to become baggy. In an active laying hen, the body is well held up, almost free from fat, and is on a level with the keel of the breastbone. C. T. Patterson says: "There is an old expression, 'Hens get too fat to lay,' which is incorrect.

It should be said, 'The hen can't lay is the reason she gets too fat.'"

Capacity, thickness of pelvic bone, width between pelvic bones, condition of the fowl, and a broad, medium long back are essential characteristics of a good layer. The bright red color of the comb does not last long, and indicates that the fowl is either laying or will soon lay, but does not prove that a fowl is a good layer the entire year. The fact is that heavy laying soon takes the bright color out of the comb. (See Exercises 9 and 10.)

Courtesy of J. B. Lippincott Co.

FIG. 123. — The work of the scaly leg mites.

Since the male bird is at least half of the flock in the transmission of characters, it is equally important that he be selected with the greatest of care. The Hogan Test is as applicable to the males as to the females, with this difference, however, that males have a smaller capacity than females, and their pelvic bones are more closely set. The application of the Hogan Test will soon enable the average person to detect differences in conformation, and to discriminate against the male bird that will not transmit egg-producing ability.

Poultry Diseases. — Prevention of poultry diseases is more important than curing them. There are two factors essential in preventing poultry diseases. These are breeding and raising chickens that have good vigorous constitutions; and sanitary measures. Fowls that lack constitution succumb to diseases much easier than do strong, vigorous fowls. If the poultry house and poultry yards are kept clean, most of the poultry diseases will be prevented. Uncleanliness favors disease. There are so many diseases to which poultry are subject that it would require a separate book to treat them all. A few diseases and enemies of poultry will be mentioned. Write to your state experiment station for information on diseases that may now be troubling your poultry; and to the United States Department of Agriculture for further suggestions.

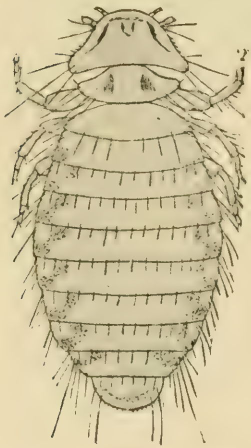


FIG. 124. – The common hen louse.

Scaly leg is caused by a small mite getting under the scales of the shanks of the fowls. The symptom of the disease is an enlargement of the shanks, usually just above the toes. To treat this disease, dip the shanks in kerosene. This kills the mites. Repeat the treatment in about a week. Two treatments are enough, except in rare cases.

Roup is a contagious disease which appears on the face of the fowl in the form of a tumor. Often the eyes are almost swollen shut. There is a discharge from the nostrils which sometimes obstructs the breathing. In treating this disease, isolate all the fowls affected. With the thumb press all cheesy matter out of the tumor, and dip the part affected in kerosene. Bulletin No. 530, United States Department of Agriculture, says, "Put sufficient permanganate of potash in all drinking water to color it a deep red." This is a cure as well as a prevention of roup. Some authorities claim that roup is one of our most injurious poultry diseases.

Lice and *mites* are controlled by keeping the house clean and spraying occasionally with a lime solution, or greasing fowls with equal parts of lard and kerosene. Insect powders will also kill lice and mites.

Summary. — The products from chickens rank favorably with other sources of farm incomes. The sales from poultry products in many cases provides groceries, shoes, and clothing. The selection of good pure-bred varieties, according to the *Standard of Perfection*, proper housing, feed, and care increase the sales from poultry products. Eliminating non-layers and low producers raises production. Cleanliness and combating disease are essential to profitable production of poultry. The average yearly egg production in the United States is estimated to be about 60 eggs per hen. It should be 120 or more.

LABORATORY EXERCISES

1. **To Study the Shapes of Breeds of Fowls.** — With the *Standard of Perfection* in hand, study the pictures of the various breeds of chickens as to shape, kind of comb, length of back, angle of tail, etc.

2. **Verifying Shape Differences of Different Breeds of Fowls.** — With fowls of several pure breeds verify the shape differences noted in Exercise I, and as described in the *Standard of Perfection.*

3. **A Study of the Color Markings of Different Varieties of Fowls.** — Study from live fowls the color of one or two pure-bred varieties, reading the description of the variety from the *Standard of Perfection*, while the fowl is being studied.

These three exercises, if properly done, will require at least five full one-hour periods. When these lessons are attempted, the teacher should have, for each one, at least an hour to one and one-half hours at her disposal.

4. **Judging Fowls of Several Varieties.** — Judge at least one fowl from several varieties, using the *Standard of Perfection*, and especially that part in which cutting for defects and general disqualifications are mentioned.

SCORE CARD FOR DIFFERENT CLASSES OF FOWLS
(Note their variations)

Section of Fowl	American Class Perfect Shape	American Class Perfect Color	Asiatic Class Perfect Shape	Asiatic Class Perfect Color	Mediterranean Class Perfect Shape	Mediterranean Class Perfect Color	English Class Perfect Shape	English Class Perfect Color
Symmetry	4		4		4		4	
Weight	4		4		4		4	
Condition	4		4		4		4	
Comb	8		8		10		8	
Head	2	2	2	2	2	4	2	2
Beak	2	2	2	2	2	2	2	2
Eyes	2	2	2	2	2	2	2	2
Ear lobes and wattles	2	2	2	2	4	6	2	2
Neck	4	6	4	6	3	5	4	4
Wings	4	6	4	6	4	6	4	6
Back	5	5	6	4	5	5	6	4
Tail	5	5	5	5	5	4	6	4
Breast	5	5	6	4	4	4	6	4
Body and fluff	5	3	5	3	3	2	5	3
Legs and toes	3	3	3	3	2	2	5	3
Total		100		100		100		100

5. Estimating the Cost of Poultry Houses. — Have the pupil bring an estimate as to the cost of construction and building material of some poultry houses, giving dimensions, etc. Be definite.

6. Points Observed in Some Poultry Houses. — Have the pupils bring the following data and record it in a notebook in the following form:

POINTS TO BE OBSERVED IN SOME POULTRY HOUSES

Kind of Foundation	Kind of Wall and Description	Kind of Roof	Provision for Ventilation	Amount of Floor Space	Amount of Glass Space	Height in Rear, Front etc.

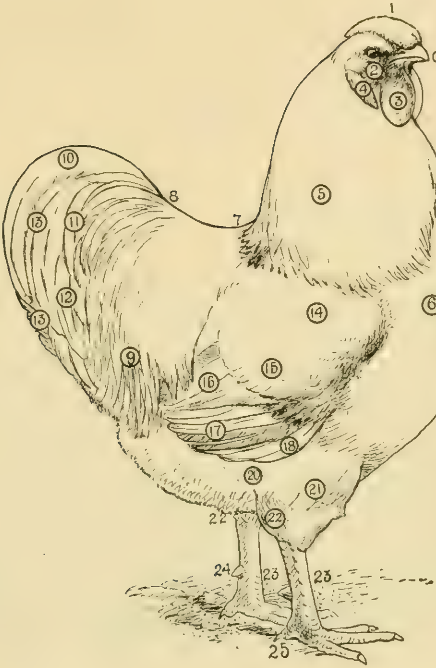


FIG. 125. — Parts of a fowl.

0. Beak.
1. Comb.
2. Face.
3. Wattles.
4. Ear lobe.
5. Hackle.
6. Breast.
7. Back.
8. Saddle.
9. Saddle feathers.
10. Sickles.
11. Lesser sickles.
12. Tail coverts.
13. Main tail feathers.
14. Wing bow.
15. Wing coverts, forming wing-bar.
16. Secondaries, wing bay.
17. Primaries, or flight feathers.
18. Flight coverts.
19. Point of breastbone.
20. Fluff
21. Thigh.
22. Knee joint.
23. Shank.
24. Spur.
25. Toes, or claws.

7. Judge Egg according to Egg Score Card. One Dozen as a Sample.

EGG SCORE CARD

SCALE OF POINTS	PERFECT	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED	STUDENT'S	CORRECTED
1. Weight	24								
2. Uniformity of size	6								
3. Uniformity of shape	6								
4. Uniformity of color	8								
5. Shell texture	4								
6. Condition of shell	4								
7. Quality (candling)									
1. Size of air cell	24								
2. Interior color	24								
Total	100								

Explanation of Score Card.

1. *Weight.* — 24 Points. — Extras, weigh 26–28 and firsts 24–26 ounces per dozen. Cut 2 points for each ounce under or over weight in either class.

2. *Uniformity of Size.* — 6 Points. — All eggs should be uniform in size. One-half point is allowed each egg. For each egg varying from the average size, cut according to judgment.

3. *Uniformity of Shape.* — 6 Points. — All eggs should be uniform in shape. For each egg varying markedly in shape, cut from one-fourth to one-half point.

4. *Uniformity of Color.* — 8 Points. — White eggs should be of a uniform white shade. Brown eggs may vary in shade; but all eggs of a sample should be of the same shade. Two-thirds of a point is allowed for each egg. Cut according to judgment.

5. *Shell Texture.* — 4 Points. — The shell should be free from spots, breaks, wrinkles, and roughness. Cut one-third of a point for each egg showing the above defects.

6. *Condition of Shell.* — 4 Points. — Shell should be bright, fresh, unwashed, free from dirt or stain. Cut according to judgment. One-third point allowed each egg.

7. *Quality* (candle eggs).

1. *Size of air cell.* — 24 Points. — Test eggs with candle, kerosene, lamp, or electric light. Air cells should be small, not larger than a dime, showing freshness. Two points are allowed for each egg. An egg showing an air cell as large as a quarter, cut the limit, two points. Cut for intervening sizes of air cells according to judgment.

2. *Interior Color.* — 24 Points. — The interior color when candled should have a reddish color. An egg having a dark color or a floating yolk is defective. Two points are allowed each egg. Cut according to judgment.

Disqualifications. — A broken, cracked, musty, chick-developed, floating-yolked, or blood-ringed egg will disqualify the whole dozen.

Courtesy of International Harvester Co.

FIG. 126. — A dozen eggs should weigh from 24 to 28 ounces.

8. To Study the Loss of Weight of Eggs. — Weigh the same dozen eggs weekly for eight or ten weeks; and keep the weekly weights. Find at the close of the experiment the per cent of loss. (This loss is due to evaporation.)

9. Application of the Hogan Test. — Examine fowls for capacity, thickness of pelvic bone, condition, — and fill a miscellaneous column, including a statement on width of back, constitution, etc. Record your findings. What is the capacity of each hen examined for egg production?

10. Survey of the Poultry in the District. — Record as follows. (May be an exercise in which all pupils take part.)

Farmer's Name	Variety of Fowls	Class to Which They Belong	Breed	Number

CHAPTER XVI

NATURE OF SOILS

Introduction to the Study of Soils. — The soil is the richest agricultural heritage of all ages. It is the asset of all assets. Upon it and its fruitfulness everything is dependent. The mines, the factories, and the commerce of the world would soon stop, and our cities would crumble to dust, were it not for the fact that "Mother Earth" continues to respond constantly to the hands and the intelligence of man. Let the earth withhold her yields for one year, and a gloom of sorrow, and even death, would appear. For these reasons we should diligently study the soil; how to maintain its fertility, and by better practices to make our people more prosperous, prepared, and peaceful.

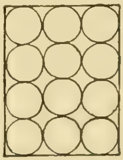


FIG. 127. — Pore space of sandy soil. Large soil particles, large pore space.

Texture of Soils. — The texture of soils refers to the size of the soil particles. The texture of a coarse sand is coarse; the texture of clay is fine; the soil particles of clay soils are the smallest of all soil particles The following measurements and names of soils on page 264 are based upon the size of the soil particles.[1]

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Samples of clay; fine and coarse sand; tall glass bottles, test tubes, or graduates; two one-quart tin cans, and, if possible, tall glass tubes (1 inch × 3 feet).

[1] Bureau of Soils, United States Department of Agriculture.

	Measurement	Relative Sizes
Fine gravel	1 to 2 millimeters	
Coarse sand	1 to 0.5 millimeter	
Medium sand	0.5 to 0.25 millimeter	
Fine sand	0.25 to 0.10 millimeter	
Very fine sand	0.10 to 0.05 millimeter	
Silt	0.05 to 0.005 millimeter	
Clay, less than	0.005 to 0.00 millimeter	

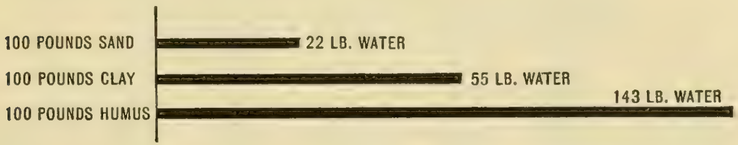
Clay soil particles are microscopic. One sand particle, 2 millimeters in diameter, if crushed and ground to the size of the finest clay particle, would make thousands of such particles. (See Exercises 1 and 2.)

The composition of six types of soils, from an analysis based upon the texture of the soil, is as follows:

	Clay Soil	Clay Loam	Silt Loam	Fine Sandy Loam	Sandy Loam	Coarse Sand
Clay	50	35	20	15	15	5
Silt	30	42	60	30	20	10
Very fine sand	12	15	10	25	15	10
Fine sand . .	5	5	6	20	25	30
Medium sand	2	2	2	5	10	25
Coarse sand .	1	1	1	4	10	15
Fine gravel .	0	0	1	1	5	5
Total .	100	100	100	100	100	100

The question may be asked what is the composition of a clay soil? Sandy loam? Silt loam? These questions should be answered from the above table.

Relation of Size of Soil Particles to Water-holding Capacity. — Coarse sandy soil particles have much less surface area than do the particles of clay soils. Cutting a cubic inch of soil into four equal cubes doubles the surface area. The film water a solid cubic inch could hold is one-half as much as the same block would hold if it were cut into cubes one-half inch each way. But if a cubic inch of rock were crumbled into a thousand soil particles, the surface area is increased many, many times, and the amount of film water it is capable of holding would be in direct proportion to the additional surface exposed. Clay soils will hold much more water than sandy soils. The water-holding capacity of a coarse sandy soil, a clay, and a humus soil is as follows:[1]



GRAPH 9. The water-holding capacity of various types of soil.

It has been estimated that the surface area of a cubic foot of clay soil particles is 150,000 square feet, and that the surface area of the particles of a cubic foot of coarse sand is 40,000 square feet. From this it is apparent that a clay soil holds more capillary water than does a coarse sandy soil. It is also evident that an inch of rain falling upon a clay soil does not wet it as deeply as the same amount of rain wets sandy soil. (See Exercise 3.)

[1] Hunt and Burkett: *Soils and Crops.*

Pore Space in Soils. — Sandy soil particles afford less pore space than do clay soils. (See Fig. 127.) Large particles have small pore space. Small particles have large pore space.

If a small soil particle were placed between each of four large particles, the open pore space would be closed to some extent. If a dozen soil particles were placed in the same open space, the open pore space would become very small.

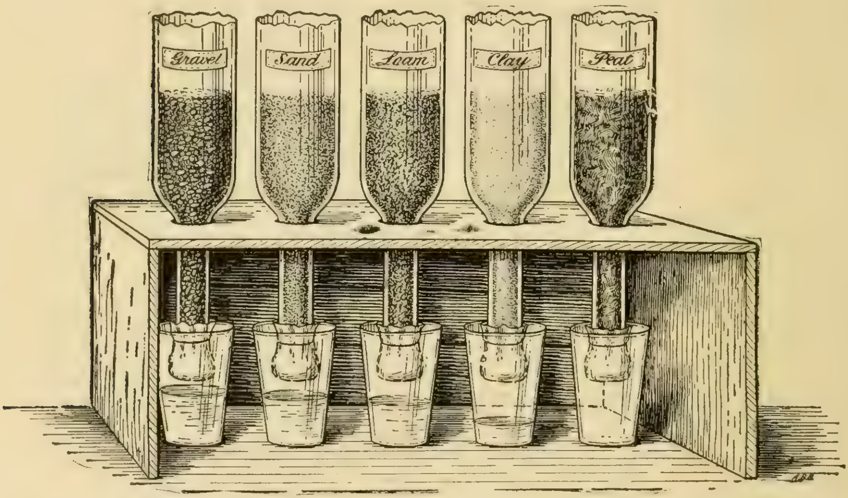


Fig. 128. — Simple and cheap apparatus which may be used to show percolation of water through different kinds of soil.

Water Passing Through Soils. (Percolation.) — A heavy rain readily passes through a coarse sandy soil, but will percolate through a clay soil very slowly. Water passes through a clay soil so slowly that the top layers soon become saturated to such an extent that the surface begins to wash. It is for this reason that clay soils wash so readily. The two reasons for water percolating through a sandy soil so much more rapidly than through clay are:

1. A sandy soil has much larger pore spaces.

2. A sandy soil having less surface area lessens the friction in percolation. (See Exercise 4.)

Some Facts about the Porosity and the Texture of Soil. — Any soil that is well drained, and loses its free water rapidly, is a warm soil, sometimes called an "early soil." Such soils get warm much quicker than do soils that hold water. For this reason a sandy soil may be ready for spring plantings a few weeks earlier than a clay soil. "It requires about twenty heat units to raise the temperature of one hundred pounds of dry soil one degree Fahr. To raise the temperature of the same weight of water one degree Fahr. requires 100 heat units. But the effect of water is most striking when it evaporates. To evaporate 100 pounds of water requires 966.6 heat units."[1] Since clay soils will not permit percolation, most of the water must be taken off by evaporation. It is for this reason that a clay soil requires so much heat to warm it. All the heat is required to evaporate the surplus water. Since truck farmers want early crops, they prefer sandy soils because they get warm early.

Coarse-textured soils permit the free circulation of air more readily than do fine-textured soils. This is one reason why sandy soils free themselves quickly of a surplus of soil water.

Bacterial life is more active in a well-aërated soil than in a "water-logged" soil. Organic matter is transformed to available plant foods by bacterial life. A medium dry soil aids in this work.

A soil of fine texture usually contains more available plant foods. This is true for two reasons: (1) The finely textured soils have an origin having a better chemical basis. Sandy

[1] Warren: *Elements of Agriculture.*

soils are of sandstone origin, and contain little usable plant foods. The clay soils are of limestone formation, and lime is needed in plant growth. (2) Fine soil particles expose more surface to the soil water, and thus chemical reactions take place more rapidly, and more plant foods are thereby elaborated and made available.

Adaptability of Soils. — Soils of a sandy formation are adaptable to truck and vegetable gardening. Melons, onions, turnips, all root crops, and deep-rooted plants thrive best on sandy loam soils. Grasses, which have a fibrous root system, do better in soils of a limestone formation. The corn, wheat, oat, and blue grass regions have soils of a medium fine texture, largely of limestone formation, mixed with some sand and a great deal of organic matter. Whitney gives the following table to show the relation of the number of soil particles per gram, and the kind of farming to which each is adapted:

	Soil Particles per Gram
Early truck	1,955,000,000
Truck and small fruit	3,955,000,000
Tobacco	6,786,000,000
Wheat	10,228,000,000
Grass and wheat	14,735,000,000

It will be observed that an early truck soil is one with but few large soil particles, and that typical grass soil has more soil particles per gram. They are, therefore, much smaller. Orchard soils should be of a loose porous nature. They should be deep, and the subsoil should also be porous. Orchards will not thrive in a compact clay soil.

For general purposes, deep, black loam soils are the best. Black loam soils have about the following composition: humus, 3 to 5 per cent; silt, 40 to 60 per cent; fine sand, 5 to 10 per cent; clay, 10 to 25 per cent. Such soils are fairly fertile and are easily cultivated. (See Exercise 5.)

Summary. — The soil is our richest agricultural heritage. The texture of the soil refers to the size of the soil particles; clays have a fine texture, and sands a coarse texture. Water percolates through sandy soil rapidly, and very slowly through clay soil. Sandy soils will hold less film or capillary water than clay soils. Sandy soils are therefore more adaptable to trucking, and heavier soils are suited to general farming.

LABORATORY EXERCISES

1. To Study the Texture of Some Soils. — Secure two kinds of sand — a fine and a coarse sand — and some clay. Wet each, and examine by rubbing each soil between finger and thumb. Describe each soil. Also hold soil to ear while rubbing. Describe the sound produced. Record findings. Insert drawing into notebook, showing the comparative sizes of the particles examined.

2. To Determine which Soils Settle More Rapidly. — Put a small quantity of coarse sand, fine sand, and clay in a tall bottle or test tube. Add water until the bottle is three-fourths full. Shake thoroughly, inverting the bottle occasionally while shaking. After soil and water are well mixed, let it settle. Note the order in which the soils settle. Draw and record results.

3. To Find the Amount of Water Soils Will Hold. — Get two quart tin cans, make some small holes in the bottom of the cans, making the penetrations from the inside. Fill one can with a definite weight of sand, and the other one with an equal amount of clay. Pour water into each soil until it becomes thoroughly saturated. Keep pouring water in until some of the water passes through the soil and comes through the openings. Find weight of water required to saturate each soil. The result will give the amount of water each of the two kinds of soils will hold. Write your findings.

4. To Study the Relation of Size of Soil Particles to Percolation. — If possible, use tubes (about an inch or two in diameter and three or four feet long), though long wine bottles with the bottoms broken out will do. Tie a piece of cloth over the neck of each bottle, and fill one bottle about full with well-pulverized clay, and the other with sand. Pour water on each soil, and take the time required for water to percolate through each soil. Record your findings.

5. To Study the Relation of Size of Soil Particles to Capillarity. — Use the longest tubes available (though wine bottles will do). Tie a cloth over the neck of each bottle. Fill one bottle with sand and the other one with

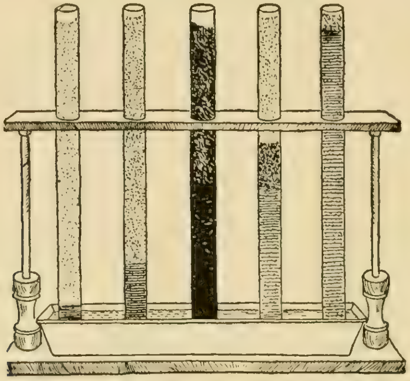


FIG. 129. — Pan and glass tubes, illustrating the apparatus used in showing the rise of water by capillarity.

clay. Now set the neck of the bottles in shallow water. See how long it will require the water by capillarity to rise to the top. Record as follows:

HEIGHT OF WATER AT EACH OF TWO SUCCESSIVE FOUR-MINUTE PERIODS

	FOUR MINUTES	EIGHT MINUTES	TWELVE MINUTES
Sand			
Clay			

Write your conclusions.

CHAPTER XVII

STRUCTURE OF THE SOIL

Soil Structure. — Soil structure refers to the arrangement of the soil particles. If the soil particles form into groups or into crumbs, the soil is said to be friable, loose, and in good tilth. Soils that crumble and break readily are in splendid physical condition, but, on the other hand, soil that breaks into clods when stirred is in poor physical condition. Soils in good physical condition hold more water, permit percolation more freely, allow bacteria to multiply more rapidly, elaborate more plant foods, and afford the best conditions for plant growth.

Puddling of Soils. — Sometimes we cannot make snowballs, for the snow will not pack. If we wait until the snow begins to melt, we shall find that we can then make compact, icy snowballs. Similarly, soil, if tilled, driven, or tramped over when it is wet, will pack just as snow will pack at a proper temperature. By this packing of the soil, known as puddling, the structure of the soil is broken down and gives the evidences of poor tilth. The particles are crowded so closely together that there is not sufficient pore space left for the necessary amount of air or water.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are :

The same as in preceding chapter ; and some well-decomposed organic matter and lime.

The formation of crusts on the soil during heavy rains is the result of a broken-down structure. The soil becomes puddled. Such a crust brings all the soil particles in close contact, promotes capillarity, and allows the wind and sun to carry away the soil water. If the soil water is to be conserved, the crust must be broken up. (See Exercise 1.)

Maintenance of Good Structure. — The factors which aid in keeping the soil in good physical condition are: (1) tillage, (2) addition of organic matter, (3) liming the soil, and (4) drainage.

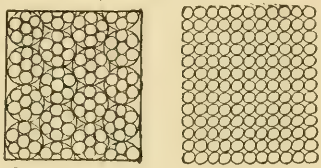
1. Soils should not be tilled when wet, for then the structure of the soil is broken down, as in puddling. Plowing a soil when wet causes the soil particles to slide one upon the other, bringing them much closer together, and breaking down the crumb structure. To quote Professor Whitson: "In this condition the soil is much denser, and does not permit air or water to pass through it readily. There are then practically no air spaces, all the spaces between the soil grains being occupied by water. When clay soils of very fine texture are puddled, then dried and baked, they become hard or even stony. This is the basis of the process of common brick making."

Cultivating soils, driving over fields, or grazing pastures while wet, are bad farm practices. Soils should be stirred only when the structure and tilth of the soil will not be harmed.

2. Frequently, soils puddle readily because of a lack of organic matter. The addition of organic matter partially protects soils from beating rains, and also helps to hold the soil particles apart. Organic matter aids aëration, percolation, and bacterial development, and makes for conditions which prevent the breaking down of the soil structure. A soil rich in humus and decaying plant life does not puddle so easily as does a soil that is devoid of humus and organic matter. (See Exercise 2.)

3. Soils often pack and puddle because of the absence of lime,

which improves the soil structure. The "grouping" tendency of the soil is increased by the addition of lime. Lime effervesces in the presence of soil water and keeps the soil loose and friable. The compounding of soil particles is indicated in Fig. 130.



Limed soil — soil particles are flocculated. Unlimed soil — soil particles remain separate.

FIG. 130.

In the figure shown it will be noted that in the limed soil the particles have formed into groups, and are said to be flocculated. In the unlimed soil, the particles remain separate. Such a soil puddles easily. (See Exercises 3 and 4.)

4. Proper drainage rids the soil of surplus water. This benefits it in several ways:

a. It permits more air to get into the soil.

b. Bacteria thrives better in a well-drained soil, and nitrification is hastened.

c. A well-drained soil warms up more quickly in early spring.

All of these points, due to proper drainage, improve the tilth of the soil.

Summary. — Soil structure refers to the grouping or the arrangement of the soil particles. A soil of good structure is friable and in good tilth. A soil with poor structure and tilth puddles readily. A good physical condition of the soil may be secured and be maintained to a fair degree by: 1. Proper methods of tillage. 2. The addition of organic matter. 3. Liming the soil. 4. Drainage. (See Exercise 5.)

LABORATORY EXERCISES

1. To Study the Effect of Puddling. — Put about equal quantities of clay in each of two saucers. Add enough water to each to well saturate it. Stir one thoroughly. Do not stir the soil in the other saucer. Set both away and let them dry. After they are dry, try to crumble each between finger and thumb. Record your findings. What important principles pertaining to farm practices may be deducted from the experiment?

2. A Study of the Relation of Organic Matter to Puddling. — Mix together about equal quantities of well-decomposed organic matter and ordinary soil. Wet well and stir the mixture thoroughly. Wet and stir another batch of the same soil without the organic matter. Set the two soils away to dry. After they are dry, pulverize each soil with your hands. Record your findings as to the effect of the presence of organic matter upon soil structure.

3. To Study the Relation of Lime to Puddling. — Take two batches of clay, each weighing two hundred grams. Add to one batch 50 grams of lime. Mix well. Leave the other batch unlimed. Wet each soil thoroughly and work into a mud ball or brick. Set them away to dry. When dry, pulverize them with your hands. Record your findings. What effect does liming have upon the structure of the soil?

4. To See if Lime Flocculates the Soil Particles. — If test tubes are available, use them; if not, use tall bottles. Put about an equal amount of clay and lime into one bottle, and into the other bottles put clay alone. Fill each bottle about full with water. Mix thoroughly, then let the bottles stand until the water above the soil in each becomes clear. Record your results and make a drawing showing the results. Record the time required for the water in each bottle to become clear. How do you account for the difference?

5. Define soil structure, puddling, baking, and flocculation of soils. Write the definitions, and append a statement with each definition.

CHAPTER XVIII

THE SOIL WATER SUPPLY

Importance of Soil Water. — We have already learned the importance of a proper water supply for plant growth. It has been found by experimentation that to produce a hundred pounds of dry matter of various farm crops requires from 300 to 750 pounds of water. Water is taken into the roots, then through the plants, and then to the leaves where it is transpired into the air.

Amount of water lost by transpiration for each ton of dry matter produced in the crop has been found to be:[1]

Corn	310 tons equal to 2.64 inches rainfall
Red clover	453 tons equal to 4.03 inches rainfall
Barley	393 tons equal to 3.43 inches rainfall
Oats	522 tons equal to 4.76 inches rainfall
Potatoes	422 tons equal to 3.73 inches rainfall

Similar results have been found by European experimenters.

If it is true that farm plants require from 300 to 750 pounds of soil water to produce one pound of dry matter, then it may also be concluded that weeds require enormous quantities of

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Samples of soils brought from fields; two one-gallon earthen jars, or buckets; scales; six porcelain evaporating dishes.

[1] King, University of Wisconsin.

water for their development. Weeds should therefore be destroyed by proper tillage.

Plants are largely composed of water. The composition of a few plants at the time of maturity of the green roughage follows:

	Water	Total Solids
Corn	79.3	20.7
Wheat	72.6	27.4
Oats	73.9	26.1
Blue grass	76.2	23.8
White clover	78.2	21.8

The composition of other plants is very similar to that of corn, wheat, oats, blue grass, and white clover.

Some of the functions of water for plants follow:

1. It makes up a large part of the composition of the plant and is an actual plant food.

2. It serves as a carrier of plant food. Plant foods are taken into the plant through water solutions. These plant foods are carried in such small quantities that it is necessary for enormous quantities of water to pass through plants in order that they may be properly nourished.

3. Water helps to maintain the proper temperature of plants. Water, in the transpiration process, cools the leaves to a considerable extent. Young shoots of plants would be burned up were it not for the cooling effect of the water that passes through them.

Water is so important that Vivian, in *First Principles of Soil Fertility*, says: "There is no doubt, however, that the proper condition of moisture is the most important single factor in determining the fertility of the land, and that more soils fail to produce good crops for lack of it than for any other cause." Water in proper amounts and coming at the right seasons practically controls the yields. Twenty inches of rainfall when properly distributed is sufficient to produce the best corn yields; but, when improperly distributed, may cause an absolute failure of the crop. Sometimes an additional rain or two would double the crop yield. Hunt and Burkett, in *Soils and Crops*, say: "A piece of land was once planted to corn. The yield was thirty bushels per acre. The next year it was planted with the same kind of corn and otherwise treated as in the previous year. The yield was ninety bushels. During the first season, the rainfall for the five growing months was thirteen inches; the second season it was twenty-two inches for a like period. The extra nine inches of rainfall was the principal factor in producing the additional sixty bushels of corn." (See Exercise 1.)

Forms of Soil Water. — Soil water is found in three forms:

1. Free or gravitational water.
2. Capillary or film water.
3. Hygroscopic water.

When a soil becomes so full of water that some of the water seeps away, that which seeps away is called free or gravitational water. Free water is harmful to plants because it keeps the air from the soil and prevents the work of the beneficial nitrifying soil bacteria. Tile drains are laid to carry away gravitational water.

Capillary or film water adheres to the soil particles just as water adheres to one's hand when it is dipped into water. Every soil particle is covered with capillary water, which moves by capillarity from soil particle to soil particle. And just as the oil comes up the wick and is burned, the soil water comes to the surface of the ground and evaporates. Capillary water is the form in which plants can use it to best advantage. Capillary water, under good field conditions, constitutes from 20 to 30 per cent of the weight of the soil.

Hygroscopic water is water that exists in soils when they are air dry and has little if any value for plant growth. The driest road dust contains hygroscopic water. Soils must contain about 12 per cent water before plants can secure any. Hygroscopic water seldom exceeds 3 per cent of the weight of the soil. (See Exercise 2.)

Regulating the Water Supply. — Since water is such an important plant food, and is so frequently a limiting factor in plant development, every farmer should study carefully how to conserve the soil water. Soil water escapes from the soil in four ways: (1) by drainage, (2) by evaporation, (3) by plants using it, and (4) by transpiration. We shall discuss soil drainage and the evaporation of soil moisture in this chapter; the loss of water from the soil by the last two ways named will not be discussed, except to say that soil water should be so regulated that plants at all times have sufficient but not an excess of water, and that transpiration is not reduced below the normal amount.

1. Often there is an excess of water in the soil. This may be partially disposed of by drainage. There are large areas in the United States that are marshy and swampy during certain seasons of the year, but when drained are among the most fertile lands of our country.

There are two systems of drainage: surface drainage and underground drainage. In surface drainage open ditches carry off the surplus water. Some soils have a compact undersoil through which water will not percolate. Sometimes the water table is so near the surface of the ground that drainage is almost impossible. Many such fields have been made productive by the use of tile drainage. Four-inch tiles have been found more satisfactory than smaller tiles. A large tile is more easily laid than a smaller one and does not become stopped up so easily. A proper fall will help in making a tile drain more serviceable. A four-inch tile should have at least two-inch fall per each one hundred feet, while a six-inch tile may have less. And tiles with a foot diameter may have as little as one-half to three-fourths inch fall per one hundred feet. Accurate measurement records and maps should be kept on any drainage project, to help in repair work. Proper drainage often makes a soil manageable and productive.

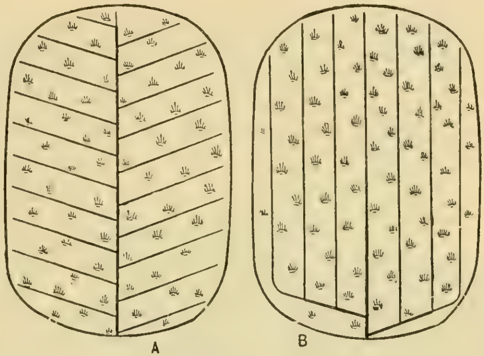


FIG. 131. — Two systems of arranging tile drains — when laid maps should be kept, showing the location of the tiles.

2. Too little moisture in the soil more often hurts plant growth than too much. The rainfall in the growing season is often insufficient for the best plant growth. Therefore, the water that is in the soil must be conserved. Soil water is lost mainly by evaporation. The sun and the air take up all the water that comes to the surface of the ground; water comes to the surface by capillarity. The particles of the soil are all in contact, piled one above the other. Capillary water travels in any direction, from particle to particle. When the water reaches the surface of the soil, it is taken away by the sun and the air. A compact surface or crust fosters capillarity. Every one has observed that well-tilled fields are moist and black in the morning, but lighter in color a little later in the day. The black color indicates that

the soil is moist. When this moisture is removed by the sun and wind, the soil becomes lighter and drier. The extent to which moisture is removed by evaporation depends upon the texture, the tilth, the amount of water in the soil, and the atmospheric conditions. It has been found that as much as $1\frac{1}{3}$ pounds of water per square foot evaporated daily.

The conservation of moisture lost by evaporation is one of the big problems in the management of soils. If the soil could be protected from the wind and the direct sunshine, the losses of soil moisture would be greatly reduced. The reason we find the soil moist under a board is because it is protected. A bunch of straw, weeds, or leaves may protect the soil so that the soil moisture cannot be taken up by the sun and the wind. This is called a mulch. Growing potatoes are sometimes covered with straw. In dry seasons this is an excellent practice, for the soil moisture is thus maintained.

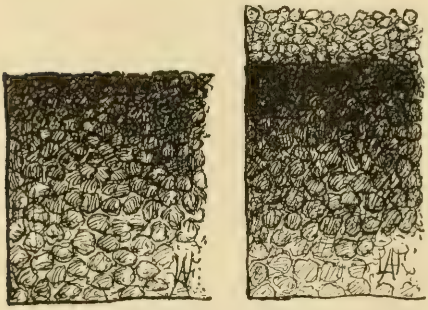


FIG. 132. — An earth mulch such as is illustrated to the right above conserves soil moisture, while the compact soil, as illustrated on the left, promotes the evaporation of soil moisture.

Leaves, straw, boards, sawdust, and similar things may be used as a mulch to the soil, but the most practical method of protecting the soil and conserving the soil water is by the use of the soil mulch. A soil mulch is maintained by keeping the top 2 or 3 inches of the soil well stirred and pulverized. This blanket protector of the soil is called *a soil mulch* or *dust mulch*. The earth mulch conserves soil moisture because it destroys the close contact of the soil particles, rendering it impossible for moisture to pass by capillary action from particle to particle.

The moisture may rise in the soil up to the dust mulch, but cannot go any farther. Consequently, the air and the sun can-

Fig. 133. — The cracks in the soil expose additional surface to the wind and sunshine. Much soil moisture is thus lost.

not draw heavily on the water in the soil. All farmers know by experience that stirring the surface of the soil during a dry season aids very much in the growth of the crop. A three-inch mulch has been found most effective in preventing evaporation.

Soil mulches are made by the use of the hoe, harrow, narrow, shoveled cultivators, and other similar tools and implements. Occasionally, mower wheels are dragged between the rows of corn to break up the crust caused by rains. This is done after the corn is too large for the usual methods of cultivation. It has been found in unusually dry seasons that the acreage yield may be increased from 5 to 10 bushels by the use of the drag. (See Exercises 3 and 4.)

Level cultivation is preferable to ridging the soil, if the soil moisture is to be conserved, because ridged soil exposes more surface to the sun and the wind, and therefore causes a greater amount of moisture to be lost.

Summary. — The lack of soil water is the most frequent limiting factor of plant growth. Capillary water can be used to better advantage by growing plants than the other two forms of soil water. Drainage may be employed to rid soils of an excess of soil water. The maintenance of an earth mulch aids greatly in the conservation of soil moisture.

LABORATORY EXERCISES

1. To Find the Per Cent of Water in Soils under Field Conditions. — Secure some soil from a near-by field. Weigh out, say, 250 grams of soil, and then put soil in some vessel and heat over a stove until all the moisture is driven off. Weigh the dry soil. Find the per cent of moisture the soil contained.

2. To Find the Per Cent of Hygroscopic Water in Road Dust. — Take 200 grams of the driest road dust obtainable, and by the method described in Exercise 1, find the per cent of hygroscopic water in road dust.

3. To Study the Effect of an Earth Mulch. — Fill two quart tin cans with about an equal amount of soil. Weigh each. Put about a one and one-half inch dust over the soil in one of the cans. Set both soils in the same place and weigh both soils on alternate days for about three or four weeks. Record weights in the following manner:

Weights of Mulched and Unmulched Soils

Date	Mulched Soil	Unmulched Soil
Initial weight		
Weights on soils on intervening days		
Final weight		
Total loss		
Percentage loss		

What are your findings? What conclusions can you draw from the experiment?

4. To Find the Extent to which Plants can Remove Water from the Soil. — Fill one gallon bucket or jar with coarse sand, another one with soil from a garden. Plant corn or wheat in each one. Maintain conditions so that the plants will grow. When plants have several leaves, stop watering them and note the number of days that elapse before the plants begin to wilt. As soon as plants are well wilted, find the per cent of moisture in each soil, using about 200 grams of soil to make the test. Compare the per cent of moisture still remaining in each soil. Write your findings.

CHAPTER XIX

PLANT FOODS

Foods Essential to Plant Growth. — Plants generally contain fourteen elements, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, iron, sodium, silicon, chlorine, and manganese, of which the first ten are essential to plant growth. Experiments have shown that when one of the ten elements is not present, plants will not grow. Hydrogen, oxygen, and carbon constitute the greatest part of plants. The other elements are found in small quantities only. To suggest the general composition of plants we give the composition of one thousand pounds of the corn plant:[1]

- Corn plant 1000 pounds
  - Water 793
    - Hydrogen 88.1
    - Oxygen 704.9
  - Dry matter 207
    - Organic matter 195
      - Protein 18
      - Fat 5
      - Fiber 50
      - Carbohydrates 122
        - (Nitrogen 2.9, Carbon 90.5, Oxygen 88.9, Hydrogen 12.7)
    - Ash 12
      - Chlorine 0.4
      - Potash 4.0
      - Phosphoric acid 1.2
      - Lime 1.6
      - Magnesia 1.4
      - Iron oxide 0.3
      - Sulphuric acid 0.3
      - Soda 0.4
      - Silica 2.4

[1] Vivian: *First Principles of Soil Fertility.*

Sodium, silicon, chlorine, and manganese are very frequently present in plants, yet they are regarded by some authorities as not essential to plant growth.

Sources of Plant Foods. — Carbon, hydrogen, and oxygen come from the air and from water. Water, which is composed of hydrogen and oxygen, makes up the greatest part of the plant, as we have already learned. Carbon comes from the air. In ten thousand parts of air, there are three to four parts of carbon dioxide. Decaying organic matter, and the air exhaled from animals, are constantly restoring what is used by plants. Carbon is frequently not present in the soil in the proper amount. Nitrogen makes up a small part of plants. Although four-fifths of the air is nitrogen, it is one of the most limiting elements of plant growth. Nitrogen in a proper form is comparatively rare in the soil. It requires about 40 pounds of nitrogen to make 30 bushels of wheat. It has been found by experiment that the rainfall brings down to the soil annually from 2 to 3 pounds of nitrogen per acre. As we have already learned, the bacterial life on the root of leguminous crops forms some nitrogen. The amount of nitrogen added to the soil in this manner is also small. More nitrogen must be supplied by barnyard manures and commercial fertilizers. These will be discussed in a later chapter.

The elements iron, sulphur, magnesium, sodium, phosphorus, potassium, silicon, chlorine, calcium, and nitrogen are supplied by the soil. The first four elements are inexhaustible. Calcium, like nitrogen, is often limited in supply. Soils are composed largely of decomposed rocks. The elements named in this paragraph, excepting nitrogen, in combination with oxygen, really

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Two one-gallon buckets or earthen jars; subsoil; some well-rotted manure; various kinds of rocks found in the locality.

form the basis of the soil. The nature of the soil, its texture, structure, and chemical composition are largely dependent upon the kind of rock from which the soil was formed. All the elements which plants need for growth are abundant in the soil except potassium, phosphorus, and nitrogen, and sometimes lime. (See Exercise 1.)

Organic Matter in Soils. — Organic matter constitutes from 2 to 5 per cent of the average soil. Decaying organic matter is called humus. The dark color of the soil is due to humus. Since plants contain the elements necessary for plant growth, the addition of plants to the soil enriches it. When plants decay, they provide some of the necessary plant foods. As we learned from the preceding paragraph, plants are composed of hydrogen, oxygen, carbon, nitrogen, potash, phosphorus, magnesium, iron, and sulphur. These are added to the soil when barnyard manure, green-manure crops, or weeds are plowed under.

Humus or decaying organic matter in the soil has the following important uses:

1. Organic matter prevents washing of soils because humus holds more water than do any of our soils.

2. Organic matter improves the physical condition of the soil. A soil rich in humus is seldom in poor tilth. A sandy soil is made more compact by the addition of humus, and a clay is made more mellow and porous.

3. Humus unlocks and liberates plant foods. When water comes in contact with organic matter, it forms humic acids which dissolve the compounds in the soil particles, and put them in a condition to be absorbed by plants.

4. Organic matter and humus provide food for bacteria which are essential in keeping the soil in good condition.

5. Humus is important because it is rich in nitrogen, potash, and phosphorus.

Therefore, a soil rich in humus is usually a rich fertile soil, and one with little humus is not fertile. (See Exercise 2.)

Function of the Plant Foods in Building up the Plant. — The raw materials coming from the soil and the air combine and make the plant. The roots, stems, leaves, flowers, and fruits are the result of various combinations of the plant foods of soil and air. Carbon, hydrogen, and oxygen combined in plants make the carbohydrates, or sugars and starches. Carbon, hydrogen, oxygen, and *nitrogen* combined make the proteins. Fats contain carbon, hydrogen, and oxygen, with a larger proportion of carbon than in carbohydrates. Fats are often defined as concentrated carbohydrates. Water, carbon dioxide, and nitrogen form these three compounds: carbohydrates, proteins, and fats.

The mineral matter of plants is made up of the ash elements, — calcium, magnesium, sodium, phosphorus, potassium, silicon, and chlorine. When plants are burned, these elements make the ashes.

Specific Function of the Different Elements in Plant Growth. — Soils rich in nitrogen produce luxuriant vegetative growth. Plants having an abundance of dark green foliage indicate that the soil contains a great deal of available nitrogen. Barnyard manures and commercial fertilizers, because they contain nitrogen, make plants grow rapidly and luxuriantly. Nitrogen also helps to make the protein found in the grains.

Potassium builds up the stem and the grain. However, it is found in the straw in larger amount than in the grain. Potassium aids greatly in making starch in plants.

Phosphorus helps to form proteins. Since proteins are found in the seeds, phosphorus is an element essential to the production of seeds or kernels. It also hastens the maturity of seeds.

Calcium, one of the lime compounds, helps to form leaves. Soils in which lime is absent develop plants with small leaves.

The chemical composition of a few common plant and animal products follow:

Starch	$C_6\ H_{10}\ O_5$
Fruit, sugar	$C_6\ H_{12}\ O_6$
Stearin (fat in butter)	$C_{57}\ H_{110}\ O_6$
Legumen (a protein in legumes)	$C_{718}\ H_{1158}\ O_{238}N_{204}\ S_2$

The composition of the grain and straw of corn, wheat, and oats, and the number of pounds of nitrogen, phosphorus, potash, and calcium each removes from the soil, follow:

Crop	Weight of Crop	Nitrogen	Phosphorus	Potassium	Calcium
	Pounds	Pounds	Pounds	Pounds	Pounds
Wheat grain 30 bushels . . .	1800	33	6.2	7.7	0.70
Straw	3158	15	9.2	16.2	5.85
Oats grain 50 bushels . . .	1600	35	5.2	8.3	1.1
Straw	3000	15	2.6	29.1	6.8
Corn grain 65 bushels . . .	3640	40	7.9	12.5	0.7
Stalks	6000	45	6.1	66.4	14.3

It will be observed from the above table that 30 bushels of wheat removes 33 pounds of nitrogen, and that the straw removes 15 pounds of nitrogen. Other crops remove the same elements. Phosphorus, potassium, and calcium are removed also by each crop, and the same elements are needed in plant growth.

One Element cannot Substitute Another. — Nitrogen cannot take the place of potassium or phosphorus. There is no single element that can take the place of another element in plant growth. If there is sufficient nitrogen in a soil to produce 45 bushels of wheat to an acre, and potassium to produce 50 bushels, and phosphorus to produce 20 bushels, the maximum yield cannot exceed 20 bushels an acre, because the scarcity of phosphorus in the soil prohibits a greater yield. It is the limiting factor. "No chain is stronger than the weakest link." The weakest link in the above acre chain, in its capacity to yield wheat, is phos-

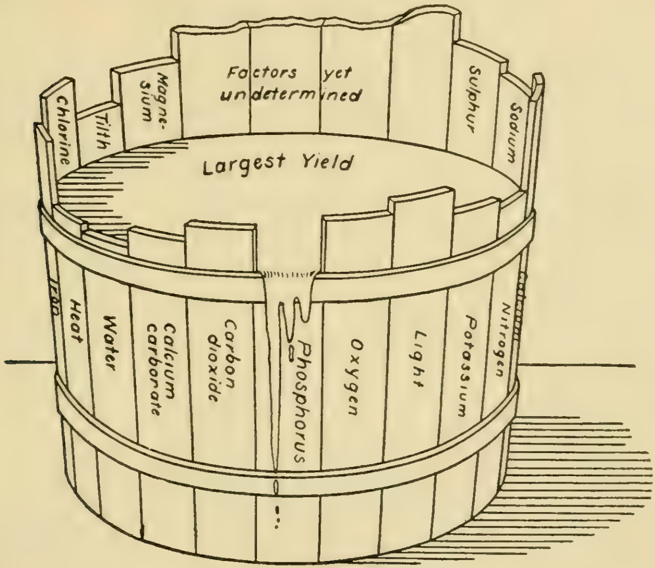


FIG. 134. — Just as the height of the lowest stave determines the amount of water the barrel can hold, so the yield of a crop on a field is determined by that element or condition which is least satisfactory.

phorus, which prevents a greater yield than twenty bushels an acre. The principle set forth in this paragraph is illustrated diagrammatically in Figure 134.[1]

The limiting factor in plant growth may be a lack of any of the following elements, — nitrogen, phosphorus, potassium, lime, oxygen, and water. Suffice it to say that one element cannot take

[1] Whitson and Walster: *Soils and Soil Fertility.*

the place of another element in plant growth, and a balance of all the plant foods is essential to full and complete growth. It is impossible to get something out of the soil that is not in the soil. Soil exhaustion refers mainly to a scarcity of nitrogen, phosphorus, potassium, or lime. The other elements are usually present in excessive quantities. Total exhaustion of soils is impossible. By soil exhaustion is meant such a soil condition that production of crops is unprofitable. A lack of one or more elements in the soil may cause soil exhaustion for practical agricultural purposes. (See Exercise 3.)

Summary. — Fourteen elements are usually found in plants, ten of which are essential to plant growth. If any one of the ten is not present, plants will not thrive. The soil and air are the sources of plant foods. Humus is important in providing plant foods and producing good conditions for plant growth. One element cannot take the place of another as a plant food, and all elements essential to plant growth must be provided in a properly balanced form if profitable production is to be secured.

LABORATORY EXERCISES

1. To Study the Relation of Humus to Plant Growth. — Fill two one-gallon buckets or jars about full with subsoil. To one of these add about a quart of well-decomposed manure or organic matter. Plant about six kernels of corn or some wheat in each. Maintain good conditions for growth. Examine and record findings for about ten weeks of growth.

2. Study of Different Kinds of Rocks. — Have pupils bring as many kinds of rock as are found in the locality, and examine rocks as to color and hardness. If rock cannot be broken with hands, use a hammer. Study the solubility of the rocks brought, by putting parts of the rock in water.

3. A Study of a Fertile and Non-fertile Soil. — Describe in a well-written way the soil and the subsoil of a fertile and a non-fertile soil of your neighborhood. Describe texture, structure, color, depth, etc. Mention the kind of rock or rocks from which the soil was formed.

CHAPTER XX

LOSSES OF PLANT FOODS

Amount of Plant Foods in the Soil. — All soils contain large quantities of nitrogen, phosphorus, and potassium. These plant foods vary in different soils about as the table indicates.

AMOUNT OF PLANT FOODS PER ACRE IN THE SURFACE FOOT

KIND OF SOIL	NITROGEN PER ACRE	PHOSPHORUS PER ACRE	POTASH PER ACRE
	Pounds	Pounds	Pounds
Peat	11,865	550	1,697
Sand	1,675	620	39,750
Clay	3,250	5,600	12,600

The amount of nitrogen in the surface foot of peat soil to an acre, according to the table, is 11,865 pounds, while in a similar area of sandy soils there is only 1675 pounds of nitrogen. The potassium supply in sandy soils is often relatively large, while the phosphorus and nitrogen content is small. The amounts of different elements in different kinds of soils will be discussed in a later chapter.

Eighty-five pounds of nitrogen, 14 pounds of phosphorus, and 79 pounds of potassium are required to produce 65 bushels of

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Soils as indicated in Exercise 1; decomposed organic matter as indicated in Exercise 2; a half-gallon commercial fertilizer containing nitrogen.

corn. These needs of corn seem meager in comparison to the total amount of the elements found in soil. But we should remember that only a small amount of the plant foods in a soil are available. Hopkins states that we can assume for a rough estimation that the equivalent of two per cent of the nitrogen, one per cent of the phosphorus, and one-fourth of one per cent of the total potassium contained in the surface soil can be made available during one season by practical methods of farming.

If this be true, then to produce 65 bushels of corn there must be at least 4250 pounds of nitrogen, 1400 pounds of phosphorus, and 31,600 pounds of potassium, in the seed bed available to the growing plants. From the table given above on the composition of different kinds of soils, and the figures just given on the amount of foods required to produce 65 bushels of corn per acre, it will be readily seen that low yields may be frequently due to the lack of one or more of the elements, — nitrogen, phosphorus, or potassium.

Chemical analysis of soils shows the total plant foods in soils. It does not show, however, how much of the elements are available to growing plants. Many plant foods are locked up in insoluble forms and are given up slowly to plants. This is fortunate, for if the plant foods were soluble, they would be leached away and evaporated.

How Grain Farming Removes Plant Foods. — Every farmer knows that if one crop is grown year after year, on the same soil, the productivity of the soil is greatly decreased. Even on the richest soils, if the same crop is grown for five or ten consecutive years, the yields are smaller each year. In the "corn belt" many fields are unprofitable because they have been constantly producing corn. In the Northern States where wheat is grown abundantly, the fields are irresponsive, compared to what they were in their virgin condition. In the South where cotton has been planted on the same field every year, soil does not produce as it formerly did; and so it is in every section. Where the people have grown one crop on the same field from year to year, the soil does not respond, is less productive, and often unprofitable.

At the Rothamsted Station, England, an experiment was carried on for 32 years with the object of finding out the effects of continuous cropping on yields, and of rotation of crops on yields. On one field wheat was grown continuously for 32 years. On another field 8 crops each of turnips, barley, clover, and wheat were grown. The crops were removed from the fields and no manures were added, so that the difference in the yields shows the relation of rotation of crops to yields. The average yield of wheat where it was grown continuously was 12 bushels an acre; and where the above rotation was practiced it was 26 bushels an acre. The field in which wheat was grown for 32 consecutive years produced a total of 384 bushels in that time, and the field where eight crops were harvested, one every fourth year, produced a total of 208 bushels of wheat. This and other experiments show that continuous cropping removes plant foods and reduces crop yields.

Surface Washing Decreases Plant Food. — Surface washing greatly reduces the resources of the soil. The loss caused by the depletion of our forests is small in comparison to the loss caused by the erosion, or washing away, of our soils.

The extent of erosion is affected by (1) slope, (2) heavy rainfall over short periods, (3) type of soil, and (4) cultivation and vegetation. Steep slopes, when tilled, are subject to severe erosions. Heavy rains falling on hillsides do inestimable damage, especially if the slope has been plowed, and there is no vegetation growing upon it. Soils that are compact and do not permit water to freely percolate through them, are much more liable to erosion than are porous soils.

Soil-washing, or erosion, carries away plant foods and causes gullies and a rough contour of the land so that the land becomes untillable. Humus, because it is lighter than soil, is carried off first; and the smaller soil particles are carried more easily than coarser sand. Since humus is very rich in plant foods, it should be protected above everything else. The fine particles of the soil contain more plant foods than do the coarse particles, and for that reason should not be allowed to wash away.

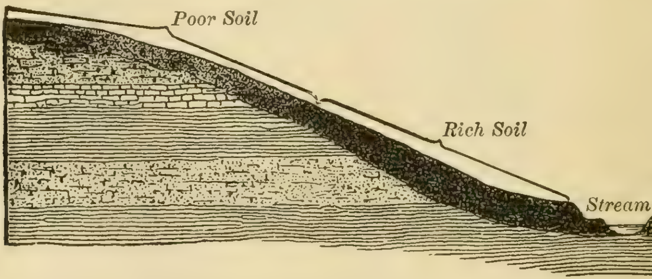


FIG. 135. — Showing movement of soils from higher to lower levels.

Soil erosion may be partially prevented by (1) keeping all slopes in grass, (2) the addition of organic matter, (3) proper methods of cultivation, and (4) drainage. Growing vegetation naturally prevents erosion by checking the water flow. Since organic matter holds more water than soils do, its addition to soils prevents soil erosion. All hillsides when tilled should be cultivated along the slopes, never up and down the slopes. A tile drain may be used to carry off surplus water on slopes, and a ditch along the slope just above the land that is tilled, often prevents the water that accumulates higher up the slope from washing the tilled soil. (See Exercise 1.)

Losses of Humus Causes Losses of Plant Foods. — It has been rightly said that "humus is the life of the soil." This is true for at least two reasons: First, because of its effect upon the soil as indicated in a paragraph in a preceding chapter; and second, because of its rich plant food composition. Decaying vegetable matter, which is humus, is composed of carbon, oxygen, hydrogen, and nitrogen. Since the greatest part of the plant is composed of these elements, humus, therefore, adds these elements directly, in an available form, to soils.

Humus is decreased in soils in the following ways:

1. By continuous cropping, without returning any vegetable matter to the soil.

2. By allowing an abundance of air to come in contact with it. If the soil is constantly wet, organic matter accumulates. It is for this reason that so much humus may be found in swamps. Peat soils are formed as a result of prevailing wet conditions. The organic matter is not decomposed, but in dry soils humus is decomposed by the air, and the gases, carbon, oxygen, hydrogen, and nitrogen, escape. Cultivation aids aëration, and therefore hastens the decomposition of organic matter. Dry seasons are said to burn out the soil. This is partially true, because organic matter decomposes more rapidly.

3. Humus is wasted when stubble, cornstalks, grass, and straw stacks are burned. This is generally bad farm practice, and should occur only in rare cases. (See Exercise 2.)

Loss of the Important Plant Food, Nitrogen. — Nitrogen is taken from soils in three ways, (1) by plants, (2) by water leaching it away, and (3) by denitrification. Each crop, when it is removed, takes with it a definite amount of nitrogen. Again, when organic matter decays, it changes to ammonia. From ammonia it changes to nitrites, and from nitrites into nitrates. This whole process of changing organic matter to nitrates is called nitrification. Each step in the nitrifying process is caused by specific bacteria.

Denitrification of the nitrates occurs if they are not used by plants. Denitrification is just the opposite of nitrification, and is an undesirable condition in the soil. The factors that cause denitrification are:

1. A water-saturated soil.
2. Lack of oxygen in the soil.
3. A supply of nitrates.
4. And the presence of denitrifying bacteria.

Plowed soils left without growing crops are liable to lose a great deal of nitrogen. Plowing soils makes plant food available, but if these foods, especially the nitrates, are not used by plants, they are leached away. It has been found that little nitrogen is lost in summer months, but that most of the nitrogen is lost during rainy seasons. It has also been found that growing crops reduce to a minimum the losses of nitrogen due to leaching. Vivian says, "Numerous experiments confirm the observation that if fields are covered with growing plants, practically no nitrogen is lost in the drainage water, not because the nitrates are not formed, but because the plants appropriate them as fast as they are produced." [1] This is one reason why green cover crops should be grown on lands that are plowed in the fall. (See Exercise 3.)

Summary. — The supply of plant foods, though varying in different soils, is rather large. Fortunately plant foods become soluble very slowly. If this were not the case, soils would soon be depleted of the elements essential to plant growth. Plant foods are decreased by continuously cropping the soil and removing the crops, by soil erosion or washing, by decreasing the humus content of soils, and by the losses of nitrogen due to leaching and

[1] Vivian: *First Principles of Soil Fertility.*

denitrification. All of these losses can be controlled to a considerable extent by proper methods of farm practice. (See Exercise 4.)

LABORATORY EXERCISES

1. **To Study the Fertility of Soils that Have Been Washed, and Soils that Have Not Been Washed.** — Get soils from the top or slope of a hillside where the soil has been exposed to severe erosions, and a soil from the foot of a hillside where there was no soil erosion.

a. Study each soil as to color, texture, structure, composition, amount of organic matter, etc.

b. Fill one-half gallon jar with each soil. Plant wheat seeds in each, and grow plants for six or eight weeks.

Write your findings.

2. **To Study at what Stage of Decomposition of Organic Matter are Its Plant Foods Most Available.** — Fill two one-gallon jars almost full of medium fine sand. Add to one jar a quart of well-rotted organic matter (manure). To the other jar add a quart of similar vegetable matter except that the vegetable matter must not be in a well-decomposed condition. Plant wheat seeds in each, and record results about eight or ten weeks later.

3. **To Study the Effect of Nitrogen upon the Growth of Wheat Plants.** — Use two small plots near the schoolhouse; ten feet by ten feet will do. The soil should be prepared as farmers prepare soils for wheat sowing. Add to one plot a half gallon of fertilizer containing nitrogen. Add nothing to the other plot. Sow each to wheat. Write your observations every two weeks for at least three months.

4. Write an essay on "Losses of Plant Foods from the Soil."

CHAPTER XXI

IMPROVEMENT OF SOILS

Introduction. — Yields are affected by the kind of seed planted, by the amount of moisture, by the amount of heat and light, and by the available plant foods. The four points named have been discussed, and we have now to learn how to improve the soils as a home for plants.

The improvement of soils is a physical or a chemical process, or both. When the physical character of the soil is improved, it is usually accompanied and followed by important chemical changes.

Conditions of Soils Causing Low Crop Yields. — Soils are often in poor physical condition for crop growth. Soils that pack easily and become hard after every rain are in poor physical condition. Many clay soils become so hard and compact that plants are unable to secure sufficient plant foods from them. Although clay soils chemically are generally rich soils as far as the mineral elements are concerned, they are quite often deficient in organic matter and nitrogen.

As long as a soil is compact and hard, it will not respond to the best advantage. It will not liberate any of its plant food rapidly enough for the maximum crop production. The improvement of

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Several samples of soils brought from the garden and fields; blue litmus paper (may be had at drug stores); lime; two one-gallon buckets or earthen jars; salt and water.

its physical condition is the problem for the farmer. Drainage and proper methods of cultivation aid somewhat in improving the physical condition, but the addition of organic matter helps more in making the soil pervious and friable. Liming compact soils also helps in making them more easily tillable. Lime loosens the soil and helps greatly in improving its physical condition. (See Exercise 1.)

Improving Soils by Correcting Acidity. — Soil acidity hinders the growth of some plants. Red clover, alfalfa, and beets will

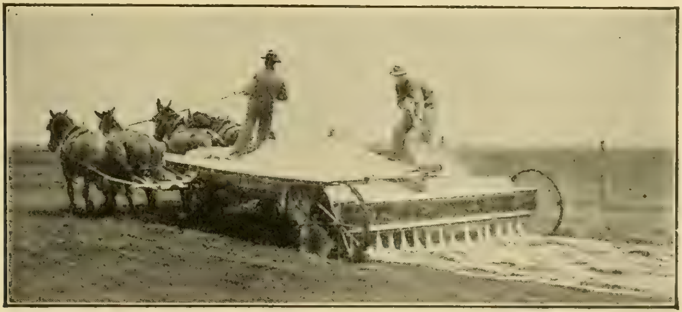


FIG. 136. — The lime spreader.

not thrive in an acid soil. White clover, red top, potatoes, and oats do fairly well in a soil that is slightly acid.

To test soils for acidity insert a small piece of blue litmus paper into a small opening made with a knife or a stick in the soil, and press the moist soil against the paper. Allow paper to remain in contact with the soil for about ten minutes. If the soil is acid, the blue litmus paper will turn red.

Acidity of soils may be corrected by the addition of lime. Unslaked lime should not be applied to soil, because it will burn the organic matter. Ground limestone is the best form in which to apply lime to soils. However, water-slaked lime may be used. A good method of applying lime is indicated in Fig. 136.

It should be remembered that lime does not add any plant foods to the soil, but merely makes more plant foods available. It has been said that liming soils makes the father rich, but the son poor. This is true according to the best authorities, especially if lime is used alone. But if organic matter is added along with lime, the caustic effects of the lime will be largely overcome. From two thousand to six thousand pounds of ground limestone are usually applied to an acre. (See Exercises 2 and 3.)

Improving Soils by Correcting Alkalinity. — Alkali soils are found in arid regions. Rain water carries a small amount of salts. In arid regions these salts are deposited in the soil, because not enough water falls to drain or leach out the salts, and because the water evaporates and leaves the salts in the soil. Salt lakes are formed in this way. Alkali soils may be made neutral by flooding the soil. This carries the salts out. Plants are unable to get any plant foods from alkali soils because in the presence of salts osmotic pressure of the cell sap is outward. (See Exercise 4.)

Improving Soils by the Use of Legume Crops. — Leguminous crops, such as clovers, alfalfa, soybeans, and cowpeas, have both a physical and a chemical effect upon the soil. The deep penetrat. ing roots of the legumes loosen the soil and make it more porous- Even the subsoil is opened by the deep-growing legume roots. Every farmer knows that a soil upon which a legume has been growing is in a good physical condition. Often legumes are grown on a soil simply to prepare the soil for some other crop. (Study Fig. 137.)

The chemical effect of growing legumes is not so great as is the physical effect. Growing legumes improves the chemical composition of the soil. From 40 to 150 pounds of nitrogen may be stored in the legumes grown on an acre. This includes the nitrogen stored in the tops and the roots. More than two-thirds of the nitrogen is stored in the tops. The amount of nitrogen stored in the tops and roots of certain legumes has been found to be:[1]

Crop	Weight of Crop Air Dry	Nitrogen Stored in Tops	Nitrogen Stored in Roots
Red clover . .	4021	69.8 lb.	33.2 lb.
Alfalfa . . .	4247	54.8 lb.	40.4 lb.
Cowpeas . . .	4028	65.2 lb.	4.3 lb.
Soybeans . .	7546	130.9 lb.	9.3 lb.

From this table you will see that most of the nitrogen is stored in the leaves and about one-third in the roots.

If the soil is low in nitrogen content, the legumes store more nitrogen than if the soil has a high nitrogen content. It has been demonstrated by experiment that if the soil is rich in nitrogen, legumes draw upon the nitrogen in the soil first, and take very little nitrogen from the soil air. In fact, the nodules in which the bacteria do the work of gathering and storing nitrogen on the roots of legumes, frequently do not form when the plants are growing in a soil rich in nitrogen.

In some soils, the bacteria of a particular legume may not be present. The farmer cannot always tell, and therefore finds it practical to inoculate the soil with the specific bacteria. This may be done by sowing with the seed two hundred to three hundred pounds of soil from a field where the crop has been growing successfully. The bacteria growing on alfalfa and sweet clover may be used one upon the other for inoculation. The fixation of nitrogen on other legumes is done in each particular crop by a different species of bacteria, but the bacteria living

[1] Delaware Experiment Station.

on the roots of soybeans, and storing nitrogen, will not live and store nitrogen on the roots of white clover. The same is true of the other legumes, except of sweet clover and alfalfa, because a different species of bacteria causes the fixation of nitrogen on each particular crop.

FIG. 137. — The nodules on the roots of the above alfalfa plant improved the chemical composition of soil; the deep penetrating root improved its physical condition.

Improving Soils by Rotation of Crops. — A mere rotation of crops will not of itself add fertility to the soil. But a rotation conserves the soil fertility and, when practiced in a proper manner, aids greatly in keeping the soil in good condition. There are a few points which should be kept in mind in planning a system of rotation. These are:

1. A cultivated crop helps to make plant food available by keeping out noxious weeds and improving the physical condition of the soil.

2. A legume crop should be included in the rotation, because its deep-growing roots loosen the soil and make it porous and because it adds nitrogen to the soil.

3. A pasture or meadow crop should be included in the rotation, because the decaying roots store a large amount of humus in the soil. One reason why virgin soils are so rich is that large amounts

of humus are left in the soil by the decay of roots. It has been found that the amount of organic matter left on the top 6 inches by the roots of timothy and redtop is 7606 pounds per acre. Some have thought that the stems and the leaves furnished the organic matter of soils, but it has been proven that the decaying roots of grasses furnish the greatest amount.

4. Different crops need different plant foods. Some crops draw more heavily upon one element than do others, and for that reason rotation of crops should be practiced. For illustration, a corn crop removes a great deal of nitrogen while a legume restores it. This provides for a balanced removal of plant foods.

SUGGESTED CROP ROTATIONS FOR 2, 3, 4, 5, 6, AND 7 YEAR PERIODS

	TWO YEAR ROTATION	THREE YEAR ROTATION	FOUR YEAR ROTATION	FIVE YEAR ROTATION	SIX YEAR ROTATION	SEVEN YEAR ROTATION
First year	Corn or wheat	Corn and soybeans	Corn	Corn	Corn	Corn
Second year	Soybeans	Oats	Oats	Corn	Corn	Oats
Third year		Clover	Wheat	Oats	Oats	Soybeans
Fourth year			Soybeans	Clover	Clover	Grass
Fifth year				Soybeans	Wheat	Grass
Sixth year					Clover	Grass
Seventh year						Wheat

Crop rotations vary greatly in different states and countries. Each of the rotations suggested in the table may be considered from the following standpoints: 1. Improvement of soil. 2. Distribution of labor. 3. Keeping down weeds and supplying humus to the soil.

The effect of crop rotations may be gathered from the following data:[1]

[1] Quoted from *Circular No. 96* of the Illinois Station.

Rotation	Yield of Corn
Corn and oats for twenty-eight years	36 bu. per acre
Corn, oats, and clover, twenty-eight years	59 bu. per acre
Pasture (18 yr.), corn, oats, and clover, ten years . . .	74 bu. per acre

This experiment along with others of a similar nature emphasizes the point that crop rotations conserve the fertility of the soil.

Improving Soils by Tillage. — Tillage does not add plant foods to the soil, but it does put the soil in such condition that plants can take the food in it. The plant foods are made available (1) by improving the physical condition of the soil, and (2) by making more plant foods available from a chemical standpoint. Crops will not grow in a soil that has not been plowed and thoroughly prepared as a seed bed. Soils are plowed and seed beds are prepared so that the growing plant will have a maximum amount of feeding surface. If plants are growing in a cloddy soil, there is little soil surface exposed to the roots of the plant. But if the clods are crushed, and disintegrated into the finest particles, then from a physical standpoint we have the best conditions for plant growth. One reason, then, why soil is tilled is to improve the tilth, friability, and physical nature of the soil, and to increase the soil surface exposed to the growing roots of plants, and to make the plant foods available to the growing plant.

Fig. 138. — Discing the soil improves its physical condition, and thereby makes more plant food available to the plant.

Tillage hastens chemical activity in soil and makes more plant foods available. Tillage loosens the soil and causes better aëration. An improvement of aëration permits more oxygen to enter the soil, and this hastens the processes which make plant foods available. An average amount of oxygen in the soil aids in putrefaction and decay, and provides a condition necessary to the development of bacterial organisms necessary for transforming vegetable matter into available plant foods. The processes due to bacterial organisms are accompanied by chemical changes. Air is essential to these processes.

Improving Soils by Plowing under Green Manure Plants. — Green manure crops are grown and plowed under to enrich the soil. Any crop plowed under adds organic matter to the soil, and causes more plant foods to be set free. Green manure crops are of two classes:

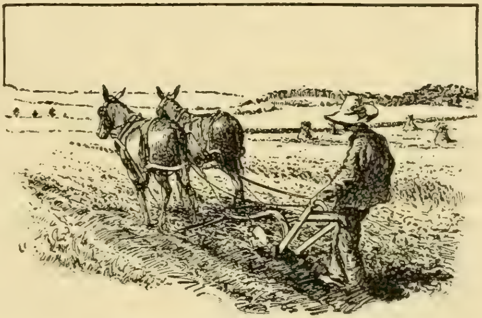


FIG. 139. — Turning under a green manure crop improves the soil physically and chemically.

1. Cover crops such as rye and wheat sown in the autumn and left on the soil through the winter to protect the land, and plowed under in the spring.

2. The legume crops, which are grown in summer and plowed under in the autumn.

Even if the legume hay is removed, the soil will be somewhat improved. However, the main value of a green manure crop comes from the organic matter that is added to the soil.

Summary. — Low yields are due often to soil conditions. Soils that are in poor physical condition seldom produce good crops, because they do not liberate plant foods fast enough.

The physical condition of soil is improved by tillage, by addition of organic matter, by growing legumes, and by proper rotation of crops. Good physical condition of soils is favorable to chemical processes which make plant foods available. An acid soil is made neutral or sweet by the addition of lime, but lime should not be depended upon alone as an improver of soils. Organic matter should be added also. In attempting improvements of the soil, both the physical character and chemical nature of the soil should be kept in mind.

LABORATORY EXERCISES

1. Essay on Low Yields. — Write a two hundred word essay, giving the causes of the low yields of some particular field in your neighborhood.

2. To Test Soils for Acidity. — Have pupils bring several samples of soils. Soils from garden and fields are preferred. Test each soil for acidity as directed in a preceding paragraph. Test some soils from fields that have grown corn for several years. Write your findings.

3. Correcting Acidity in Soils by Adding Lime. — To a half pint of some acid soil add a tablespoonful of lime. Add water and mix the two thoroughly. Test for acidity just as you did in Exercise 2. Write your findings. How may soil acidity be corrected?

4. To Study the Relation of an Alkali Soil to Plant Growth. — In each of two gallon buckets or jars grow some plants. Probably some of the plants used in previous exercises may be employed for this exercise. Make a saturated solution of a quart of water and salt. Pour this on the soil in which one of the plants is growing. Repeat this for a few days; observe results. How do you account for the results? Record.

CHAPTER XXII

BARNYARD MANURE

Importance. — The value of farm manures has not been fully realized in the United States. Barnyard manures are the greatest means of maintaining the fertility of soils. The value of the manures produced annually in the United States is more than $2,000,000,000.[1] Compare this with the value of our three important crops:

GRAPH 10. The value of manure production compared with the value of important crops.

The value of manure is equal to the poultry, dairy, swine, and sheep products combined. We see how important it is, then, to guard against the losses which may come to this important source of plant food. (See Exercise 1.)

Factors Affecting the Value of Manure. — Aside from losses of manures due to exposure, which will be discussed in a later paragraph, most of the factors affecting the value of manures are:

1. Kind of feed.
2. Kind of animal.
3. Age of animal.
4. Kind and amount of litter used.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Manure water, secured by soaking manure in water for 24 hours or longer; two one-quart tin cans.

[1] Data for 1915.

It is evident that when feeds are fed that are low in food value, the manure produced will have a low fertilizing value. On the other hand, if feeds are fed that are highly nutritious, the manure produced will contain a high fertilizing value. To illustrate, if a steer is fed wheat straw alone, the manure voided has little value, but if good clover hay is fed, the manure voided has much greater value as a fertilizer. To bring out this point a little further, let us study the figures following taken from Henry and Morrison's *Feeds and Feeding*:

Fertility Value per Ton and Manurial Value of a Ton of Feeding Stuffs

Feed	Nitrogen Lb.	Phosphoric Acid Lb.	Potash in 2000 Lb.	Fertility Value	Manurial Value
Cottonseed meal, choice .	141.2	57.4	36.2	$29.63	$23.70
Wheat bran	51.2	59.0	32.4	13.49	10.79
Oat straw	11.6	4.2	30.0	3.78	3.02
Corn silage	6.8	3.2	8.8	1.81	1.45

The table shows the nitrogen, phosphoric acid, and the potash content in 2000 pounds of each feed. The fertility value is found by multiplying the number of pounds of nitrogen by 18; the number of pounds of phosphoric acid and potash each by 4¼ cents. Of course, the prices of the elements named vary, but are usually about 18 cents per pound for nitrogen and 4½ cents per pound for each of the other two named. The manurial value is based upon the general fact that 80 per cent of the fertilizing constituents of the feeds fed is recovered in the manure. The manurial value of a ton of cottonseed meal is $23.70, while the manurial value of a ton of corn silage is $1.42. From this it will be evident that the kind of feed fed greatly affects the value of the manurial product.

The second factor that affects the value of manure is the kind of animal from which the manure is derived.

Composition of One Ton of Average Manure from Farm Animals [1]

	Water Per Cent	Nitrogen Pounds	Phosphoric Acid	Potash Pounds	Value Dollars
Sheep manure	68	19	7	20	$4.74
Horse manure	78	14	5	11	3.30
Cow manure	86	12	3	9	2.74
Pig manure	87	10	7	8	2.52
Chicken manure	88	32	32	16	7.92

Sheep and horse manure have a smaller water content and a higher nitrogen and potash content than the other manures named. This is the reason for their higher value. Sheep and horse manures are known as "hot manures," because they have great capacity for fermentation. Poultry manure has the highest fertilizing value.

Again, the age of an animal influences the manurial value. Younger animals secure more of the food nutrients of a feed than do old animals. A young animal uses food for growth. An old animal simply uses food for maintenance. For this reason a young animal gets more food out of the feed. A young calf digests fully 50 per cent of the elements of its food, but an old cow digests less than 20 per cent of her food. It is for this reason that manure from older animals has more fertilizing material than that from young animals.

And finally the kind of litter used affects the value of manure.

[1] Henry and Morrison: *Feeds and Feeding.*

Such materials as sawdust and wood shavings, where used as litter, add little, if any, fertility to manures. Wheat and oat straw add a great deal to the value of manure, and where alfalfa and clover hay is mixed with the bedding, the manure is greatly enriched.

Amount of Manure from Different Animals and Its Value for a Year. — It has already been seen that the amount and value of manure depends upon the animal producing it. Swine eat about twice as much as does a horse and produce almost twice as much manure per one thousand pounds live weight. Poultry eat more than twice as much as cattle in proportion to the weight, and the manure voided is almost twice as great in value. The following table shows the amounts and values of manures produced by different farm animals:

AMOUNT OF MANURE PRODUCED PER ONE THOUSAND POUNDS LIVE WEIGHT

	Excrement per Year	Manure with Bedding per Year	Nitrogen per Year	Phosphoric Acid per Year	Potash per Year	Cost of Elements if Purchased in Commercial Fertilizers
	Tons	Tons	Lb.	Lb.	Lb.	
Horse . .	8.9	12.1	153	81	150	$33.72
Cow . . .	13.5	14.6	137	92	140	31.20
Sheep . .	6.2	9.6	175	88	133	36.84
Calf . . .	12.4	14.8	150	105	102	32.28
Pig . . .	15.3	18.0	331	158	130	64.48
Fowls . .	4.3	4.3	293	119	72	54.52

It is shown that a cow weighing one thousand pounds voids 13.5 tons of manure per year. This manure contains 137 pounds of nitrogen, 92 pounds of phosphoric acid, and 140 pounds of potash. The values of the manures are figured upon the basis of nitrogen being worth 16 cents per pound and the phosphoric acid and potash being worth 4 cents each per pound. Eckles states, " A dairy cow weighing 1000 pounds voids about 12 tons of solid and liquid manure in a year, worth, on the basis of the elements of fertility contained, about $30 in round figures."

Another method of figuring the value of manure is to multiply the additional number of bushels of crop produced by the current

Cornell Station.

20 tons manure 7420 lb. hay per acre — 10 tons manure 4350 lb. hay per acre — Nothing 2230 lb. hay per acre

FIG. 140. — Timothy hay responds to barnyard manure.

price per bushel of the article produced. That is to say, if a ton of manure will increase the corn yield one hundred pounds and corn is worth 74 cents per bushel or 1½ cents per pound, the value of the additional corn is $1.50. This may be considered the value of the manure for the first year. Of course the effects of manure upon the crops may be well seen for several years. Experiments have shown that for 10 years the average increase of crops produced by one ton of manure was valued at $3.44. If 50 cents per ton is allowed as a cost of applying the manure to the field, there still remains a handsome profit as a result of the application. (See Exercise 2.)

Relative Value of Liquid and Solid Manure. — The composition of the liquid and solid parts of manure is quite different. The liquid part contains much more nitrogen than does the solid part, and the solid part contains the greater part of the phosphoric acid, and a very small part of the potassium. The relative composition of the solid and liquid portions is as follows:

		Nitrogen	Phosphoric Acid	Potash	Value per Ton
		Per Cent	Per Cent	Per Cent	
Horse	Liquid manure	1.52	0.0	0.92	$7.00
	Solid manure	0.56	0.35	0.10	2.69
Cow	Liquid manure	1.05	0.0	1.36	5.56
	Solid manure	0.44	0.12	0.04	1.92

Liquid manure is worth about three times as much as solid manure. Although the liquid excrement is only about one-third as much as the solid portion, its fertilizing value is more than equal to that of the solid portion. The liquid manures are often lost. Such bedding as will absorb the liquid portion of the manure should be used. Straw and leaves are good absorbers and help especially to conserve the nitrogen which is so abundant in liquid measure.

Losses of Manures. — The direct losses of manures are caused by leaching and by fermentation. Liquid manures naturally leach away unless absorbed by straw and litter applied to bedding. Often barns are built in such a place that the liquid portion of the manure drains away. If the liquid manure is lost, it is estimated that about half of the fertilizing elements are lost. Again, farmers often throw the manure out of the stables and allow it to lie for some time under the eaves of a building. This is just like taking paper money out of a bank and throwing it out to the rains and the winds. This is illustrated by the following results of an experiment extending over five months, from April to September, to show losses from leaching :[1]

	Value of Manure at Beginning	Loss	Loss
	Per Ton	Per Ton	Per Cent
Horse manure	$2.80	$1.74	62
Cow manure	2.29	.69	30

From this experiment it is evident that manures lose much in a short period when exposed to rains and the weather. A ton

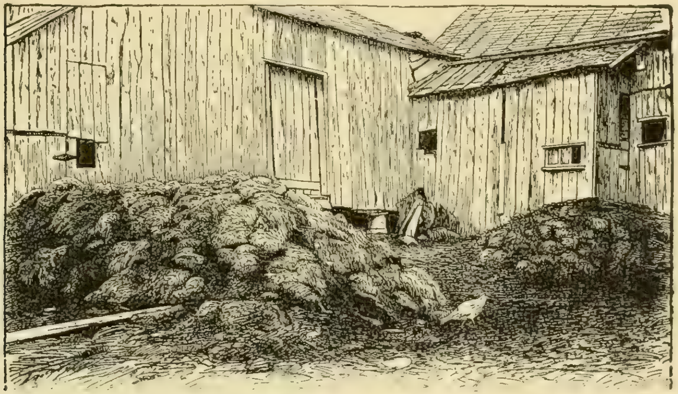


FIG. 141. — Manure exposed under the eaves where it loses 30 to 60 per cent of its value.

of horse manure exposed for five months lost $1.74 worth of its fertility, and a ton of cow manure lost 69 cents' worth of its fertility. The loss from twenty tons of manure so exposed is greater than the average profits produced under average condi-

[1] Data from Cornell University, 1890.

tions in the United States, from an acre of corn. Every farmer should save the losses of manures from leaching.

FIG. 142. — An expensive way to apply manure. Thrown in piles and then spread.

The other cause for losses in manures is fermentation. Piled manures, or even manures left in a stable, become hot and ferment. The odor about horse stables is due to the fact that fermentations are going on; the gas which we smell is ammonia. This ammonia contains the element nitrogen, and indicates that the manure is losing this valuable fertilizing constituent. It has been proved by experimentation that from 30 to 60 per cent of the nitrogen in a manure may be lost by fermentation. When a manure becomes hot because of processes of fermentation, its value is rapidly decreased. (See Exercise 3.)

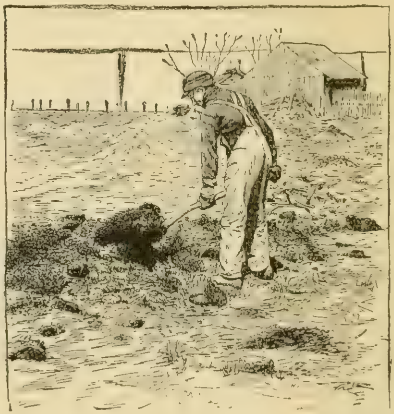


FIG. 143. — An expensive way of applying manure. This manure was pitched out of the barn on to a pile, pitched from the pile on to a wagon, pitched from a wagon to the ground, and pitched around in the field to spread it — handled four times.

Care of Manure. — To get the best results out of manure it should be scattered over the land as soon as produced. It should not be heaped in piles, and later scattered, but should be spread evenly over the soil when it is applied. Piling manures is an expensive way of applying them for two reasons:

1. It means an additional handling of the manure.

2. Its losses from leaching and fermentation are greater where manure is piled.

Spreading manure directly by hand or with a manure spreader is the most economical method of handling it. Often, however, conditions are such that manure cannot be hauled directly into the field or pasture on account of growing crops, soils being too wet, demands on labor, or weather conditions. It is for these reasons that every farmer should provide some protection for the manure. Sheds with a concrete floor and concrete walls three or four feet high, and well covered, aid greatly in keeping the fertility contained in manure. Manures stored in sheds should be kept moist and compact. A compact, moist heap of manure prevents hot fermentations. The heating of manures is due to bacteria which require oxygen for their existence. Manure properly cared for is an important financial asset to the farmer, as well as to all consumers of food and food products.

FIG. 144. — Spreading manure directly from the wagon, a better method than that shown by Figs. 142 and 143.

FIG. 145. — Spreading manure with a manure spreader. This manure was pitched from the stable to the spreader — handled once only.

Summary. — The value of manure is not properly appreciated by the people of the United States. Its value is more than that derived from the corn crop. The value of the manure voided by animals weighing one thousand pounds is about $30 per year. Generally speaking the liquid excrement is equal in value to the solid excrement. The most economical method of handling manure is to distribute it evenly over the land as soon as it is produced. The manure spreader is an indispensable implement on farms where a good deal of stock is kept. If manures cannot be spread immediately after production, they should be stored in water-tight sheds, and kept compact and moist, in order to protect them from losses due to leaching and fermentations.

LABORATORY EXERCISES

1. To Approximate the Value of Manure Produced on Several Farms. — Have pupils estimate the number of tons of manure produced on some farm. The manure contains about fourteen pounds of nitrogen, six pounds of phosphoric acid, and twelve pounds of potash per ton. The prices of the three elements as fertilizers may be had from the agricultural chemist of your agricultural college. For the purpose of this exercise you may allow nitrogen to be worth 18 cents a pound, and phosphoric acid and potash each to be worth $4\frac{1}{2}$ cents a pound.

2. To Figure the Amount and Value of Manure Produced by the Animals on Your Home Farm. — (If you have no animals, figure the amount and value of the manure produced by twenty cows and four horses, supposing that each animal weighs one thousand pounds.) Fill an outline as follows and incorporate it into your notebook.

Amount and Value of Manure Produced

Kind of Animal and No.	No. of Tons Produced per Year	Value per Ton	Value of Manure

3. To Show that Soils Absorb the Elements of Manures when they are Scattered over the Soil. — Let manure soak in water for about twenty-four hours. A quart cup of water with a small amount of manure will provide the manure water desired. Make holes in another quart can, and fill it almost full with soil. Now take some of the manure water, and pour it on the soil, and let it percolate through the soil. Catch some of the water percolating through in a glass tumbler. Compare the color of the water that passes through the soil with the manure water. Write your findings. What conclusions from the experiment may you draw regarding the absorbent power of soil? What is your opinion regarding the check on leaching of manure when the manure is spread over the land?

CHAPTER XXIII

COMMERCIAL FERTILIZERS

Need for Fertilizers. — All soils are not equally supplied with the elements of plant growth in the proportion which will produce crops to the best advantage. We studied in preceding chapters that the chemical make-up of soils depends upon their source of formation. Soils having a foundation of sandstone are different from soils built upon limestone mixed with some organic matter and from soils made almost wholly from vegetable matter, such as peaty soils. To quote the table again, we have:

Amount of Plant Food per Surface Foot

Kind of Soil	Nitrogen, Lb. per Acre	Phosphorus, Lb. per Acre	Potash, Lb. per Acre
Peat	11,865	550	1,697
Sand	1,675	620	39,750
Clay	3,250	5,600	12,600

A peaty soil generally contains nitrogen, but is usually deficient in phosphorus and potash. Sandy soils generally need nitrogen and phosphorus, and clay soils need nitrogen, phosphorus, and potash.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Samples of commercial fertilizers secured from a local dealer, from the packing houses or fertilizer dealers; six one-gallon jars or buckets; blue and red litmus paper.

Stock and vegetable products are constantly being shipped to the cities, and the amount of fertility thus removed from the farm must be replaced by fertilizers.

FERTILIZING CONSTITUENTS IN TWO THOUSAND POUNDS

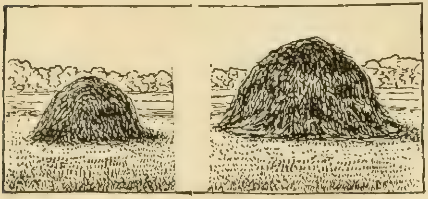
	NITROGEN, REMOVED	PHOSPHORIC ACID, REMOVED	POTASH, REMOVED
	Pounds	Pounds	Pounds
Dent corn	32.4	13.8	8.0
Wheat	39.6	17.2	10.6
Oats	39.6	16.2	10.2
Fat ox	46.6	31.0	11.2
Fat pig	35.4	13.0	2.8
Milk	11.6	3.8	3.4

For this reason we go to the packing houses for the by-products obtainable from otherwise waste products of the slaughter of animals and turn them back to the soil, and so maintain the soil fertility. Mines and factories also supply the three essential chemicals for plant growth, — nitrogen, phosphorus, and potash.

Present Use of Fertilizers in the United States. — It has been found that 28.7 per cent of all the farms of the United States purchased commercial fertilizers.[1] The expenditure per farm was $63. The New England States, the Middle Atlantic, and the Southern States are the heaviest purchasers of fertilizers. However, much commercial fertilizer is being used in the North Central States, and there seems to be an increasing demand for its use. The amounts expended in 1899 and 1909 were $53,430,000 and $114,882,000, respectively. The amount expended in the North and South Central States for commercial fertilizers in 1909 was $12,369,000. At the present time its use is still greater.

[1] Census Report, 1910.

Kind of Commercial Fertilizers. — There are three elements from which fertilizers are named. These elements are nitrogen, phosphorus, and potash; and we have nitrogenous, phosphatic, and potassium fertilizers. Usually each fertilizer contains all three elements mentioned. The source and composition of different kinds will be briefly discussed. (See Exercise 1.)



No nitrogen. Nitrogen added.

FIG. 146. — The effect of top dressing grass with sodium nitrate.

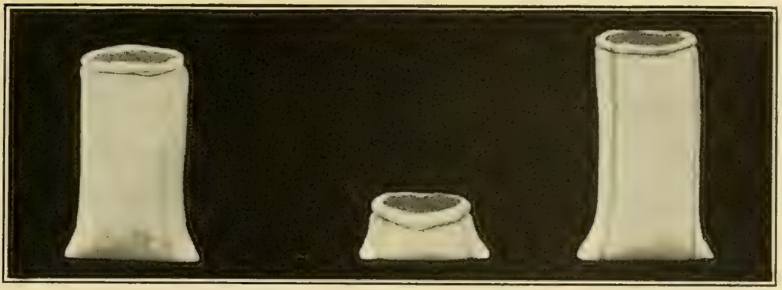
Nitrogenous Fertilizers. — Besides the nitrogen added to the soil by leguminous crops and barnyard manures, there are two sources from which the nitrogenous fertilizers are supplied, — the slaughter houses and mines. The slaughter houses provide dried blood, tankage, and bone meal. These have about the following fertilizing constituents in them per ton:

	NITROGEN	PHOSPHORUS	POTASH
	Pounds	Pounds	Pounds
Dried blood	260–280	10–20	
Tankage	80–240	30–120	
Steamed bone meal . .	20–30	560–600	

Since these fertilizers contain much nitrogen, they are expensive. Sodium nitrate, or Chili saltpeter, which contains nitrogen, is mined in Chili and Peru. It contains from 15 to 16 per cent of nitrogen. As it is very soluble, it should be applied only where it will be used immediately by plants.

Phosphate Fertilizers. — The phosphate fertilizers are derived from dissolved phosphate rock, bone meal, and tankage. In some parts of the United States there are natural deposits of rocks that contain phosphates, in combination with lime. These rocks are ground and treated with sulphuric acid, which unites with the lime and makes the unsoluble phosphorus soluble, a form in which it is available to plants. The product is called acid phosphate; and contains about 15 to 20 per cent of soluble phosphorus.

Bone meals contain both nitrogen and phosphorus. They are sold either as raw bone meal or steamed bone. Raw bone meal is freshly ground bone. The ground bone is then steamed.



Courtesy of the Agricultural Extension Department. Purdue University.

21.3 bu. per acre. Dried blood, 60 lb. per acre. Acid phosphate, 200 lb. per acre.

4.2 bu. per acre. Not fertilized.

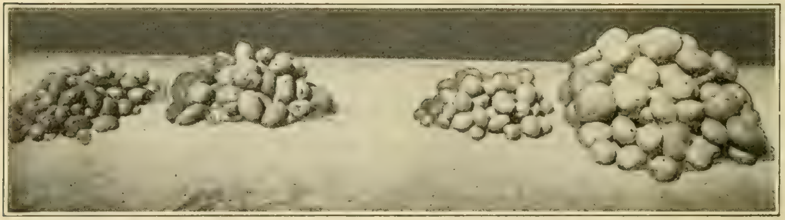
22.6 bu. per acre. Acid phosphate, 200 lb. per acre. Muriate of potash, 30 lb. per acre.

FIG. 147. — Effect of fertilizers on wheat.

The steaming removes some of the nitrogen and fat from the bone. It contains about 1 per cent of nitrogen and 11 per cent of phosphorus.

Potassium Fertilizers. — The four forms of potassium fertilizers most commonly used are potassium chloride, potassium sulphate, kainite, and wood ashes. Kainite is a potassium fertilizer mined in Stassfurt, Germany, and is used in the manufacture of most of the potassium fertilizers. The supply of kainite at these mines is said to be inexhaustible. Potassium chloride is a manufactured product, and contains about 45 to 50 per cent of potassium. Potassium sulphate is made from kainite, and contains about 45 per cent of potassium. This form of potassium fertilizer is used for fertilizing potatoes. Wood ashes contain from 2 to 8 per cent of potash, which is very soluble and leaches away easily. Wood ashes make a valuable fertilizer and should be carefully saved. (See Exercise 2.)

Value of Commercial Fertilizers. — The value of a fertilizer depends upon its nitrogen or ammonia, phosphorus, and available



Courtesy National Fertilizer Association, Chicago.

FIG. 148. — Analysis of potato crop on farm near Tripoli, Wis.

Unfertilized acre yield = 390 bu. analyzing 330 bu. marketable, 60 bu. unmarketable.
Fertilized acre yield = 470 bu. analyzing 432 bu. marketable, 38 bu. unmarketable.

potash content. All other materials in a fertilizer are worth little or nothing and are known as "filler." In order to mislead purchasers of fertilizers, meaningless statements are put on fertilizer bags. The following is such an illustration:

GUARANTEED ANALYSIS (FOUND ON BAGS)	PER CENT
Nitrogen	.82 to 1
Equivalent to ammonia	1 to 2
Available phosphoric acid	8 to 10
Equivalent to available bone phosphate	18 to 22
Total phosphoric acid	9 to 12
Equivalent to bone phosphate	25 to 30
Potash actual	2 to 3
Equivalent to sulphate of potash	3.5 to 5

All of the above and more statements may be found on bags containing fertilizers. When the above is reduced to its correct form, it reads as follows:

	Per Cent
Nitrogen	0.82
Available phosphorous acid	8
Available potash	2

There should be a Federal law compelling fertilizer companies to label bags of fertilizers correctly, and without adding a lot of meaningless terms and statements, simply printed on sacks to mislead the purchaser.

Price of Commercial Fertilizers.— The price of fertilizers is based upon the nitrogen, phosphorus, and potash contained in them. The prices of these elements vary in different sections of the country, and change just as the price of any other commodity changes. Generally the price of nitrogen ranges from 15 to 20 cents per pound, and the prices of phosphorus and potassium range from $4\frac{1}{2}$ to 6 cents per pound each. To figure the real money value of a commercial fertilizer, multiply the number of pounds of nitrogen by 18 and the number of pounds of available phosphorus and potash, each by

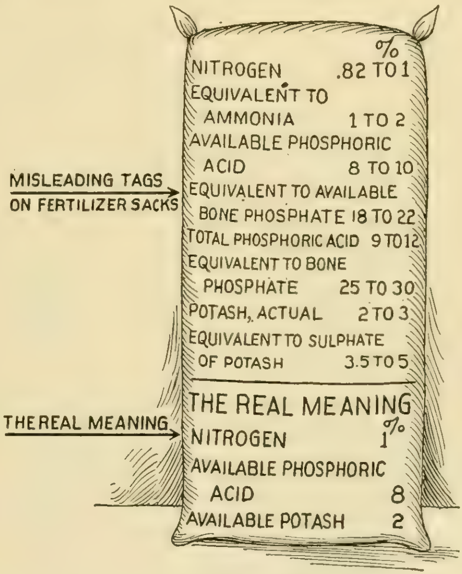


Fig. 149.

5, and add the results. The result will be the approximate value of the fertilizer. For example: A ton of the above fertilizer, which contains 0.82 per cent nitrogen, 8 per cent available phosphorus, and 2 per cent available potash, will contain 16.4 pounds of nitrogen, 160 pounds of phosphorus, and 40 pounds of potash. Then to find the value of each we have:

20 × 16.4 =	$ 3.28	value of nitrogen
160 × 5 =	8.00	value of phosphorus
40 × 5 =	2.00	value of potash
Total	$13.28	

Such fertilizer is worth about $13.28 per ton. It is, of course, quite likely that we should allow some additional cost for freight. The price of any fertilizer may be figured in a similar manner. For the current prices of the elements in fertilizers write your state agricultural college. (See Exercise 3.)

How to Determine What Fertilizer to Use. — There is no very definite way of determining what fertilizer to use, because kinds of soils, seasons, and different varieties of plants have different requirements. The information that one gains from the production of each crop should help in the successful production of the next. Information should be asked from the Agricultural Experiment Station and from the state agricultural experts. It has been suggested by some authorities that field plot studies be made. This undoubtedly is the best method of determining approximately what elements to use. But even if the same fertilizer and the same crop are grown, the function of the fertilizer will be affected to a considerable extent by the season. If experiments are tried out with fertilizer, plots 1 rod wide and 8 rods long may be used. Such plots contain one-twentieth of an acre. The experiment may be carried out as follows:

No fertilizer
15 lb. of nitrogen fertilizer
15 lb. of nitrogen fertilizer 15 lb. of phosphoric acid
15 lb. nitrogen fertilizer 15 lb. phosphoric acid 15 lb. potash
No fertilizer
15 lb. phosphoric fertilizer
15 lb. phosphorus 15 lb. potash
15 lb. of potash
150 lb. of lime

If plants are planted across the plots, much can be discovered in one or two seasons about the value of commercial fertilizers in the growth of various crops.

In general it may be said that nitrogen promotes leafiness, phosphorus acid and potash help in seed formation. Leguminous crops generally respond to phosphoric acid, potash, and lime. Potatoes need an abundance of potassium. Oats, wheat, rye, and corn generally need all the elements of a commercial fertilizer.

Another important point to consider in the use of commercial fertilizers is the kind of farming practiced. In trucking, when the value of the crop is $100 to $150 per acre, it may be economic to use $10 worth of fertilizer, but the same amount of fertilizer on an acre of timothy would usually result in loss.

"It does not pay to put commercial fertilizer on poor land. Such land usually needs humus, and must be treated before it will pay to use fertilizers. About forty farmers in New York have reported trials of nitrate of soda for the production of timothy hay. In very few cases has it paid if the field did not yield at least 1¼ tons when untreated, and in very few cases did it fail to pay when the unfertilized area yielded over 1¼ tons. It seems to be very nearly as easy to double a yield of 1½ tons, as to double a yield of one-half ton. In the former case the gain will be three times as much as the latter."[1]

Home Mixing of Fertilizer.— After it has been determined what elements are needed, fertilizers can be easily mixed in the proper proportions by the farmer. For just as the ingredients of a chicken feed are raised in price when mixed, so are also the elements that go to make a fertilizer raised when mixed by the manufacturer. Oats, corn, and wheat, when mixed, often sell for 3 to 4 cents a pound, when neither of them is selling for more than 1½ cents a pound when sold alone. Home mixing also has the advantage of enabling the farmer to know what elements are in the fertilizer. By knowing this he can more nearly meet the requirements of the crop and soil conditions. Home mixing of the elements of commercial fertilizers is recommended as being good farm practice.

Commercial Fertilizers Not All-sufficient. — To use commercial fertilizers exclusively without using barnyard manures, green manure crops, and a legume to supply nitrogen to the soil, is bad farm practice. To use commercial fertilizers continuously without adding organic matter, results in breaking down the physical condition of the soil. Commercial fertilizers

[1] Warren: *Elements of Agriculture.*

add very little humus to the soil, except the part added by the "filler" in the fertilizer, and that is very little, and of poor character.

And again, if 200 pounds of the commercial fertilizer above discussed, containing nitrogen 0.8 per cent, available phosphoric acid 8 per cent, and available potash 2 per cent, were added to an acre, only 1.6 pounds of nitrogen, 16 pounds of phosphoric acid, and 4 pounds of potash would be added to the acre. If the surface foot of an acre of clay contains 3250 pounds of nitrogen, 5660 pounds of phosphorus, and 12,600 pounds of potash, then the addition of 200 pounds of the above fertilizer to an acre of clay soil contains such a small percentage of the essential ingredients to that already in the soil that it is a negligible amount. It is for this reason that we must turn to other farm practices than the use of commercial fertilizers, if permanency of our agriculture is to be maintained.

The use of commercial fertilizers should be supplemented with all other means of farm practice that will maintain and build up the fertility of the soil. Vivian[1] says, "Notwithstanding the fact that commercial fertilizers have an important place in rural economics, they should not be used to do the work that can be better accomplished by properly husbanding the home resources."

Summary. — There are soil conditions where the use of commercial fertilizers will prove economic. The three essentials of a commercial fertilizer are nitrogen, phosphorus, and potash, upon which the value and price of commercial fertilizers is based. The nitrogenous fertilizers are furnished by the packing houses, in the form of dried blood, bone meal, and tankage. Nitrate of soda is mined in Peru and Chili. Nitrogen is worth about 20 cents per pound in fertilizers. Phosphoric fertilizers come from rocks, treated with sulphuric acid, and bone meal. Potash comes

[1] *First Principles of Soil Fertility.*

mainly from Stassfurt, Germany. Phosphorus and potash are worth about 5 cents per pound. Commercial fertilizers should be supplemented by manures and good farm practices. (See Exercise 4.)

LABORATORY EXERCISES

1. To Study Commercial Fertilizers. — Secure as many samples of commercial fertilizers as possible from a local dealer or elsewhere. Study these fertilizers (1) as to composition and (2) as to their source, and (3) as to their color, texture, and odor.

2. To Study the Effect of Commercial Fertilizers upon Plant Growth. — Fill six one-gallon jars or buckets with black loam. To each one add 8 grams of the following. To one add a nitrogen fertilizer, containing about 2 to 3 per cent nitrogen; to another add a fertilizer containing about 8 per cent available phosphoric acid; to a third add a potassium fertilizer containing about 3 per cent available phosphorus; to the fourth jar add 8 grams of lime; to the fifth add 4 grams each of the above ingredients, and to the sixth add nothing. Plant eight to ten grains of wheat in each. Maintain conditions for growth for ten or twelve weeks. Record results.

3. To Figure the Value of Commercial Fertilizers. — From the guaranteed analysis of three or four commercial fertilizers, figure their value, assuming that nitrogen, available phosphoric acid, and available potash are worth 20 cents, 6 cents, and 6 cents, respectively.

Note. — No hasty conclusions should be drawn from this experiment. Fairly accurate conclusions can only be made when an experiment is continued over several years and crops are grown to maturity under field conditions.

4. To Test Commercial Fertilizers for Acidity and Alkalinity. — Test about six samples of commercial fertilizers for acidity and alkalinity with litmus paper. Record results as follows:

Kind of Fertilizer	Alkali or Acid

Note. — If blue litmus paper turns red, it shows acidity. If red litmus paper turns blue, it shows alkalinity.

CHAPTER XXIV

PLANT PROPAGATION

Plant Propagation by Seeds. — *Formation and Distribution of Seeds.* Plants are multiplied most frequently by seeds. A corn kernel may reproduce a thousand fold annually, a wheat kernel a hundred fold, a pigweed seed two hundred thousand fold, and

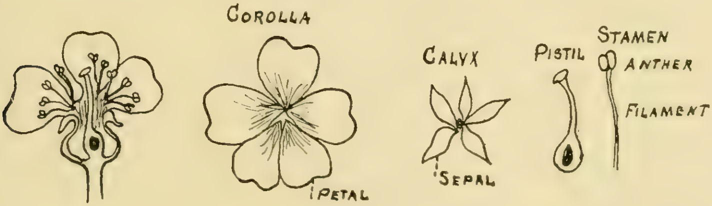


FIG. 150. — Parts of a flower.

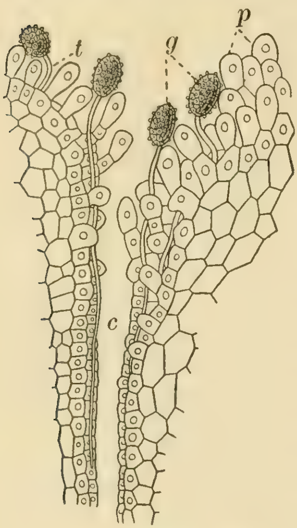
an apple tree may grow millions of seeds annually. Seeds are nature's most universal way of propagating higher forms of plant life.

Flowers are essential to seed development. Before a seed can begin to grow there must be a flower. A *perfect flower* has four parts: the calyx, the corolla, the stamens, and the pistil. The stamens and the pistil are the organs of reproduction. The

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Apple, pear, or cherry flowers; seeds which have special devices to aid their dissemination; a propagating box; one-half pound of tallow; one pound of beeswax; two and one-half pounds of rosin.

stamens are the male organs of the flower, and the pistil is the female organ. The stamens produce the pollen. When the pollen falls upon the top part of the pistil, the flower is said to be pollinated. If proper conditions for growth are present, the pollen grain begins to grow and to develop a pollen tube. This pollen tube grows down the hollow opening in the pistil to the ovary. As soon as the pollen tube penetrates the ovary of the flower, the flower is said to be fertilized. Seeds do not form until the ovary is fertilized. Extremely wet, rainy weather, and very hot, dry weather, hinder the processes of pollination and fertilization. When corn tassels dry up, the pollen grains lose their power, fertilization does not take place, and the plant produces barren ears.



Courtesy of Ginn & Co.

FIG. 151.—Pollen grains producing tubes, on stigma of a lily. (Much magnified.)

g, pollen grains; *t*, pollen tubes; *p*, papillæ of stigma; *c*, canal or passage running toward ovary.

Imperfect flowers are flowers that have only one of the organs which make a perfect flower. In imperfect flowers, either the stamens or pistils are absent. Some varieties of strawberries, cucumbers, and muskmelons bear imperfect flowers. Imperfect flowers cannot reproduce until they are fertilized by the pollen from some other flower. Occasionally when strawberries bloom but do not fruit, the flowers are imperfect. The gardener should plant by the side of barren plants a variety which contains both stamens and pistils. (See Exercise 1.)

After seeds are matured they are scattered by nature's methods, wind, water, animals, birds, and man.[1] Every plant must have room to grow, and it is for this reason that seeds must be widely disseminated. This is nature's way. Seeds fall upon places not conducive to their growth, but man provides a well-prepared seed bed in which seeds can grow. In nature only the most fit survive; but man often perpetuates both weak and strong seeds alike. (See Exercise 2.)

Three Essential Conditions for Seed Germination. Before seeds will grow, there are three factors which must prevail. These three factors are proper moisture, proper temperature, and free air (oxygen).

1. The seeds of the water lily will grow in the presence of free water, but corn will not germinate in water. It will sprout best in a soil having about 20 to 25 per cent of moisture. Other seeds will germinate in semi-arid regions. The amount of moisture may be controlled to a considerable extent by tillage and drainage.

2. Each kind of seed has a minimum, a maximum, and an optimum temperature at which it will germinate. The following table shows approximately the minimum, the maximum, and the optimum at which various seeds will germinate:

TABLE SHOWING TEMPERATURE AT WHICH SEEDS GERMINATE

SEED	MINIMUM	OPTIMUM	MAXIMUM
Corn	41–51° Fahr.	99–111° Fahr.	111–122° Fahr.
Wheat . . .	32–41 Fahr.	77–88 Fahr.	88–108 Fahr.
Oats	32–41 Fahr.	77–88 Fahr.	88–99 Fahr.
Beans . . .	41– Fahr.	77–99 Fahr.	88–99 Fahr.
Melon . . .	60–65 Fahr.	88–99 Fahr.	111–122 Fahr.
Red clover . .	88–99 Fahr.	99–111 Fahr.	111–122 Fahr.

[1] **Note to the Teacher**: The appendages that seeds have which facilitate them in their distribution may also be studied at this point.

Some seeds will germinate at temperature just above freezing; others require warm summer conditions for their best growth. Soil temperature may be controlled to some extent by tillage, by drainage, by turning under vegetable matter, and by choosing the right season.

3. There must be air present if seeds are to germinate. Seeds germinating in the water get air needed for their germination from the water, and seeds growing in the soil get soil air needed for their growth. Tillage opens the soil and aids air circulation. (See Exercise 3.)

Preparatory Treatments Aiding Seed Germination. 1. We may aid some seeds in the germination process. Seeds to be planted in dry or sandy soils will germinate more rapidly if they have been soaked for twelve or eighteen hours. Seeds which have a heavy tough seed coat, such as beans and peas, tomatoes, turnip and melon seeds, may be profitably soaked.

2. Some seeds may be softened by pouring boiling water over them in cool air; for example, clover seed, alfalfa seed, and black locust seeds. Seeds that are two or three years old do not need such treatment because the air oxidizes the seed coat.

3. Freezing will help to split the seed coats and thus prepares seeds for germination. Nuts, acorns, apple, pear, and cherry seeds, may be prepared in this way. The above-named seeds are often placed in a box of cinders or sand and exposed to the moisture and frosts of the winter season. This is called stratification. The coats are split open and the young plantlets make their appearance in early spring. Walnuts often do not grow until the second summer. This is largely due to a mild winter. The seed coats remain unbroken, and the young plant is unable to penetrate the covering.

4. Mechanical treatment may be occasionally employed as a

process preparatory to seed germination. Cracking, filing, or boring a hole in nuts shortens the germination period.

Plants Propagated on Their Own Roots. — Many plants and practically all vines can be multiplied by layerage. This means

FIG. 152. — By compound layering several new plants are produced from the same shoot.

partially covering the decumbent shoots and runners with earth, under which new roots form. In a year, good plants may be thus secured. Dewberries, raspberries, and grapes are readily propagated by layers.

Methods of Layering. 1. In *simple layering*, one new plant is grown from each shoot.

2. In *compound layering*, several new plants are produced from the same shoot. (Fig. 152.)

FIG. 153. — Mound-layering of gooseberry.

3. *Mound layering* is practiced in the propagation of shrubs, gooseberries, and currants. The earth is mounded up about the plant in May or June. (Fig. 153.)

4. In the *Chinese system* of layering, a layering pot is tied around a limb, and filled with earth or moss, which is kept wet. The limb is bruised where it is to grow roots. (Fig. 154.)

FIG. 154. — Chinese system of layering.

In all systems of layering, soft shoots a year old are best suited for propagation purposes. (See Exercise 4.)

5. White clover plants, strawberries, and some grasses increase by *runners*. A single strawberry plant may in one season multiply a hundred fold by runners. (Fig. 155.)

Plant Propagation by Cuttings. — Plants may be propagated by four kinds of cuttings: tuber cuttings, root cuttings, hard and soft wood cuttings, and by leaf cuttings.

Tuber Cuttings. Tubers are thickened portions of roots or underground stems. Irish potatoes are stem tubers, because, like stems, they have buds. The fleshy part of the Irish potato contains much water and some starch, which furnishes food to the bud. Irish potatoes are cut so that each cutting has an eye or bud, but sweet potatoes will grow new plants from any part of the epidermal covering.

Root Cuttings. Blackberries and red raspberries may be propagated by root cuttings. Roots cut from 2 to 3 inches long are placed in a propagating medium; and if the conditions for growth are maintained, they will in due time produce plants.

Hard and Soft Wood Cuttings. Any shrub or vine can be propagated by cuttings, but grapes, currants, and shrubs used for ornamental purposes are especially adaptable to this type of propagation. Hardwood and softwood cuttings are similar. Hardwood cuttings are those made from perennial plants; softwood cuttings are made from soft-stemmed plants. Hardwood

FIG. 155. — Branch of white clover, showing the method of forming new plants.

cuttings should be made in the early winter, before there has been a hard frost; softwood cuttings may be made at any time. One illustration of each of the hardwood and softwood cuttings will be given. Grapes are given as an illustration of hardwood cuttings.

Grapes are almost always propagated in the nurseries by cuttings. Current year's growth is cut in lengths of from 8 to 14 inches, and tied in bundles of 50 cuttings each. They may be made in November and stored in a cool cellar (about 40° Fahr.) for the winter, covered with sand or sawdust. They should be planted in the nursery plot about the first of April. The ground upon which cuttings are to grow should be deeply plowed the preceding fall and be fairly fertile. In these nursery rows, which should be about 3 feet and 6 inches apart, the cuttings may grow for one or two years when they should be transplanted into the permanent vineyard. They should be planted leaning toward the south, with two buds beneath the ground and one above. When they are properly cared for, 95 per cent of them will grow. The vineyard rows should be about 8 feet apart, and the vines about 6 feet apart in the rows.

FIG. 156. — Grape cutting.

Softwood cuttings are made from geranium, chrysanthemum, carnation, fuchsia, coleus, begonia, and similar plants. Propagating softwood cuttings is carried on in greenhouses, and under glass. For softwood cuttings neither too hard nor too soft wood should be used. Wood that is hard does not develop roots easily, and wood that is soft has not sufficient substance for the development of roots. Softwood cuttings grown in greenhouses during the winter may be transplanted in the spring.

FIG. 157. — One style of chrysanthemum cutting.

Technique of Cuttings. Cuttings should be cut on a slant, just beneath a bud or leaf. The reasons for this are:

1. More surface is exposed.

2. There is supposed to be more food at the nodes than at the internodes.

3. Roots will grow at the nodes more readily.

Plant cuttings with one or two buds above the ground and several below, as illustrated in the above figures.

One leaf should be left on the cutting for the following reasons:

1. It reduces transpiration.

2. It encourages circulation of plant foods.

3. The green part of the leaf aids in the manufacture of plant foods.

Leaf Cuttings. Some plants may be propagated by leaf cuttings, the Rex begonia, the Bryophyllum, and the Gloxinia. These plants have leaves which contain large quantities of plant foods, either in the body of the leaf, or in the ribs of the leaf, upon which the leaves draw until roots are developed. The leaf is able to manufacture plant food itself from the chlorophyll which it contains. When whole leaves are planted, the entire leaf stem and a part of *the leaf* is buried in the sand. Occasionally the leaves are laid flat, right side up, and partly covered with sand. Cutting or bruising the veins of the leaf aids in the development of roots.

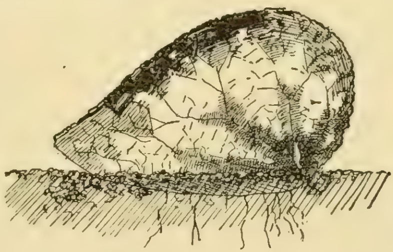


FIG. 158. — An upright begonia leaf cutting.

Medium for Propagating Cuttings. A good medium for propagating cuttings is a coarse, sharp sand, for the following reasons:

1. It permits free air circulation.

2. It permits free water circulation, and may easily be kept moist, yet does not become water-logged.

3. Its temperature can be kept fairly even, if kept away from the direct sunlight.

4. It is generally free from organic matter, which by decaying produces bacterial and fungous diseases. (See Exercise 5.)

Plant Propagation by Graftage. — *Reasons for Graftage.* Grafted plants produce fruit like that of the parent plant, and seedlings produce fruit smaller than the parent plant. Seeds are often the result of two parents, and therefore not true to type. A hundred seeds from the same tree may produce as many different varieties, but a hundred grafts from the same tree will produce the same kind of fruit. Plants may be changed in size by graftage. Grafting on plants that have smaller root systems dwarfs the plant, but grafting on vigorous root systems increases the plant's size. If pears are grafted on quince roots, the result is a dwarfed plant. Also, conversely, if the quince is grafted on the pear, the resulting plant is larger than the quince.

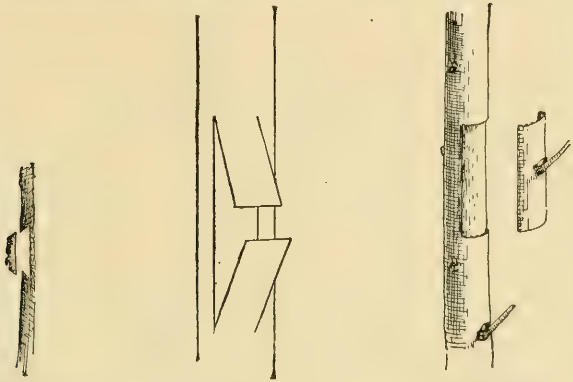
Grafting may be used to adapt plants to adverse soils. Plums thrive best in moist soils; peaches do best in fairly dry, porous soils. These plants may be budded one upon the other, and thus the plant may be made to grow in an otherwise adverse soil.

Grafting is sometimes used to make barren plants fruitful. Fruit trees may be top grafted, and thus the stock which has a good root system may be used to advantage. A barren tree may thus be made fruitful.

Propagations by Bud Graftage. Bailey[1] says: "Budding is the operation of applying a single bud bearing little or no wood, to the surface of the growing wood of the stock. The bud is applied directly to the cambium layer of the stock." Budding is employed especially with young plants where the stock is one or two years old. The limbs from which the buds are to be used, are taken from the current year's growth. Budding may

[1] *Nursery Book.*

be done about June, or as soon as the bark slips or peels easily. A T-shaped incision is made in the stock about 2 or 3 inches above the surface of the ground. The bud is cut and inserted into the incision, and tied with a soft string or raffia. After ten



Chip budding. H-budding. Flute budding.

FIG. 159. — Three kinds of budding.

or fourteen days it should be examined. If it is living, it will be green and show signs of growth. The string may then be cut. The following spring the main trunk of the stock should be cut off about one-third or one-half of an inch above the growing bud, which will then grow rapidly, for all the growing energy of the plant will be forced into it. In one year the plants may be transplanted into the permanent orchard.

There are several methods of budding. The shield, plate, chip, and tubular methods are the ones most commonly employed. (Fig. 159.)

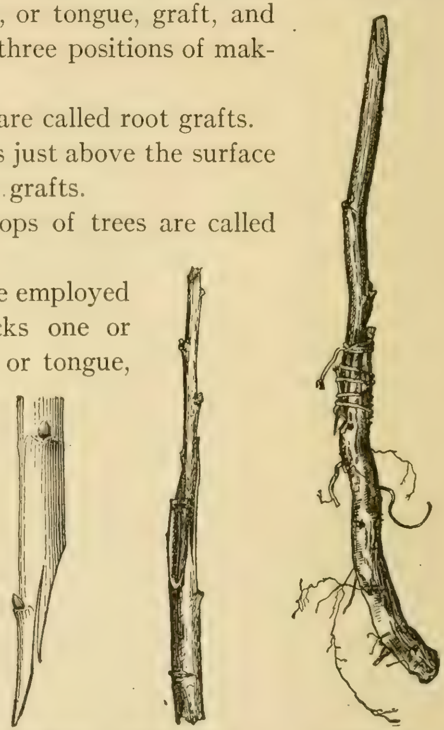
All the methods of budding are based upon the same general principle, namely, that the cambium layer of the bark of the scion must fit and meet the cambium layer of the stock. It is through the cambium layer that the plant foods of the scion are carried to the stock. This is an important principle to observe in all grafting and budding work. From one thousand to two thousand buds can be set by an expert budder in a day.

Methods of Scion Grafting. There are essentially two methods of scion graftage; the whip, or tongue, graft, and the cleft graft. There are three positions of making grafts:

1. Grafts made on roots are called root grafts.
2. Grafts made on stocks just above the surface of the soil are called crown grafts.
3. Grafts made in the tops of trees are called top grafts.

Root and crown grafts are employed in grafting scions on stocks one or two years old. The whip, or tongue, method is generally employed in root and crown grafts. Top grafting is used in grafting scions upon tops of old trees. The cleft graft is used almost wholly in top grafting.

Whip Grafting. Stocks of one year's growth are used in whip grafting. Seeds are planted in rows four feet apart in early spring, cultivated during the summer, dug up after the leaves have fallen off, and stored in convenient bundles in a cool cellar.



Cion of whip graft. Whip graft in position. Root graft.

FIG. 160.

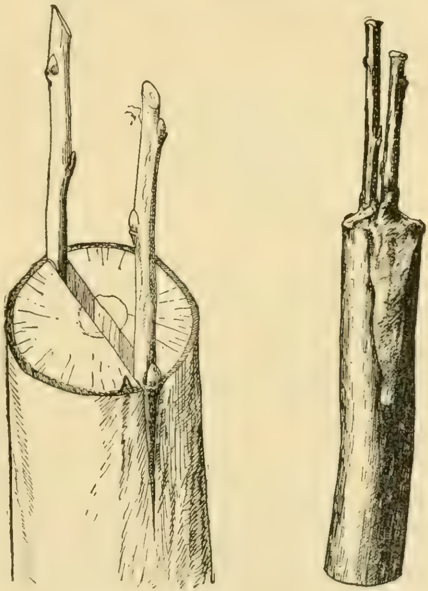
The desired variety of scions is also cut in late fall and stored in bundles of fifty or one hundred each, in places similar to those used in storing the stock. Grafting may be done in January or February. This is a convenient time for making grafts for two reasons:

1. The stock and scion become somewhat calloused during the winter.

2. January and February are not busy months.

It will be observed that Figure 160 shows a root graft. Crown grafts are made in the same way except that the stocks are not cut so close, and the graft meets at a point on the stock just at the base of the trunk.

Relative to root grafting, Professor Howard says, "Owing to cheapness as well as ease in handling, I prefer scions six or seven inches long, and a section of root about three inches long." After grafts are made and well fitted they should be tied firmly, but not too tightly, with a string that will decay quickly after the young trees are planted the following spring. Trees should be stored in bundles of fifty or one hundred in a cool cellar to be kept until planting time.



Cleft grafting. A waxed stub.

FIG. 161.

Cleft Grafting. In top grafting, the following points should be observed:

1. The scion should be cut very smoothly and be from 4 to 6 inches long above the stock.

2. The lowest bud should stand just at the point shown in Fig. 161.

3. The stock having a large area of exposed surface should be well covered with grafting wax to avoid decay. See the note below.

4. Top grafts are made in early spring at about the time when trees begin to grow. The scions used should be entirely dormant, due to having been stored. (See Exercises 6 and 7.)

Note.— Grafting wax has the following formula:

Common rosin	5 parts
Beeswax	2 parts
Beef tallow	1 part

(See Exercise 8.)

Summary. — Plants are multiplied by seedage, by layerage, by cuttings and by graftage, depending on the kind of plants. But the increase of plants and the kinds of plants multiplied may be largely controlled by the selective power of man.

LABORATORY EXERCISES

1. Study the Parts of a Flower. — (Apple, pear, and cherry flowers are perfect flowers and good for this lesson.) A dictionary or a botany textbook may be used as a reference. These will show names of the parts of the flower. Draw the flower and the parts of the flower in your permanent notebook.

2. Study of Seed Dissemination. — Bring to school three or more kinds of seeds which have special devices which aid them in their dissemination. Paste or draw these seeds in your notebook, and briefly describe how each may be disseminated. The written part may be made a language lesson.

3. Fill a Table like the Following, Examining at least Fifteen Seeds.

Seeds Requiring a Lot of Moisture for Seed Germination	Seeds Requiring Only a Small Amount of Moisture for Seed Germination
1.	
2.	
3.	
4.	
5.	
Five Seeds that Will Grow at a Low Temperature	**Five Seeds that Will Grow at a High Temperature**
1.	
2.	
3.	
4.	
5.	
Five Seeds Needing Little Air for Germination	**Five Seeds Needing More Air for Germination**
1.	
2.	
3.	
4.	
5.	

4. **To Propagate Plants by Layering.** — Have pupils attempt to propagate plants by using one of the systems of layering described in the text. Have them report the following year.

5. **Propagation in a Propagating Box.** — Have pupils prepare or bring a propagating box and propagate some stem cuttings as described in the text.

6. **Visiting a Nurseryman and being Instructed by Him.** — If there is a nurseryman in the neighborhood, have him come in, or go out to his place with the class in agriculture, and let him give you a lesson on plant propagation. Pupils should write such lessons in good English.

7. **Both Whip and Cleft Grafts should be Made by Pupils.**

8. **Preparation of Grafting Wax.** — Break or pulverize into small particles one pound of beef tallow, two pounds of beeswax, and five pounds of rosin. Stir the mixture thoroughly while melting. Let it cool after it is well mixed. Smaller proportionate quantities of the above ingredients may be used in this exercise in making grafting wax.

CHAPTER XXV

VEGETABLE GARDENING

Importance of the Vegetable Garden. — Exclusive of the Irish and sweet potato crops, vegetable garden products are valued at about $216,257,068 for 1909.[1] New York, Ohio, Pennsylvania, Illinois, Virginia, Kentucky, and Missouri, in the order named, are the greatest producers of vegetables. (See Exercise 1.)

Every farm home and every home in town or city should, if possible, have a vegetable garden. Some of the reasons why every home should have a vegetable garden are:

1. Fresh, home-grown vegetables furnish excellent food. All vegetables contain starches, fats, protein substances, ash, and water. All of these foods nourish the body, and aid in digestion.

THE COMPOSITION OF SOME VEGETABLES[2]

FOOD MATERIALS	WATER	PROTEIN	FAT	CARBOHYDRATES	ASH	HEAT VALUE IN A POUND. CALORIES
Butter (for comparison)	10.5	0.6	85.0	0.5	0.3	3515
Peas . . .	12.3	26.7	11.7	56.4	2.9	1565
Beans . . .	12.6	23.1	2.0	59.2	3.1	1615
Tomatoes . .	95.3	0.8	0.4	3.2	0.3	80

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Boards and a sash for making a hotbed (may be used to start plants for the gardens of the patrons); some samples of fruit (five of a kind make a sample).

[1] United States Census Report, 1910.

[2] By permission of Professor F. M. Walters. Taken from his book entitled, *Principles of Health Control.*

From this table and other similar tables it may also be concluded that vegetables do not have the heat-producing capacity that meats and animal products have. Eating meats adds heat-producing fuel, whereas vegetables have a lower fuel value and may be eaten to advantage in summer in order to keep down the body temperature. The amount of heat produced in the body by food is measured in calories. A pound of tomatoes furnishes only 80 calories of heat, a pound of butter 3515 calories.

2. The home garden reduces the cost of living. Vegetables, when purchased, are fairly high priced. A small bunch of radishes, lettuce, onions, or celery sells for from 5 to 10 cents.

3. The garden is an excellent laboratory in which to learn something about soil, soil management, and how to keep up the fertility of the soil. The growing of plants, management of hotbeds and cold frames, are helpful studies. The origin, history, and development of vegetables is an interesting field for investigation.

4. Another reason why every home should have a garden is found in the fact that the garden yields about ten times as much food as a similar area will under general farm practice. A half acre planted to vegetables will yield from twelve to fifteen times as much food as when planted to corn or wheat.

Elements of Success in Gardening. — Successful gardening depends upon several important factors:

1. The soil must be a well-drained, dark, rich, sandy loam.

2. If an early garden is desired, the soil should be a sandy loam, and on a southern slope.

3. The soil should be plowed or spaded deep the preceding fall.

4. The garden must be thoroughly cultivated.

5. Good seeds must be planted.

6. A good soil mulch must be maintained in order to conserve the soil moisture. Paths in gardens violate all principles of good farm practice, because paths usually contain large cracks, through which the soil moisture escapes.

Garden Products for the Entire Year. — Gardens should be planted so that vegetables will be ready for table use the entire year. No exact dates can be given to cover this topic. Canning some vegetables and storing others must be resorted to if the garden is to be a 365-day garden. A few suggestions will be in order here.

For early spring use, plant:

Lettuce	Rhubarb
Radishes	Strawberries
Onions	Cabbage
Peas	Mustard

For summer use, plant a little later:

Potatoes	Beans
Tomatoes	Sweet Corn
Beets	Celery

These vegetables can be used until late fall or early winter. Can tomatoes, sweet corn, and strawberries for winter use. Store turnips, sweet potatoes, Irish potatoes, and onions. A well-planned garden is one which partially supplies the table daily the year round. (See Exercise 2.)

Construction and Use of Hotbeds. — Hotbeds may be made any size according to the size of the glass available. A convenient size is three by six feet. A pit 18 inches deep should be dug and filled with about 12 inches of half-decomposed horse manure, well packed. Manure composed of about one-half wheat straw is better, for fermentation will go on more rapidly. Cover this with 6 inches of good soil. Make the top so that the glass cover slants toward the south. (See Fig. 162.)

A cold frame is made like a hotbed except that it is built on top of the soil. Hotbeds and cold frames are usually built on the south side of a building to get the greatest heat from the sun.

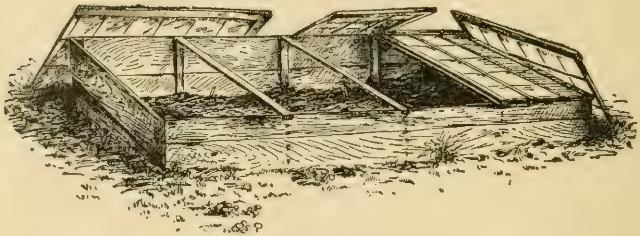


FIG. 162. — A hotbed.

Hotbeds are used for starting lettuce, radishes, tomatoes, cabbage, and other plants. After plants are well started in the hotbeds they should be transplanted into cold frames, where they become hardened. Hotbeds and cold frames should be maintained at a uniform temperature if the best results are to be obtained, and they should be protected from extremes of sunshine and cold. (See Exercise 3.)

Plan of the Garden. — A long narrow garden is more easily tilled than a square one of the same size. A large garden can be cultivated with horse power. Vegetables should be planted the long way of the garden, and each row should extend from one end to the other. If the rows are planted 18 inches apart, a hand plow can be used to advantage. If a horse is to be used in cultivating, the rows should be at least 24 inches apart.

The vegetables should be arranged when planted, so the planting can be started at one side of the garden and continued until the entire garden is planted.

Above is a suggestive diagram of a home garden. Double cropping may be used; that is, as soon as the growing plant is almost mature, others may be planted between the rows. For illustration, between the rows of lettuce, radishes, peas, cabbage, and potatoes, other vegetables may be grown. Corn may be grown between the lettuce. Vining beans may be grown with the corn. Turnips may be sown in autumn where bunch beans

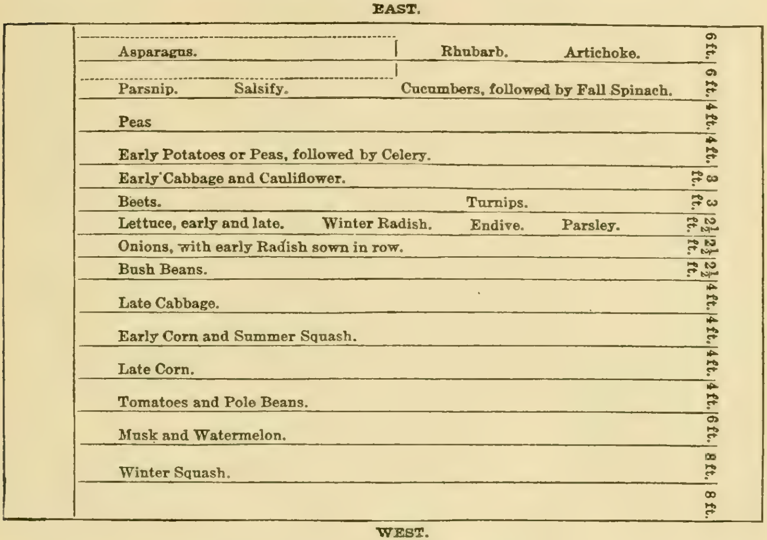


FIG. 163. — Diagram of home garden.

grew in early summer. Double cropping has the following advantages:

1. It produces more vegetables.
2. It utilizes the land for a longer period.
3. It has a tendency to keep the land more fertile, especially when beans and peas are rotated with other vegetables.
4. The soil is tilled more, keeping the garden free from weeds. (See Exercise 4.)

Lettuce. — Lettuce is grown for a salad plant more extensively than any other vegetable. Crisp, fresh lettuce is an excellent food for early summer, and is therefore an important crop among truck growers and gardeners. Lettuce is adaptable to a wide range of climatic conditions, and with proper cultivation will grow in almost every section of the United States the year round. In the South it is grown in the garden throughout the year. In the North it is grown under field conditions in early spring, summer, and fall, and during the winter as a forced crop in greenhouses.

Lettuce plants are started in hotbeds by sowing the seeds in rows 3 or 4 inches apart, and covering them with a half inch of soil. After the plants are large enough they are transplanted into the cold frame, and later into the garden. Frequent cultivation is essential to hasten the growth of lettuce.

Mildew and rot are the most common diseases of lettuce, caused by wet, hot conditions. Especial care should be taken in watering lettuce to keep the water from coming in contact with the leaves of the plant. Sub-irrigation is usually employed in forcing lettuce.

Potatoes. — *Origin and History.* The potato is of American origin, and at the time of the discovery of America was a domestic plant in parts of South America, Mexico, and in the southern part of the United States. About 1585 or 1586 potatoes were introduced into Europe, and soon became an important crop in Great Britain. They are grown so extensively in Ireland that in 1846, when potatoes were destroyed by blight, it caused the Great Famine, during which many Irishmen came to America. Potatoes furnish more food for direct table use than any other crop in the world, except rice. Three hundred and eighty-nine million bushels of potatoes, valued at $166,000,000, were produced in the United States in 1909. The average yield was 106.1 bushels an acre.

Management of Potatoes. A rich sandy loam is best suited to potato production. They should be planted early in the

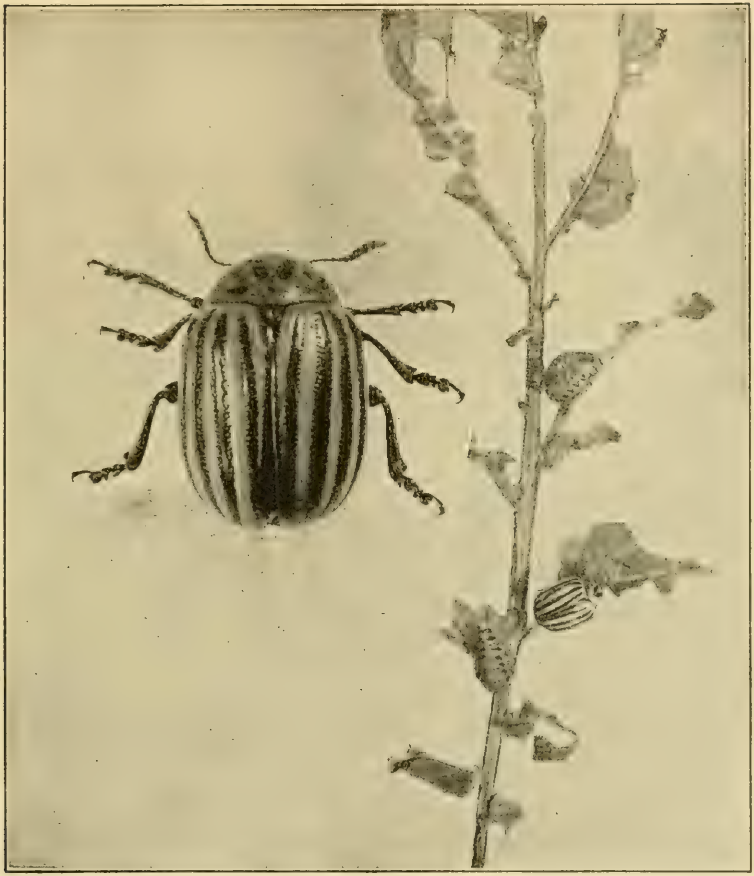


FIG. 164.— The Colorado potato-beetle. Forerunner of modern methods of insect control.

spring, and be cultivated as soon as they come up. Level cultivation is generally the best, until the last cultivation, when it is well to ridge the soil up to the potato rows. The potatoes are thus protected and the plants are prevented from falling down.

Potatoes a little above average size should be selected for seed. Hills vary in the number of potatoes produced. Seed potatoes should be taken only from hills that are prolific. S. Fraser says that " a piece of potato weighing three ounces, or as large as a good-sized egg, and having at least one good eye, is most profitable to plant." Experimental evidence seems to indicate that planting single eye pieces and quarters of potatoes is not as profitable as planting halves. And it has not been proved that planting whole potatoes produces larger yields than planting halves.

If potatoes have a tendency to produce all tops and no tubers, there is a surplus of nitrogen and a lack of potash and lime. In this case potash in the form of wood ashes and lime should be added to the soil.

For early maturing varieties, plant Early Rose, Early Ohio, and Irish Cobbler. For the late maturing varieties, plant Carmen, Rural New Yorker, Burbank, and White Giant.

Enemies of Potatoes. The Colorado potato beetle is known by every gardener. The second crop of beetles defoliates the potato plants. Spray plants with a Paris green solution made by mixing one ounce of Paris green to two gallons of water. London purple and arsenate of lead may also be used.

Potato scab is a fungous growth, causing rough corky areas over the potato. The fungus causing the disease lives in the soil from year to year. It may also reside on the potato. An abundance of stable manure fosters the growth of scab. To plant clean potatoes in a clean soil is the only way to prevent scab. The potatoes may be cleaned by soaking the uncut seed potatoes for two hours in a solution made by mixing one pint of formaldehyde in thirty gallons of water. The soil may be kept clean by planting it in potatoes about one year in every four. All insecticides are poisonous and therefore must be used with the greatest of care. (See Exercise 5.)

Tomatoes. — Tomatoes are of American origin. They were carried to Europe from Peru. For a long time tomatoes were thought to be poisonous; they were used only for ornament, and were called "Love Apples." After the notion that they were poisonous disappeared, their use for food grew rapidly, and to-day tomatoes are of considerable commercial importance. They are an important food because of the protein, sugar, and ash that they contain, and because the acid in them aids digestion.

U. S. Dept. of Agriculture.

FIG. 165. — Pruned tomato vines.

Tomato Culture. Tomatoes are started in hotbeds in early spring. They require 100 to 140 days for their maturity, and therefore must be started early. Transplanting into the permanent garden should be done when the season is fairly sure, and when the plants have from 6 to 8 leaves. Plants must be set deeply and the soil packed firmly about them. This precaution in setting out plants will aid much in keeping them alive. Where tomatoes are hand tilled, they may be set 3 to 4 feet apart each way, depending on the variety.

If the seed bed for the plants was well prepared, little other than surface cultivation is needed to keep down the weeds and conserve the moisture.

Another important phase of tomato culture, if the best results are to be secured, is proper staking and pruning. Since they are susceptible to fungous diseases, they need much air and sunshine. They should be staked and tied to the stakes. All suckers growing in the lateral axils should be removed.

Varieties. For early use, plant the Earlianna, Bonnie Best, Early Jewell, and June Pink. For late use, plant the Ponderosa Stone, Acme, Matchless, Trophy, and Beauty.

Fertilizers. Since tomatoes are grown for their fruit, fertilizers may be used to increase the yield. Potash and phosphoric acid fertilizers supply the needs of fruit; and nitrogen fertilizers stimulate vegetative growth. Stable manures are not often used as fertilizers for tomatoes, because they cause an excessive growth of the plant, and hinder fruiting. Fertilizers in which the plant foods are readily available to the growing tomato plants should be used.

Spraying Tomatoes. Tomatoes are subject to a fungous disease called leaf spot which turns the leaves yellow in spots, dries them up, and kills them. The disease spreads rapidly from leaf to leaf and from plant to plant. When leaf spot appears, the plants should be thoroughly sprayed with Bordeaux mixture. They should be sprayed several times at intervals of 8 to 10 days, depending upon conditions. Wet, damp, hot weather promotes the growth of leaf spot.

Radishes. — Although they are adapted to a wide range of climatic conditions, radishes do best in early spring and fall when the temperature is moderately warm. If they are to have the best flavor and the proper crispness of texture, they must be grown quickly. A slow growth causes them to have an unpleasant, acrid flavor and a tough, fibrous texture.

Culture of Radishes. When radishes are grown alone, they are sown in rows 12 to 18 inches apart, one-half to one inch deep. The soil should be what is called a "quick soil," composed of sand, clay, and humus. A "quick soil" can be tilled soon after a rain, because it is porous, permitting the rapid escape of free water, and because the black color, caused by the humus, absorbs the sun rays and warms it quickly.

Radishes are often grown as one of a "succession crop," between two rows of lettuce. On each side of these three rows is grown a row of potatoes, cabbage, peas, beans, or sweet corn. (Fig. 163.) A continuous supply of radishes may be had by sowing seeds at successive intervals of about ten days. If radishes are to be sold on the market, they should be tied in bundles of six radishes to each bundle. (Fig. 166.) The tops are left on, because they protect the radishes to some extent. (See Exercise 6.)

Fig. 166. — Bunch of radishes.

Garden Peas. — Peas require a warm, "quick soil," if they are grown in early spring. A rich, friable, well-drained soil is desirable for their early development. The dwarf and early maturing varieties, such as the Alaska and American Wonder, should be planted early. They may be planted from 3 to 6 inches apart in rows from 15 to 18 inches apart. If peas are wanted for midsummer, larger and later maturing varieties, Telephone, White Marrow, Fat, and Pride of the Market, should be planted. Vining peas may be trained to grow on poultry wire netting. Three-foot netting makes a satisfactory trellis.

Peas as Food. Peas and beans have hardly an equal as food. They are rich, not only in protein substance, but in the other nutrients. Their composition follows:

Food	Water	Protein	Fat	Carbohydrate	Ash	Heat Value of One Pound
						calories
Butter (for comparison)	10.5	0.6	85.0	0.0	0.8	3515
Peas . . .	12.3	26.7	1.7	56.4	2.9	1565
Beans . . .	12.6	23.1	2.0	59.2	3.1	1615
Potatoes (for contrast) .	78.9	2.1	0.1	17.9	0.1	315

It will be observed from the above table that peas and beans are rich in protein and ash materials. This combined with their high carbohydrate content makes them very nutritious. Peas and beans should be grown, not only because of their excellent flavor, but also because they furnish an abundance of nutrition to the body.

Beans. — The culture of beans is like that of peas, except that beans require a warmer temperature, and therefore must be planted later. For early maturing varieties, plant early maturing dwarf or bunch beans. Red and White Kidney beans are early dwarf varieties. For later maturing varieties, use pole beans, such as the vining Lima and the Kentucky Wonder.

Cabbage. — Cabbage is a favorite garden vegetable throughout the United States, and in some sections it is grown extensively as a commercial crop. The tonnage produced per acre is large and the price generally low, but the sale of cabbage is assured because of its wide use. Cabbage requires a great deal of moisture for its growth, and for this reason may be planted in a soil that contains more than an average amount of moisture. There is an old saying that "cabbage should be hoed every day." This is almost true, for frequent cultivation maintains an earth mulch which conserves the soil moisture.

Cabbage requires an abundance of plant foods rich in potash and phosphorus. Stable manure may be applied, but, in addition, either acid phosphate at the rate of 750 pounds per acre, or muriate of potash at the rate of 500 pounds per acre, will help production. A fertilizer composed of nitrogen 2 per cent, phosphorus 6 to 8 per cent, and potash 8 to 10 per cent is usually satisfactory. About 1200 to 1800 pounds per acre should be applied.

Varieties. Early Jersey Wakefield and Henderson's Early Summer are early varieties; the Flat Dutch, Stone Mason, and Autumn King are later maturing varieties. Each of these varieties has been developed with flat, conical, or spherical heads. Different markets demand different shaped heads. Catering to the demands of the market is a part of good gardening.

The Enemies of Cabbage. Probably the worst insect enemy of cabbage is the cabbage worm. It is an inch to an inch and a half long, has a green velvety appearance and a faint yellow stripe down the middle line of the back. These larvæ, which develop into the "cabbage butterfly," eat irregular holes in the leaves, and disfigure the heads of the plants with deposits of excrement. "Arsenicals may be used safely on cabbage until they are half grown. Hellebore may be used on plants ready for market." [1]

Other insects injurious to cabbage are the flea beetle, root maggot, cutworms, and cabbage aphis. For their control write to your State Entomologist, who generally resides at the State College of Agriculture. (See Exercises 7, 8, and 9.)

Summary. — Every home, not only in the country but also in the city, should have a vegetable garden. And if the garden

[1] O'Kane: *Injurious Insects.*

is carefully planned, vegetables may be had almost every day in the year. The cost of living may be reduced to a considerable extent even by a small garden. Vegetables are healthful as well as nutritious. The elements of success in gardening are a careful preparation of the seedbed, thorough cultivation, and the successful combating of vegetable enemies.

LABORATORY EXERCISES

1. **To Estimate the Value of the Products of the Home Garden.** — Have each pupil, with the help of his parents, figure the value of the products derived from his home garden. Have the pupils bring an itemized statement of the value of the different vegetables produced in their home garden. Discuss.

2. **Methods of Preserving Vegetables.** — Have pupils discuss this question, "What are the methods used in storing, canning, or keeping ten garden vegetables?"

3. **Making of a Hotbed.** — If it is springtime, have pupils design and make a hotbed, and start some lettuce, cabbage, and tomato plants. This exercise can also be done in the fall.

4. **Planning a Garden.** — Have pupils plan the arrangement of vegetables for a garden one hundred by two hundred feet.

5. **Scoring Samples of Fruit.** — Score single plate samples of tomatoes, potatoes, radishes, turnips, or any other suitable vegetables according to the following score card. (Five of a kind generally constitute a sample.)

Score Card

	Points	Sample Scored			
Form	15				
Size	15				
Color	20				
Uniformity	20				
Freedom from blemishes	30				

Explanation of Values.

Form (*15*) refers to the normal type and shape of the variety. For each specimen varying from the type, cut according to judgment.

Size (*15*). The size most in demand by the market may be considered the best size. Oversized vegetables should be discouraged, but a size slightly above the average may be considered best. Apply score according to judgment.

Color (*20*). The color should be uniform, and show that all specimens of the sample belong to the same variety. Cut according to judgment.

Uniformity (*20*). All points pertaining to size, color, shape, and texture, are important. Cut according to judgment.

Freedom from blemishes (*30*). Freedom from blemishes is essential to a good sample. Bruised places, decayed spots, and a diseased surface are objectionable. Cut according to judgment.

(Two or more days may be devoted to this lesson.)

6. Kinds and Varieties of Vegetables Grown in your Home Garden. — Write the kind and varieties of each of the vegetables grown in your home garden.

7. Combating Insects. — What are the five worst enemies of your vegetable garden? Write a paragraph about each, telling how you would combat it.

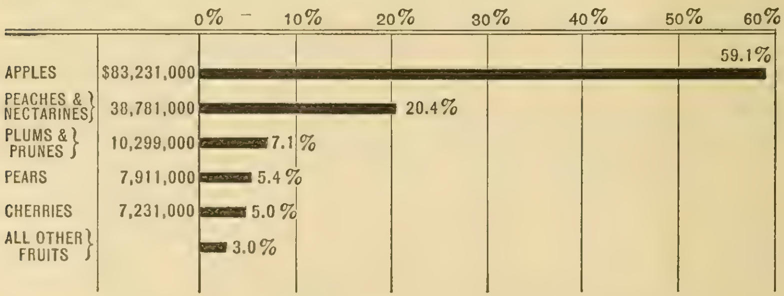
8. Play Contest. — Have a running contest, using potatoes, tomatoes, turnips, or any other suitable vegetable that is available.

9. A Composition Exercise. — Have boys write a story telling about the growing of any garden vegetable, and have the girls write about, "How to Can Some Garden Vegetable."

CHAPTER XXVI

FRUIT GROWING

Importance. — According to reports, the value of all fruits produced in the United States is about $140,867,000.[1] This represents 2.6 per cent of the total value of all the farm crops. The production of orchard fruits is distributed throughout the United States. There is hardly a home, especially in the rural districts, that has not a few fruit trees. Apples, peaches, cherries, plums, and berries are so well liked that nearly every home owner should grow one or more of these fruits. The value and relative importance of the leading fruits are here given for one year.



GRAPH 11. The value and per cent of fruits grown in the United States.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Several grasshoppers and bees; a glass jar; a cabbage worm; samples of apples, peaches, pears; scales.

[1] *Census Report*, 1909.

The chemical composition of all fruits is such that they are not only nutritious but very valuable in aiding digestion. The composition of some of the fruits is given below:

Fruit	Proteids	Fats	Carbohydrates	Total Solids	Water
Apples	0.2	0.4	15.9	16.8	83.2
Peaches	0.7	0.0	14.5	15.2	84.8
Cherries	0.5	0.0	10.0	10.5	89.5
Grapes	1.2	0.0	15.0	16.2	83.3

Most fruits contain also some acids which help to digest food and prevent constipation. An apple eaten before retiring has a helpful effect. (See Exercise 1.)

Elements of Success in Fruit Growing. — The elements of success in fruit growing are numerous and depend somewhat upon local conditions. However, a few of the fundamentals for successful orcharding which have general application throughout the country, will be discussed.

Soils Adaptable to Orcharding. — Almost all orchard trees feed deeper than does the average crop. For this reason a deep porous soil and subsoil are essential. A soil that is underlaid with hardpan is not adaptable to orcharding, but a gravelly or a sandy subsoil is not seriously objectionable. In fact, some of the most productive orchards are in regions that have a gravelly subsoil. A loose soil and subsoil allow free aëration, a condition essential to orcharding. An impervious subsoil holds the water, and few orchard plants thrive in such a condition.

Although orchards do moderately well on soils of low fertility, a soil that is fairly fertile is desirable. Soil drainage is more essential than soil fertility. Fertility may be increased, but an impervious soil cannot be made porous.

Rich bottom lands seldom furnish good orchard soils. This is because fruit trees have a tendency to produce too much vegetative growth on such lands, and to remain barren. Fairly fertile, porous, mellow uplands are best suited to fruit production.

The Location of the Orchard. — South slopes are warmer than north slopes and give more exposure to the sun, which is essential for producing highly-colored fruits. North slopes are usually more fertile and do not warm up so easily in spring. A fruit crop is often saved because the orchard is on a north slope. A north slope often prevents sun scalds of the trunks of fruit trees. The best slope for an orchard depends somewhat on the climate.

Air drainage should also be taken into consideration in locating an orchard. Cool air is heavier than warm air and sinks to the lowest levels. For this reason frosts are more common during early spring and late fall in valleys than upon higher places. Occasionally a fruit crop is lost because the orchard is in a low valley.

The top of a hill is not a desirable location for orchards, because (1) the trees are exposed too much to the winds which often break them, and (2) the fruit is blown off the trees where there is too much exposure. Both very low and very high places should be avoided in selecting an orchard site. (See Exercise 2.)

Preparation of the Soil. — The soils in which orchards are to be planted should be prepared as for the sowing of wheat or planting of corn. If the soil is to be cropped the preceding summer, soybeans or cowpeas may be used to improve the soil both physically and chemically. Soybeans are a fine crop to precede the planting of an orchard. The soil should be plowed deep and worked down so that its tilth is good. The ground may be harrowed occasionally to keep down the weeds and to keep an earth mulch which helps to conserve the moisture.

Planting Fruit Trees. — How far apart trees should be set depends upon the kind of tree and the fertility of the soil. The following table is suggestive:

Apples	25 to 30 feet each way
Pears	20 feet each way
Peaches	20 feet each way
Plums	20 feet each way
Cherries	18 feet each way
Grapes	6 feet by 8 feet

Trees should be set in the orchard at about the depth to which they were planted in the nursery. Before setting a tree all bruised and broken roots should be removed with a sharp knife, and the top should be cut back as indicated in Fig. 167. In trimming a tree it is well to remember that the tops cannot grow a root system, but that a good root system can grow a top.

In moving, trees should not be permitted to lie in the sun and wind, for this soon destroys the vitality. The violation of this rule and poor setting kill more trees than all other factors combined. The most important point in setting trees is to firmly pack the loose soil around the roots. Tramping the soil around the roots is a good practice. After a small amount of soil is shoveled around the roots, it should be packed; then more soil should be added and packed again. The top two or three inches should be left in the form of a loose mulch.

Tillage of Orchards. — Cultivation of orchard crops is neglected more than that of any other farm crop. If corn fields were permitted to grow up in hay and weeds such as are often seen in orchards, it would be quite reasonable to expect small returns. Likewise the returns from untilled orchards are short. Young orchards should be kept free from weeds, but tilled crops, cowpeas, soybeans, corn, strawberries and other plants may be grown to advantage. In cultivating orchards care should be taken not to bark the growing trees, because the bruises bring on disease. Orchards should not be cultivated after the latter part of July or the early part of August. A cover crop of rye or wheat may be sown in September. This protects the soil for the winter. Occasionally a green cover crop of soybeans or cowpeas is plowed under to maintain the organic content of the soil. Exceedingly steep orchard lands should not be cultivated.

FIG. 167. — A pear tree properly pruned.

Pruning Trees. — Most fruit trees need pruning. There are three main reasons for pruning trees:

1. To control the size and shape of the top.
2. To remove dead branches.
3. To stimulate and promote either vegetative growth or fruitfulness.

1. Trees should be pruned to a pyramidal shape, or an open vase form. Forked trees are undesirable. (See Fig. 168.) The tree may be pruned when young so that the head of the tree is near the ground. This method has some important advantages.

FIG. 168. — A shapely, well-formed peach tree.

a. The trunk of the tree will be protected from the sun, and sun scald prevented.

b. The work of gathering, spraying, and pruning can be done more easily and cheaply.

c. Trees are not so easily wind broken.

2. All dead branches should be removed. Water shoots and

other limbs that tend to crowd the top should be pruned out in order that all the strength of the tree may go into the growth of the desirable limbs or fruit.

3. To promote vegetative growth, trees should be pruned in winter. But if they grow too vigorously, they should be pruned in summer. This checks vegetative growth and causes the additional plant food to form buds. These fruit buds are formed in June and July of the summer preceding the bearing season. If pruning is employed to stimulate fruit production, it should be done about the first of June.

FIG. 169. — The wrong way to prune.

Fruit buds are borne upon short limbs called "spurs," which occur on wood one year old or more. Heading in or cutting the limbs back should be done with care, lest the bearing wood is decreased to such an extent that the fruit crop may be greatly curtailed. In pruning, the limbs should be cut so that the wound will heal over quickly. Limbs should be cut near the trunk or near the limbs from which they branch. (See Fig. 170.)

Figure 169 illustrates poor pruning. The wound cannot be quickly covered by new growth, and the part of the limb remaining on the tree will decay and cause a weak place. Limbs should be cut closely to the trunk of the tree. The wound will then heal over quickly and the covered tissues will all be sound and solid. Wounds should be covered with ordinary white lead to prevent decay. (See Exercise 3.)

Fruits: The Apple. — *Origin and Development.* Apples originated in southeastern Europe or southwestern Asia. The wild crab is claimed to be the original from which came our domestic apples. The wild crab even to-day will readily hybridize, or cross, with our domestic varieties. Apple twigs may be budded, or grafted, on root stocks of the wild crab, and vice versa. This shows the close relationship between the domestic apple and the wild crab. For lack of space we cannot touch upon the effects of the grafting of the domestic apple upon the crab, but it may be interesting to take it up in class discussion.

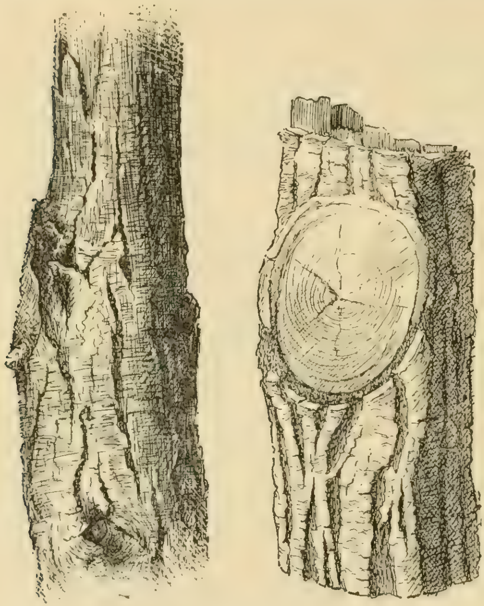


Fig. 170. — The right way to prune.

In the evolution of our domestic apple, some interesting facts may be noted. It indicates how slowly characters are developed. The wild crab possessed some characters which have been left as remnants of the past. Among these the following may be observed:

1. The wild crab bore a large number of apples in one cluster.
2. The apples in these clusters were comparatively small.
3. The flavor of the wild crab was sour and acid.
4. The apples had a large number of seeds.

In the development of the apple each of these points (characters) was largely overcome. The first problem of the breeder of apple trees was to eliminate the large number of apples to the cluster. This could be done only by selection and by using for propagation only those that had fewer apples in a cluster. It took many generations to reduce the large number of apples in a cluster such as the crab grew, to the few found in the domestic varieties that are still somewhat like the crab in this respect. The Winesap is such a variety.

As the number of apples to the cluster was reduced, the size of the apples became larger. The wild crab measured about one-half to three-fourths of an inch in diameter. To increase these kinds until they were one inch, one and one-half inches, and two inches in diameter was an interesting problem for the plant breeder. It took more than a few generations to secure this evolution.

From the wild sour crab, there have been developed over two thousand varieties of apples, each with a special flavor. These flavors, though being different in quality, are now generally classed as sweet, acid, sour, semi-acid, and aromatic.

Another problem of the plant breeders has been that of reducing the number of seeds in the apple. The wild crab apple had from 15 to 20 seeds; the best apples of to-day have only 6 or 8 seeds. Breeders are now trying to grow seedless varieties.

There are other features of the evolution of the apple that are just as interesting as the illustrations given above. In the course of evolution the "characters of plant life" have been just as numerous and marvelous as have those pertaining to the animal kingdom.

Varieties of Apples. Care should be exercised, in choosing varieties for the home orchard, to select only such varieties as are known to do well in the locality. If an orchard is planted for commercial purposes, the "market demands" should also be considered. For family use, it is good practice to plant some summer, some fall, and some winter apples. The following list may help:

Summer	Fall	Winter
Red June	Wealthy	Gano
Yellow Transparent	Grimes Golden	Ingram
Red Astrachan	Jonathan	Delicious
Early Harvest	Huntsman Favorite	York Imperial
Maiden Blush		Stayman Winesap

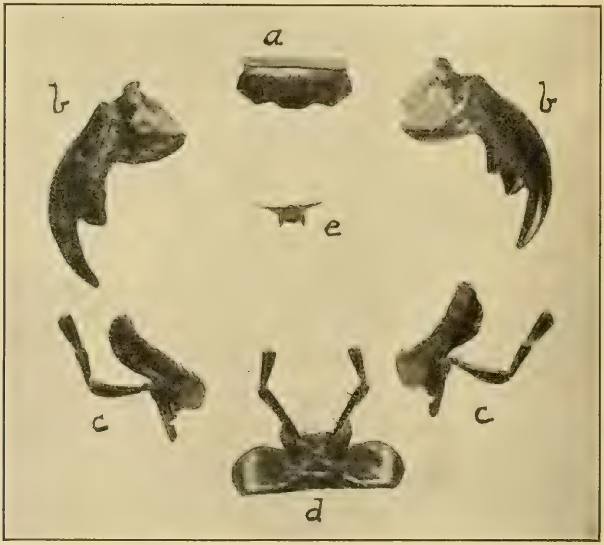


Fig. 171. — Mouth parts of a beetle, illustrating biting mouth parts.

The above list is suggestive. It may be added to and subtracted from according to the findings of apple growers of the locality. (See Exercises 4 and 5.)

Enemies of Apples: Insects. From the standpoint of control there are two kinds of insects: 1. Those that secure their food by chewing; 2. those that secure their food by sucking. The insects belonging to the first group get their food by biting off parts of the vegetation. They have a pair of jaws intended for chewing or biting. (See Fig. 171.) If we examine a grasshopper or a beetle, we shall find that it possesses a pair of biting instruments called mandibles. But if we examine a butterfly, a moth, or a bee, we find no jaws or parts that may be used to bite or to chew. Instead we find a long tube (proboscis) through which the insect sucks its food. (See Fig. 172.) Some of the enemies of the orchard belong to the first group, others to the second. (See Exercises 6 and 7.)

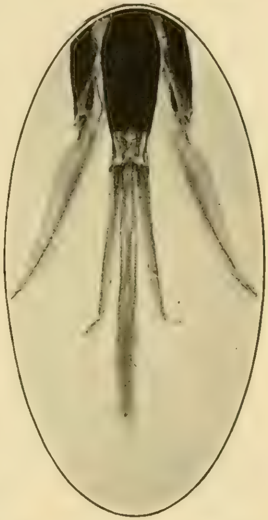


FIG. 172. — Mouth parts of a honeybee, illustrating sucking parts.

The methods for controlling are different. O'Kane says: "Insects with biting mouth parts may be killed by covering the plant on which they feed with a poison such as lead arsenate. Insects with sucking mouth parts do not eat the surface of the plant and cannot be killed by applications of stomach poison. For the latter, other remedies must be used, — some substance that will kill the insect by corrosive action on its body."[1] These remedies are usually called contact insecticides, such as kerosene emulsions or lime sulphur wash. A few enemies of the apple will be discussed and a spray mixture will be suggested that will successfully combat all enemies named.

[1] O'Kane: *Injurious Insects.*

Codling Moth. The adult Codling Moth lays its eggs on the calyx of the apple blossom. In a few days the eggs hatch and the

Fig. 173. — The time to spray for the Codling Moth. The calyx still open. Original.

Fig. 174. — Too late to spray for the Codling Moth. The calyx closed. Original.

larva enters the young fruit through the calyx end. (See Figs. 173–178.) The larva feeds on the inside of the apple, as illustrated in Fig. 178.

The mature larva comes out of the apple, finds a suitable shelter for the winter and spins its cocoon.

Fig. 175. — Larva of the Codling Moth. Slightly enlarged. Original.

Fig. 176. — Cocoon of the Codling Moth underneath a piece of bark. At the top, the pupa. Original.

Fig. 177. — The Codling Moth. Adult, slightly enlarged. Original.

Since the worm gets its food by biting, to kill it, spray just before apple blossoms bloom and again just after the blossoms have fallen. The second spraying is more important. Spray again three weeks later. Use a solution made by dissolving two pounds of arsenate of lead in fifty gallons of water, or by mix-

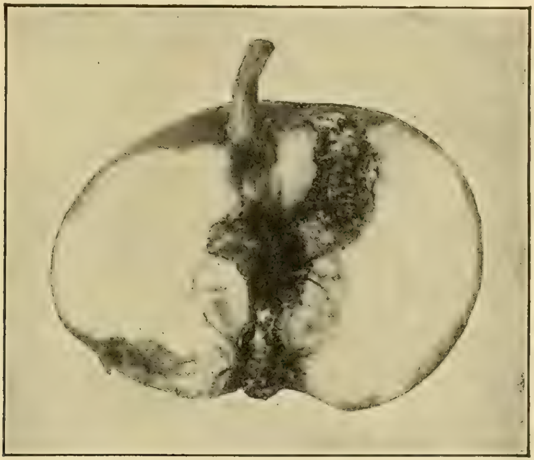


FIG. 178. — Section through apple showing characteristic work of the Codling Moth. Original.

ing four ounces of Paris Green in fifty gallons of water. (See Exercise 8.)

San José Scale. The San José Scale is among the worst insect enemies of orchards. It attacks all kinds of vegetation and in a few seasons may kill peach or plum trees. Apple trees, being more hardy, withstand its ravages a little longer. (See Fig. 179.)

The San José Scale is a sucking insect, and a contact insecticide must be used in combating it. Such an insecticide may be either of the following:

HOMEMADE CONCENTRATED LIME SULPHUR

Lump lime	60 lb.
Sulphur	125 lb.
Water	50 gallons

In making this spray, first mix the sulphur with the water, and then add the lime.

KEROSENE EMULSION

Hard soap	½ lb.
Hot water	1 gallon
Kerosene	2 gallons

Trees should be treated before the vegetation appears. O'Kane says: "The best time for application is in the spring just before the buds swell. Where the infection is severe it is well to spray in the fall after the leaves have dropped and again in the spring."[1]

Apple Scab. Apple Scab is a fungous disease of apples that attacks both fruit and foliage. It thrives best in moist, cool weather. Scab disfigures and distorts the fruit by preventing growth where it occurs.

A prevention and a remedy for Apple Scab is found in the use of Bordeaux Mixture. This spray is made by mixing the following:

Copper sulphate	4 lb.
Lime	4 lb.
Water	50 gallons

Spray trees just before blooms open, and again after the blooms are off, and a third time when the apples are about half grown. This will control the apple scab, rot, and mildew.

Borers. There are two kinds of borers that attack apple trees, the Round-headed Borer and the Flat-headed Borer. The Round-headed Borer bores under the bark just beneath

[1] O'Kane: *Injurious Insects.*

the surface or slightly above the surface of the ground. The Flat-headed Borer works about three feet above the surface of the ground. Both are killed in the same manner. Use a knife

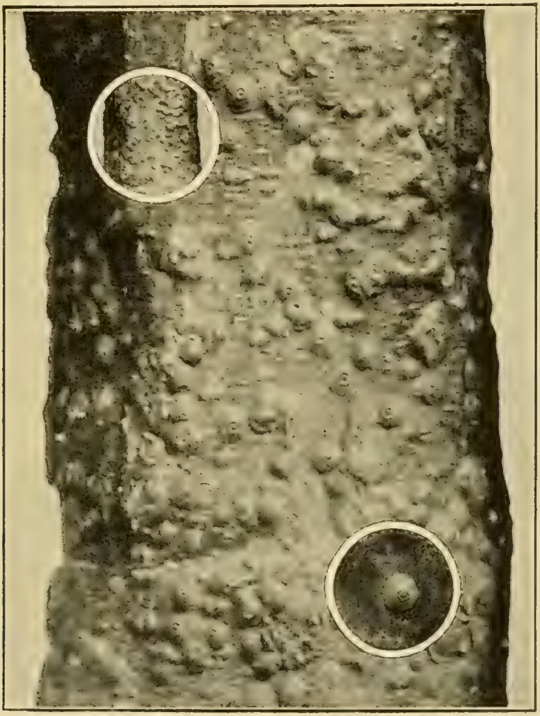


FIG. 179. — The San José Scale. Above, natural size. Center, enlarged. Below, a single scale, enlarged. Original.

to find the openings made by the worm and then insert a wire into every opening. This will probably destroy them if every portion of the opening is penetrated. (See Exercise 9.)

Peaches. — *Soil and Culture.* Peaches demand a fairly dry, porous soil, and will not thrive in a wet, compact soil. The subsoil should also be porous. Clean cultivation is recommended for peach orchards. A by-crop such as potatoes, strawberries, or currants may be grown with the peaches. Spring planting is preferable. The trees should be planted about twenty feet apart and as deep as they stood in the nursery.

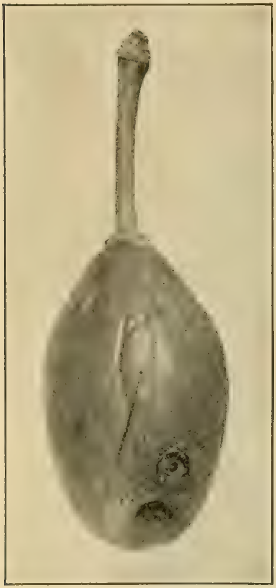


Fig. 180. — Egg-laying punctures of the Plum Curculio. Slightly enlarged. Original.

Varieties of Peaches. The following is a suggestive list of peaches classified according to the seasons in which they mature:

Summer	Fall
Carmen	Heath
Champion	Beauty
Sneed	Iron Mountain
Elberta	Krummel October
Crosby	

Enemies of Peaches. Leaf Curl, due to a fungous growth, disfigures the leaves, which often grow twice their normal size. Spray with Bordeaux Mixture just before the buds open.

Brown Rot is a soft rot which destroys the peach fruit, just a few days before maturity. It is most prevalent during hot, wet weather. There is no cure for Brown Rot. Spraying trees with self-boiled lime just after the blossoms have fallen, and again three or four weeks later, will control it somewhat.

Peach Scab causes large blotches on peaches, and often causes them to crack open. The treatment for scab is the same as for Brown Rot.

The *Plum Curculio* ruins peaches by its stings, and scatters the Brown Rot. If the curculio is controlled, the Brown Rot disappears. (Fig. 180.) To combat the Plum Curculio, spray with arsenate of lead, using the following composition:

Arsenate of lead	$1\frac{1}{2}$ lb.
Lime	2 lb.
Water	50 gallons

Spray the first time when the calyx tubes are falling off, and again three weeks later. If needed, a third spraying may be applied. (See Exercise 10.)

FIG. 181. — The Plum Curculio. Enlarged and natural size. Original.

Plums. — Plums are planted like peaches. They thrive best in moist places, on north slopes, and along streams. A classification of plums in the order of their maturity follows:

American Plum Varieties

Milton	Wild Goose
Robinson	Newman
Forest	Wayland
Missouri Apricot	

Japanese Plum Varieties

Abundance	Burbank
Chabot	

European Plum Varieties

Green Gage	German Prune
Lombard	Shropshire Damson

The principles of spraying suggested in the preceding sections apply to spraying for the enemies of plums.

Cherries. — Cherries grow best in a medium dry, porous, well-drained soil. They should be set from fifteen to twenty feet apart. After the third or fourth year, there is little need for cultivation. If they are cultivated after this, the tillage should be very shallow, because the roots of cherries grow very near the surface of the soil. The best varieties are:

Early Richmond	Wragg
Montmorency	English Morello

Cherries and plums are liable to be destroyed by the fruit-rot fungus if they are left on the trees until they are ripe. It is therefore important that these fruits be picked early.

Grapes. — There should be grapes in every orchard. They furnish an excellent arbor, are safe bearers, and provide a good fruit. A well-drained but moist soil is best adapted to grape production.

Grapes are propagated by cuttings and layerings. Layers or cuttings may be planted in the permanent place or orchard when two years old. The vines should be trained to grow on a three-wire trellis. They may be expected to bear when three or four years old.

In pruning grapes, three buds are ordinarily left on each branch. Dead wood should be removed.

Varieties of Grapes. The common standard varieties of grapes are the following:

Green Mountain — an early white grape.

Moore's Early — an early black grape.

Moore's Diamond — a white grape.

Worden — a large black grape.

Concord — the old standard black grape.

Wyoming Red — a small red grape.

Enemies of Grapes. Black Rot is the worst disease of grapes. It causes small black spots on the fruit. To combat Black Rot spray with Bordeaux Mixture. The first spray should be applied when the third leaf appears; the second before the blooms open; the third after blooming, and again two or three weeks later.

Summary. — Fruit growing is important in every section of the United States, and some fruit is found on almost every farm. Fruit growing is fairly successful in most sections, but better results would be secured if proper attention were given to it. Orchards are too frequently neglected. If an equal time were given to our orchards as is given to other crops, the results would be more satisfactory.

Selection of the orchard site, cultivation, and combating enemies are essential to success. Proper spraying is necessary if good sound fruit is to be secured. Quality and freedom from blemishes are the first considerations of the market in the purchase of fruits. The score card of the preceding chapter is worthy of close study.

LABORATORY EXERCISES

1. **Fruit Survey of School District.** — With the help of every pupil in school, take a census of the number of apple, peach, cherry, plum, and pear trees in the school district.

2. **Orchard Sites.** — Discuss the "Orchard Sites" of the five best orchards in the district.

3. **Some Observations Regarding Pruning.** — Observe the practice regarding pruning in at least two orchards. Describe and discuss each.

4. **Seasonal Maturity of Apples.** — Name, according to seasonal maturity, at least ten varieties of apples found in your neighborhood.

5. **Description of Fruit Trees and Their Fruits.** — Go to a near-by orchard and study at least two of each, of apple, peach, and pear trees, and their fruits, filling the following outline according to your findings.

DESCRIPTION OF FRUIT TREES AND THEIR FRUITS

1. Description of tree				
(*a*) Size				
1. Small				
2. Medium				
3. Large				
(*b*) Form				
1. Upright				
2. Spreading tree				
3. Open				
4. Close headed				
5. Round topped				
6. Irregular				
(*c*) Bark				
1. Smooth				
2. Rough				
3. Color				
(*d*) Foliage				
1. Abundant				
2. Sparse				
3. Color				
4. Texture				
(*e*) Productivity				
1. Prolific				
2. Not so				
(*f*) Hardiness				
1. Very hardy				
2. Easily killed				
2. Fruit.				
(*a*) Form				
1. Round				
2. Oblong				
3. Oblate				
4. Conic				
(*b*) Size				
1. Large				
2. Medium				
3. Small				

DESCRIPTION OF FRUIT TREES AND THEIR FRUITS (*Continued*)

(*c*) Stem				
1. Long				
2. Short				
3. Stout				
(*d*) Calyx cavity				
1. Large and deep				
2. Small				
3. Shallow				
(*e*) Basin				
1. Deep				
2. Medium deep				
3. Broad				
(*f*) Skin				
1. Thick				
2. Feel, — soft, rough, coarse				
3. Color				
(*g*) Core				
1. Large or small				
2. Number of seeds				
3. Stone				
(*h*) Flesh				
1. Color				
2. Flavor				
3. Texture, — firm, mellow				
(*i*) Season				
1. Spring				
2. Midsummer				
3. Fall				
4. Winter				

6. Study the Mouth Parts of Biting Insects. — Bring to school a large grasshopper and study its parts. Examine the mouth parts carefully and draw them. Write a brief discussion, stating how you would combat insects with similar mouth parts.

7. Study the Mouth Parts of Sucking Insects. — Bring to school a bee, or any other insect having sucking mouth parts, and carefully examine its mouth parts. Draw and describe what you find. Write a brief discussion, stating how you would combat insects with similar mouth parts.

8. Study of the Life History of an Insect. — Bring a worm found in an apple to the school, and place in a large glass bottle or jar. Place a worm-eaten apple in the jar with the worm. From three to six weeks may be required to note changes in the transformation of the worm. A cabbage worm may be used in this exercise. Whatever insect is used, proper feed should be provided. Draw the stages of the life history of one insect. Look up the terms larva and pupa.

9. Scoring Fruits. — Score several samples of fruit, using the general score card found at the close of the preceding chapter. (Page 358.)

10. Study One Function of the Covering of Fruits. — Bring two apples to school; weigh the smaller one. Peel the larger and pare it down until its weight is the same as the weight of the other apple. Weigh apples on alternate days for about two or three weeks. Record weights. At the close of the exercise draw a conclusion as to one of the functions of the covering of fruits. Discuss the reasons for the change of weights in the apples tested.

Note. — Potatoes, peaches, or tomatoes may be used in this Exercise.

CHAPTER XXVII

THE FARMER'S WOOD LOT

Reasons for Having a Wood Lot. — Since the forests of the United States are being largely depleted, every farmer, especially in the prairie states, where conditions permit, should have a wood lot. A wood lot provides fuel, fence posts, telephone and telegraph poles, railroad cross ties, lumber for building purposes, and materials used in making furniture and cabinets. It is often placed so that it serves as a windbreak to the house, and to the farm animals. In other instances, it protects steep hillsides from the heavy washing rains. And sometimes, it may utilize waste lands. The wood lot is of considerable economic importance and should be considered as one of the regular farm crops.

Location of Wood Lots. — In many woodland sections, timber grows along streams and hillsides, occupying places which, in many instances, would otherwise be waste lands. In some cases the wood lot may be planted along the streams and the hillsides, places which cannot be tilled profitably.

In the colder prairie sections, the wood lot is often located just north and west of the house so that it breaks the sweep of the

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Pasteboard about 14 × 20 inches; small limbs of as many varieties of woods as can be found in the district. These should be provided by the pupils; limbs should be three inches long and three-fourths inch in diameter.

winter winds. In some sections, trees are planted for this purpose alone. Even if trees are to serve as a windbreak, it may be well to consider the additional point of planting trees that have an economic value. Too often trees are planted which have little money value. Every tree, besides serving its regular purpose, should be of such a nature that it can be sold and turned into money or used on the farm.

Trees may be set along roadsides for ornamentation, but not for the purpose of growing lumber. Trees along roadsides grow many branches and much vegetation, as trees always do when growing in places where there is plenty of room. Trees along pastures and fields lay a heavy tax upon the crops growing near them. A row of mature trees growing along a field a quarter of a mile long will use the plant food of at least an acre or more. Before trees are planted along fields the results should be carefully estimated. (See exercises at close of chapter.)

Varieties of Trees to Plant. — The variety of trees to plant depends upon the kind of soil in which they are to grow, the purpose for which they are to be used, and the climate. The trees growing in a locality indicate to some extent what kind of trees will be adaptable. Maples, box elders, oaks, willows, will grow in fairly fertile soils. Walnut, hardy catalpa, hickory, chestnut, locust, and others do better in a deep soil because they have deep-growing root systems. The Osage orange will grow almost anywhere, and though it grows very slowly it gives first-class post material. Oaks are among the best lumber trees grown, also Norway spruce, chestnut, white pine, and fir are the best kinds to plant in regions where they will thrive. Every state of the Union is encouraging the planting of trees and the protecting of forests. The United States Department of Agriculture, through its department entitled "Forest Service," is doing much to protect, promote, and stimulate an active interest in our forests.

Culture and Management of Wood Lots. — Wood lots are started either by planting seeds or by setting the trees. If seeds are planted, a large number of trees may be started in a comparatively small seed bed. When trees are about two years old, they may be planted into the permanent wood lot. The Forest Service recommends that, in most cases, trees be planted four feet apart each way. In growing forest trees, the best results

FIG. 182. — Conservative lumbering. Young growth saved, brush piled to prevent fire.

are obtained where the leaves of the trees will cover the soil as soon as possible. Forests frequently need cultivation for a few years. Such methods of pruning should be practiced as will cause trees to grow erect and tall.

In the management of a wood lot, the following points may be observed:

1. In cutting out trees for firewood, choose only the unshapely, diseased trees and limbs.

2. Young trees should not be cut, but left to grow for a later wood crop.

3. All tops should be removed and burned. Rubbish becomes a hiding place for insects and provides an excellent condition for wood fires.

4. Forests should never be thinned too much, for this causes the trees to grow too bushy.

5. Stock must be kept out of the wood lot until the trees are large enough not to be injured.

Summary. — The wood lot is of considerable economic importance, and should be considered as one of the regular farm crops. It may often be located on waste places. The varieties of trees planted vary with the purpose, kind of soil, and location available. Careful management of the wood lot the first four or five years is necessary for best results.

LABORATORY EXERCISES

1. **Mounting of Woods.** — Have pupils collect and mount, on pasteboard, parts of limbs of all the useful forest trees found in the locality. Both a longitudinal and a cross section of each kind mounted should be shown. Limbs three inches long and about three-fourths inch in diameter are best suited for this work. The mountings made by all the pupils should be practically uniform.

2. **Forest Trees and Wood Lot Forestry.** — Name five forest trees growing in your locality which would yield themselves to "Farm Lot" forestry. Discuss the use and value of each kind and describe the kind of soil best adapted to its growth.

3. **Kinds of Timber and Fence Posts.** — Name the kinds of timber used in making fence posts in your locality. What are different kinds of fence posts worth? What is the value of an acre of each kind of fence posts, provided 1275 posts are grown on an acre?

4. **Value of Lumber.** — Find the selling value per one thousand feet of at least five kinds of lumber sold in your locality.

5. **Composition on the Wood Supply.** — Write a two hundred word paper on "How Every Farmer May Aid in Keeping Up the Lumber Supply."

CHAPTER XXVIII

CHOOSING A FARM

FARMS are purchased for economic purposes and for the purpose of making homes. Both of these points are so important in the choice of a farm that Cato's advice given two thousand years ago may still be followed: "When you have decided to purchase a farm, be careful not to buy rashly; do not spare your visits, and be not content with a single tour of inspection. The more you go, the more will the place please you if it is worth your attention. Give heed to the appearance of the neighborhood — a flourishing country should show its prosperity. When you go in look about, so that, when need be, you can find your way out."[1]

The economic aspect, in purchasing a farm, is important. The farm should make a satisfactory home for every member of the family. The factors bearing upon these two points will be discussed in the following paragraphs. This brief treatise is general, and the statements made will not be without exceptions in many localities of the United States.

Economic Aspects in Choosing a Farm. — *The Soil.* The kind, lay, and fertility of the soil are of greatest importance. The principles set forth in the chapters on soils will help in determining whether a soil has the proper character. The texture, structure, amount of organic matter, and the depth of the soil are important things to consider. Free use of a post

Note to the Teacher: Work out data suggested at close of chapter.

[1] Warren: *Farm Management.*

hole digger, or soil auger, on every five acres of the farm, aids in this study. A depth of from 3 to 5 feet of the soil should be carefully examined. (Fig. 183.) A soil composed of about equal parts of clay and sand makes a good foundation. This with an additional supply of organic matter gives a desirable soil. Examining the soil and the subsoil with the hand, and washing some of the soil to find its sand content, helps in gaining a proper estimate of its real productive value.

FIG. 183. A soil auger made by welding a $\frac{3}{8}$-inch gas pipe to a $1\frac{1}{4}$-inch wood auger. An excellent tool in its proper use in estimating the value of land.

The Farm Improvements. Warren says upon this point, "The site of the farm, with respect to the fields, the number and kind of buildings, fences, and orchard, will of course be carefully inspected. Chief attention should be given to the roofs, foundations, frames of buildings, and least attention to paint. The arrangement for convenience in work is of importance.

"But one should be careful not to buy a farm merely for its buildings. Many Western men buying Eastern farms are buying buildings. The farms look cheap, because the buildings are worth more than the price asked. But there is no profit from buildings. In very many cases the farms never did pay. The early settler made his little income by lumbering, and used a generous amount of lumber for buildings. The lumber is gone; the farms have such poor soils that they do not pay for working. Of course this does not apply to the thousands of Eastern farms that have rich soils, but good soils are not given away with a present thrown in."[1]

Hunt states, "From an economic point of view it is possible that for general farming, it is not wise to invest more than one-

[1] Warren: *Farm Management.*

fourth the aggregate value of the farm in buildings of all kinds." Many farms have more capital invested in buildings than can be justified upon an economic basis. Farms with such necessary improvements in the way of buildings, fences, orchards, etc., all in good repair, can generally be purchased more cheaply than can an equal amount of land, plus the cost of putting on an equal amount of improvements. However, in regard to this matter there is no general rule, to which no exceptions can be laid down.

Where a farm is supplied with buildings, it should be observed whether or not the buildings conform with the type of farming for which the farm is to be purchased. A chicken house is usually a poor corn bin or sheep stable. If buildings must be rebuilt, the cost of doing so must be carefully estimated before a farm is purchased. (See Exercise 1.)

Markets. Good markets are important to the successful operation of a farm. Dairy and truck farms should be within three or four miles of a railroad station, which is in direct line to a good market. Grain farms may be a little farther away from the market, and where grains are fed to livestock the farm may be still a little farther from the station. Dairying and vegetable gardening are hazardous occupations if the farms are removed from the trunk line of a railroad. Direct transportation facilities are important in choosing a farm. (See Exercise 2.)

Roads. Kind of roads and methods of transportation affect materially the value of a farm. Good, level roads that are open all the year increase farm values wonderfully. Transporting a pound of material one mile on unpaved roads may require as much energy and cost as much as transporting ten pounds the same distance over a paved road. In other words, transportation over ten miles of good level roads may not cost any more than transporting the same goods over one mile of unpaved roads. Good roads bring the market nearer.

Coöperation. Another factor that may well be considered is the spirit of coöperation in a locality. Coöperation in purchasing things needed about the farm and selling farm products is very desirable in any community. It is generally true that \$10 will buy more than ten times as much as will \$1. Coöperative marketing is often very convenient and economical. One man may often haul the milk sold by ten or more dairymen living along one route. This saves time and labor. Machinery may be owned coöperatively. Farmers may coöperate to improve markets. Schools, churches, a library, and other valuable institutions may be had in a community which coöperates.

Size of Farms. One of the important factors in the selection of a farm is its size. The type of farming to be practiced will influence the amount of land needed. For truck farming a few acres may be sufficient. A larger farm is needed for grain farming, and in stock production even larger farms may be more economical. The labor, the farm implements, and the number of horses needed to do the work on 160 acres is not much greater than that needed to farm 80 acres. Very small farms mean unemployment for both man and horse. The old saying, "Three acres and a cow" or "Three acres and liberty," usually means unemployment and a small income. While no general rule can be stated as to the relation of size of farms to profits, it may well be borne in mind that farms large enough to use labor-saving machinery and employ constantly horse and man labor are essential to success in farming. The size of a farm must be considered in choosing a farm. (See Exercise 3.)

Choosing a Farm for a Home. — The healthfulness, the neighborhood, the privileges of the church, school, and community organizations are very important in the choice of a farm, — even as important as are the factors influencing the economic aspects of a farm. Suitable social surroundings concern parents more than the production of a crop. Providing such conditions in the rural communities that the boy and girl of the country are satisfied to live in the country, is a problem yet to be solved in most rural communities. The two important factors in causing the boy and the girl to remain on the farm are:

1. An economic income from the farm so that the conveniences of life may be had at least to a comfortable degree.

2. The building of such a home and community that the social wants of the family are supplied. The first of these points has been discussed in the above paragraphs. Some of the factors influencing the second will be mentioned in the following sections.

Healthfulness. To choose a farm that does not provide healthful conditions is to invite failure at once. The healthfulness of a home is all-important. The house should be located on an elevated, dry, well-drained spot. Low, swampy places are conducive to malaria, typhoid fever, and rheumatism. If an entire locality is unhealthful, it will require community coöperation to remove the cause and improve the conditions. In the choice of a farm its conditions for maintaining and promoting healthfulness must be carefully considered.

FIG. 184. — A landmark of learning. Better school buildings are being built to-day.

The Neighborhood. The moral standards, the progressiveness, the community spirit, and neighborliness are of vast importance in finally choosing a farm. Well-kept roads, schools, churches, homes, and farm improvements are indications of a desirable community. A high grade of stock and farms that are well planned and cultivated, characterize a good farmer, a good stockman, a good homemaker, and a desirable citizen and neighbor. Farmers and farmers' children are compelled to mingle with their neighbors in coöperative farm work, in church, in school, and in other organizations, and it is important that neighborliness and social kindness and a brotherly spirit prevail.

Schools. No one would purchase a farm in a locality where there are no schools. Schools enhance the value of lands, and

FIG. 185. – A school garden, an important factor in economic living in country or city.

are a great factor in the uplift of any community. To be able to locate near a town, village, or consolidated school may be worth from $5 to $10 an acre of land purchased. The consolidated schools of Iowa, Ohio, Missouri, Minnesota, North and South Dakota, Illinois, Wisconsin, and Indiana are very valuable to the communities in which they are located. Community transportation of children to schools is successful (Fig. 186) and fairly economical in many localities.

Churches. The opportunities for religious service are also important. The physical, intellectual, social, and religious development and training of children and adults are all essential. Often the schoolhouse is the center of all the social and religious functions of a community. The schoolhouse is public property and should be open for use to any gathering which has for its purpose the betterment of the community. The country church adds values which cannot be measured by money. In some

FIG. 186. — Conveying pupils to school. During winter months closed wagons are used.

instances it may be feasible in the construction of schoolhouses to add a room in which the community may have meetings of various kinds, — religious, educational, and social. Such a meeting place will help solve rural problems.

The "Federated Church" represents a neighborly, brotherly, spiritually united community. The Federated Church is a landmark in the evolution of community development. Such a locality is a good place for the establishment of a home.

Social Gatherings. Literary clubs, debating societies, spelling matches, farmers' organizations, are worth much to any community; they foster community coöperation and help the community to get what it wants. (See Exercises 4 and 5.)

Summary. — In choosing a farm the economic and home-making aspects are important. The fertility and productiveness of the soil, the farm improvements, the markets, and the size of the farm are conditions that affect the choice of a farm from an economic standpoint. The healthfulness, good neighbors, school, church, and social opportunities and facilities affect the choice of a farm from a home-making standpoint. The choice of a farm may either bring success or failure.

LABORATORY EXERCISES

1. To Approximate the Per Cent of Money Invested in Farm Buildings. — Have pupils determine from several farmers the value of their farm buildings. The value of separate buildings should be itemized. At the same time the value of the land should be asked for. The buildings represent what per cent of the total value of the land and buildings? Discuss the value of different buildings in their connection with the type of farming practiced.

2. To Study the Distance to Market. — Have each pupil determine the distance traveled to and from market upon the basis of the distance they live from market, if they go to market daily. Find the cost of a year's travel to market if it costs 15 cents a mile to transport the material they carry.

3. To Study the Size of Farms. — Have pupils find the size of all the farms in the school district, and record as follows:

Name of Farmer	Size of Farm, Acres	Kind of Farming

Discuss the size of at least two farms as to the type of farming practiced. For example, compare truck farming with general farming.

4. The Community. — Write a two hundred word essay on the locality, church, school, social organizations, and privileges, and healthfulness of the community.

5. Score Two Farms according to the Following Score Card. — Pupils copy score card in a permanent notebook.

Score Card for Farms[1]

	Points
1. Location	
1. Healthfulness of surroundings	5
2. Neighbors	5
3. Schools	5
4. Churches	5
2. Equipment	
1. Size of farms (as adapted to farming)	5
2. Natural advantages (wood, water drainage)	5
3. Improvements	
1. Ditches, tile drains, buildings	5
2. Site of farmstead	5
3. Shape and size of fields	5
3. Production	
1. Soil, natural fertility	10
2. Condition (freedom from stones, stumps, weeds, and waste land)	10
3. Topography (as affecting erosion, and ease of cultivation)	10
4. Climate (annual rainfall, temperature, frosts)	5
4. Transportation and markets	
1. Wagon roads (kind, and condition)	5
2. Local markets (kind, and distance)	10
3. Shipping facilities	5
Total	100

[1] Boss: *Farm Management.*

CHAPTER XXIX

PLANNING THE FARM[1]

Reasons for Planning the Farm. — The farm plan is generally determined by accident. Irregular pastures and fields are, therefore, very common. Fields are unequal in size, and are not suited to a well-organized system of crop rotation, or economy of labor. The reasons for planning a farm are as follows:

1. Fields of equal size should be laid out. This is essential to crop rotations.

2. Regular fields and pastures require less fencing, and can be tilled more economically.

3. Farms are planned so that all pastures and fields are easily accessible.

Shape of Fields. — Square fields require less fencing, but more time to plow and cultivate. Long fields are plowed, cultivated, and harvested with less energy than square fields, and a triangular field is not prepared, sown, plowed, and harvested as cheaply as a long field. Warren says: "The time required to plow an acre in a triangular field averaging 7 rods wide was found to be 6 hours and 51 minutes. The time for a rectangular field of this width was 6 hours and 23 minutes."

Size of Fields. — Large fields are more economically plowed,

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Twice as many pieces of cardboard (about 16 × 16 inches square) as there are pupils.

[1] See exercises at close of chapter.

tilled, and harvested than are small fields. Larger machinery, drawn by three or four horses, all handled by one man, reduces the cost per acre tilled. If the same amount of machinery is purchased to till 10 acres that may be used to till 40 acres, the cost of tools used per acre is increased.

A farm laid out according to the following plan is adapted to a good system of crop rotation:[1]

160 Rods

A 1904 Corn 1905 Barley sowed to timothy and clover 1906 Meadow 1907 Pasture 1908 Pasture 1909 Fodder 1910 Oats, manure — 20 A.	B 1904 Oats, manure 1905 Corn 1906 Barley seeded to timothy and clover 1907 Meadow 1908 Pasture 1909 Pasture 1910 Fodder corn — 20 A.
C 1904 Fodder corn 1905 Oats 1906 Corn 1907 Barley sowed to timothy and clover 1908 Meadow 1909 Pasture 1910 Pasture — 20 A.	D 1904 Pasture 1905 Fodder corn 1906 Oats, manure 1907 Barley seeded to timothy and clover 1908 Meadow 1909 Clover 1910 — 20 A.
H Sweet corn $2\frac{1}{2}$ I Roots $2\frac{1}{2}$ J Sorghum $2\frac{1}{2}$ K Millet $2\frac{1}{2}$ Barn House 20 A.	E 1904 Pasture 1905 Pasture 1906 Corn 1907 Oats 1908 Corn 1909 Barley seeded to timothy and clover 1910 Clover — 20 A.
F 1904 Meadow 1905 Pasture 1906 Pasture 1907 Fodder corn 1908 Oats, manure 1909 Corn 1910 Barley seeded to timothy and clover — 20 A.	G 1904 Barley seeded to timothy and clover 1905 Meadow 1906 Pasture 1907 Pasture 1908 Fodder 1909 Oats, manure 1910 Corn — 20 A.

[1] *Bulletin No. 236*, U. S. Department of Agriculture.

This farm is well planned for a six-crop rotation extending over 7 years. The fields are well arranged in size and shape for economical production. The farmstead and barns are connected with each field by a narrow lane, making all fields easily accessible.

The above plan not only has all the advantages accruing to it due to rotation of crops, but also has the following advantages:

1. In such a system there is seldom a complete failure. One or more of the six crops will bring good returns. When only one crop is attempted, there is often a complete failure.

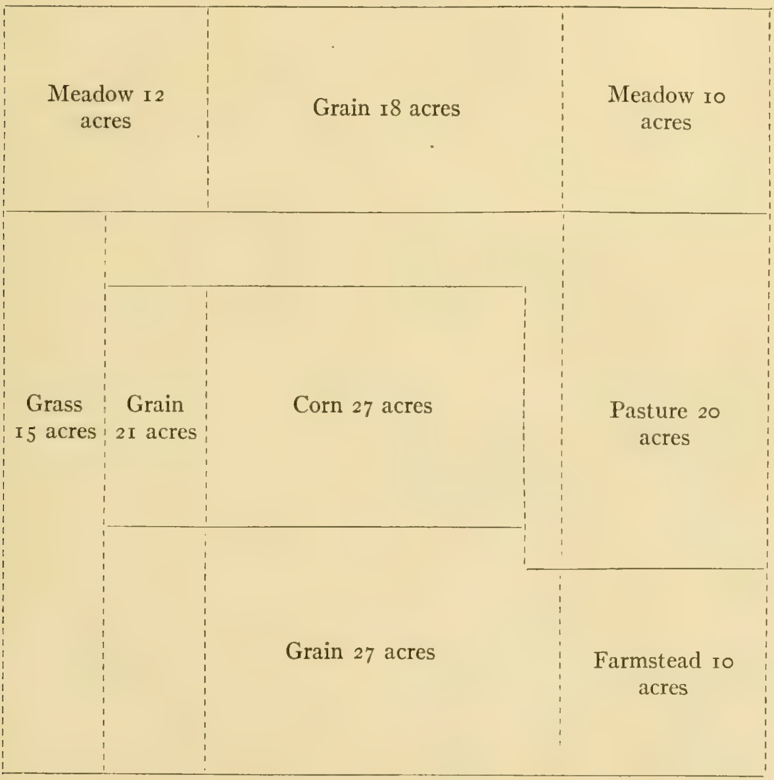
2. This plan means more steady and constant employment of man and horse labor. It has been estimated that the average farm horse in the Northern States works on the average for the year only about 3 hours a day. But at certain seasons of the year he works 10 or 12 hours, and at that time the farmer seldom has enough horses to do the required work. With a properly planned cropping system it will be possible to distribute the horse labor to secure twice the amount of work per horse, and thus reduce by one-half the number of horses required to farm a given area.

3. In the above-suggested plan the income is distributed throughout the year. The wheat farmers of the wheat states have an income only at one season of the year. This is true of any one-crop system. Where diversified crops are produced, the necessities and comforts of life are more certain to obtain every day in the year than where only one kind of farming is attempted.

Distance to Fields. — Locating farmsteads in the center of a farm reduces the distance to the fields of the farm. The distance from the house to each of the fields and back, on the farm illustrated above, is 640 rods. But if the house were located at the middle of one side, one trip to each field and back would make a distance of 1120 rods, a difference of 480 rods. With the barn located in the central portion of the farm, four fields are immediately accessible, but if it were located at B only two fields are directly accessible.

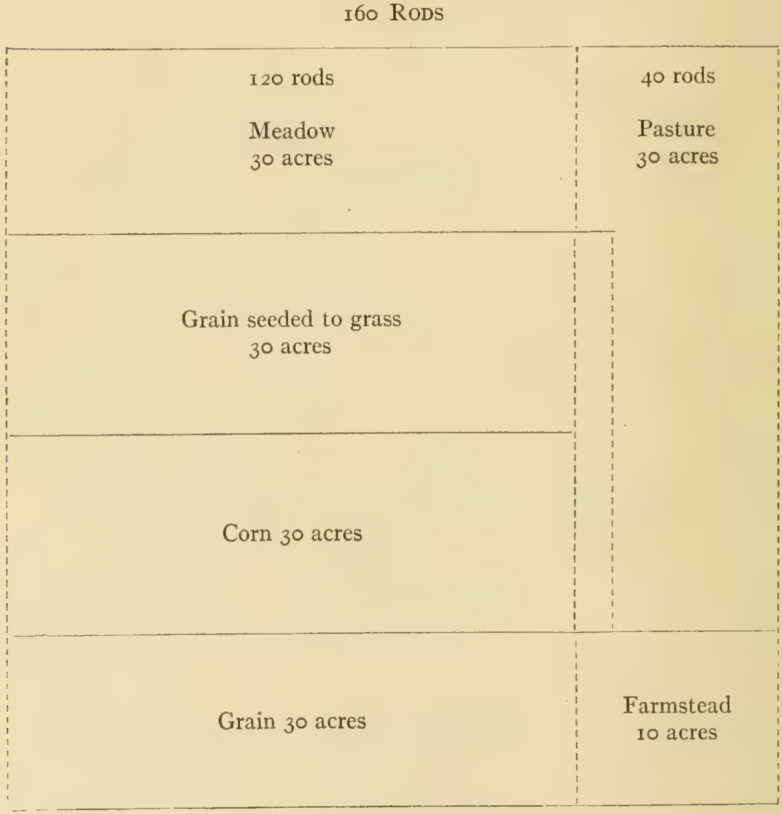
Replanning Farms. — Many unorganized farms may be reorganized to good advantage. The following plan shows an unorganized farm:

160 Rods



A Poorly Organized Farm.

This farm is poorly planned because the fields are unequal in size, some very small and several of them almost square; although streams and other surface features, and roads, do not interfere in making the plan. The following diagram shows the same farm after it was reorganized. Compare the two plans.



Same Farm Reorganized.[1]

[1] *Bulletin No. 236*, U. S. Department of Agriculture.

Although the reorganized farm requires a little more fencing, its advantages over the unorganized plan are evident when it comes to the question of tilling.

Summary. — Farms should be planned. To arrange fields so that they are about equal in size is important in the production of crops and in rotation systems. Long rectangular fields are more cheaply cultivated. If the house and farm buildings are located near the center of the farm, the fields are more easily accessible. Many farms may be replanned to advantage.

LABORATORY EXERCISES

1. **Estimating the Cost of Fencing a Farm.** — Find the amount of fences required to fence the fields indicated in the first farm plan of this chapter. Find the cost to fence all the fields if fence costs sixty-five cents per rod.

2. **Mapping a Farm.** — Make an outline map to scale, showing all fences, streams, and buildings of some farm. Show in the same drawing the crops that have been grown in the different fields for several years past.

3. **Reorganizing and Replanning a Farm.** — Revise the plan of the farm in Exercise 2, so that it can be tilled more economically, and is adapted to a well-arranged rotation of crops.

4. **Estimating the Cost of Man and Horse Labor on a Farm.** — Figure the number of days of man and horse labor required to grow one season's crops on the farm of the first figure given in this chapter. (Include days for plowing, harrowing, harvesting, etc.) If man labor is worth $1.50 per day, and horse labor is worth $.50 per day, what is the cost of labor on the farm?

CHAPTER XXX

FARM BOOKKEEPING

Reasons for Bookkeeping on the Farm. — Bookkeeping on the farm has the following advantages:

1. The farmer may know whether he is making or losing, whether his assets are increasing or decreasing.

2. If books are kept, the farmer may know just what each particular line of farming is doing. He knows whether it is increasing or decreasing his profits. Often farmers think that a certain line of farming is profitable when it really is not; and conversely, often the stock or crops they think are losing money may be the most profitable.

3. Farm bookkeeping makes farming systematic. In this way farm records are as important to the farmer as banking records are to the banker.

4. It will bring larger dividends for the amount of time spent upon it than an equal time spent upon any other farm operation.

What Books to Keep. — All bookkeeping should be simple. A definite plan should be followed, including the following points:

1. An inventory.
2. Accounts of different crops.
3. Accounts of different kinds of stock.
4. Accounts of the poultry.
5. Accounts of the orchard, garden, and pasture.

Note to the Teacher: The materials needed to do the Laboratory Exercises suggested at the close of this chapter are:

Forms on which pupils can make an inventory of a farm, farm receipts and expenditures.

The Farm Inventory. — An inventory taken yearly of the farm stock, poultry, crops, buildings, and machinery is the most important of all the farm records. This farm inventory may be taken at any time of the year. Some farmers take their inventory January first; others may prefer to take theirs in March, April, or May. At the close of the year another inventory should be taken. Values placed upon things in the inventory should be average values. To put the values too high or too low defeats the purpose of an inventory.

Sample Farm Inventory — April 1

	No.	Rate	1917	1918	1919	1920	1921
Land	160 A.	$50.00	$8000				
	100 A.	52.00		$5200			
Horses . . .	5	108.00	540				
	4	112.00		448			
Colts							

Continue this method for dairy cattle, sheep, swine, poultry, farm machinery, farm products, corn, wheat, oats, hay, etc. The divisions and topics included in the farm inventory depend on local conditions and individual farmers. Itemizing machinery will depend upon the taste of the individual farmer. Taking the inventory in considerable detail may prove satisfactory in later years. By the above outline, inventories may be kept for five successive years. (See Exercise 1.)

Another type of inventory is the following:[1]

1. Real estate:		
Land (160 acres at $50.00)	$8,000.00	
Improvements:		
40 rods tile drain at $3.00	120.00	
240 rods woven wire fence at 70¢	168.00	$8,288.00
2. Buildings:		
House	2,000.00	
Barn	1,500.00	
Other buildings	800.00	4,300.00
3. Live stock:		
Four horses at $175.00	700.00	
Ten cows at $60.00	600.00	
Six brood sows at $20.00	120.00	
Twenty sheep at $8.00	160.00	
Seventy-five hens at 40¢	30.00	1,610.00
4. Implements and tools:		
One plow	12.00	
One grain drill	45.00	
(List each machine on the farm as above.)		
Tools. (List separately all tools valued at $2.00 or more. Those under $2.00 may be included in a lump sum as hand tools.)	20.00	77.00
5. Operating capital:		
Check account at bank	72.00	
Cash in pocket	22.50	94.50
6. Feed and supplies:		
300 bushels oats at 30¢	90.00	
Two tons bran at $22.00	44.00	
Twenty tons hay at $7.00	140.00	
Two bushels clover seed at $9.00	18.00	292.00
		$14,661.50

Farm Receipts. — The income of the farm may be kept in different forms. The following is suggestive for the income from chickens:

[1] Boss: *Farm Management.*

Egg Record — Year 1917

Date	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
Total												
Dozen												
Value												

The above gives a detailed record for the poultry flock for the year. Receipts for fowls that are sold may be recorded in the above table. If studied with the inventory, it will give a fair notion of the profit from hens.

Records of dairy cows and of the herd may be kept in a similar way, with slight changes. No up-to-date dairyman will handle a herd without keeping each cow's record. For suggestions on keeping records of the dairy, turn to the chapter on dairying.

Receipts of other farm products may be recorded in the simplest fashion possible. The following is one way in which it may be kept.

Date	Kind and Amount Sold	Price	Value

In this table all receipts may be summarized for the year, and the total income for the year be found. (See Exercise 2.)

Farm Expenditures. — To keep an accurate record of farm expenditures is just as important as to keep the farm receipts. Monthly expenditures for groceries, clothing, feed, and implements should be kept. The following form may aid in keeping this record:

DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
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20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
Total expenditure												

If an inventory has been carefully taken, and the yearly income and expenditure are known, the financial standing may be easily figured. If the inventory remained the same, and the total income for the year was $980 and the expenditure $590, then the financial gain would be the difference between $980 and $590, or $390. So if the inventory remains the same, the profits or losses may be found by subtracting the expenditures from the receipts. If the inventory increases, the increase may be added to the profits. If it decreases, it should be subtracted from the income.

These simple suggestions in farm bookkeeping will help in putting the farm practices on a better business footing. (See Exercises 3 and 4.)

Summary. — Farm inventories taken yearly are the most important records a farmer can keep. Good judgment should be exercised in placing estimates on the value of things recorded in the inventory. Farm receipts will show in a general way the profit from various farm operations. Keeping a record of expenditures is also worth while. If the inventory remains the same, the receipts and expenditures will show quickly the financial standing of the farm. This is as important to the farmer as it is to the banker.

LABORATORY EXERCISES

1. **To Take an Inventory of a Farm.** — Take an inventory of some farm, according to the plan above suggested. Record the inventory under different headings, as shown in the paragraph on the farm inventory.

2. **Farm Receipts.** — Keep the income of a farm for a month. Pupil and teacher may devise a plan for keeping the receipts.

3. **Farm Expenditures.** — Have pupils keep in a suitable form the expenditures in their home for one month. Compare receipts and expenditures for the month.

4. **Per Cent Invested in Different Parts of the Farm.** — From the inventory taken in Exercise 1, figure the per cent of money invested in each part of the farm.

CHAPTER XXXI

FARM LABOR

Economy of Farm Labor. — It has been estimated that the average farm horse in the Northern States works 3.5 hours a day. The average number of hours worked by the farmers and their hired hands does not exceed more than 5 hours a day. If it costs 35 cents to keep a horse a day, his labor is worth 10 cents an hour. If man's labor is worth $1.50 a day, his labor costs 30 cents an hour. If we double the number of hours worked a day on an average, and if labor can be employed profitably, the cost of labor is reduced one-half.

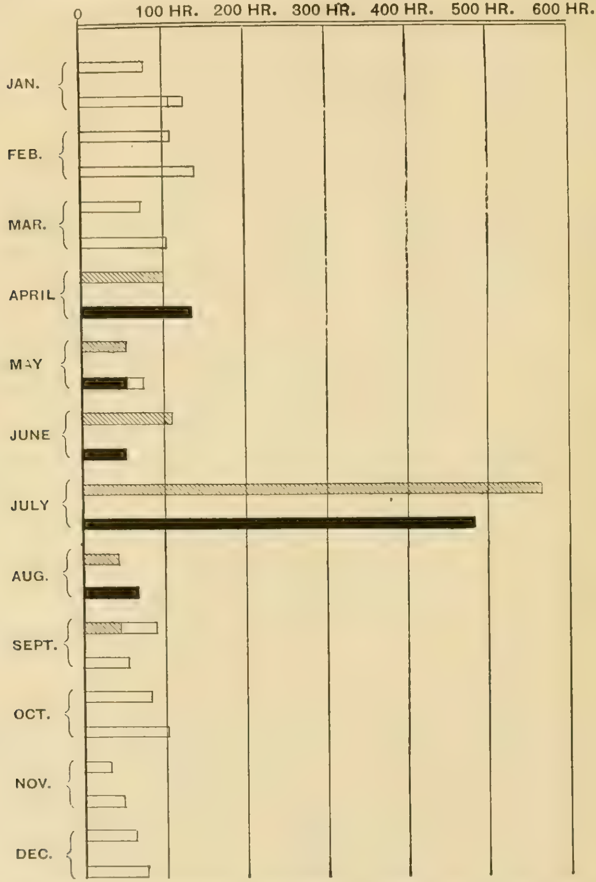
O. R. Johnson [1] found that the average number of hours worked a day by horses on three different farms was 3.9 hours, and by man 9.9 hours. He also found that men on these farms worked 3272.3 hours a year, and that each horse worked 1216.6 hours a year.

Factors that Prevent an Equal Distribution of Farm Labor. — The seasonal nature of farm work is one of the greatest factors affecting the constant employment of horse and man labor. Most of the production and harvesting of crops comes in the summer season. Horses and men are both worked hard during the summer months. In winter months men and horses are idle a large part of the time. To illustrate the amount of horse

Note to the Teacher: Follow suggestions at close of chapter.

[1] *Missouri Bulletin, No. 36.*

and man labor in the production of a timothy hay crop, the following diagram is given:[1]



GRAPH 12. Hours of labor given to 67 acres of timothy hay. The upper line in each month represents man labor; the lower, horse labor. The black and the gray lines indicate time given to seeding, haying, etc., and the white lines, manuring, baling, marketing, etc.

[1] All data for graphs, unless otherwise stated, are taken from Warren's *Farm Management*.

Analyzing the above graph, we find that the number of hours of man labor given to the production of 67 acres of timothy hay was 1025, and that more than half of this labor was required during the month of July. The amount of horse labor required to produce the 67 acres of timothy hay was 1125 hours. Almost half of this time (475 hr.) was used in the month of July. If this were the only crop produced, the labor of man and horse is employed about one-half of the time. This means unemployment, and that the cost of both man and horse labor is doubled.

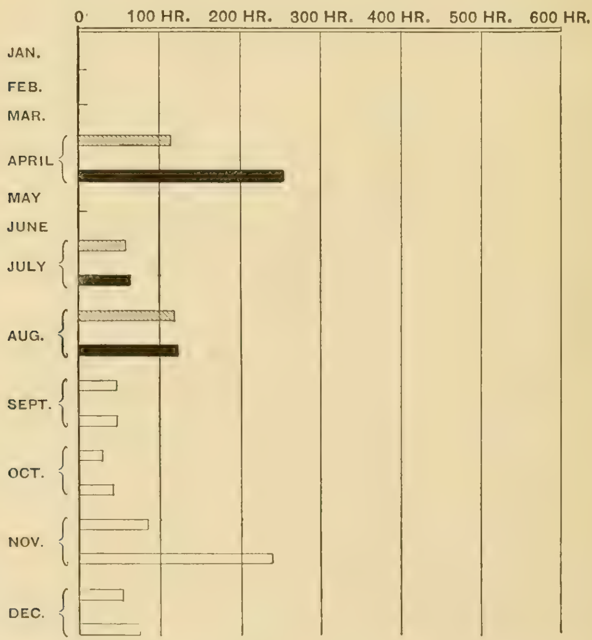
The demands for both horse and man labor are greater in the summer months. Practically all the crops need a great deal more attention in summer than during other seasons of the year.

Another factor that prevents equal distribution of farm labor is the unequal sizes of fields. To devote about the same acreage to the same crops from year to year has a tendency to make farm labor more stable. The farmer can plan his labor fairly well if he tends 40 acres respectively of corn, wheat, oats, and alfalfa hay. But if he omits one of these crops for a year, his general scheme of labor may become entirely unbalanced.

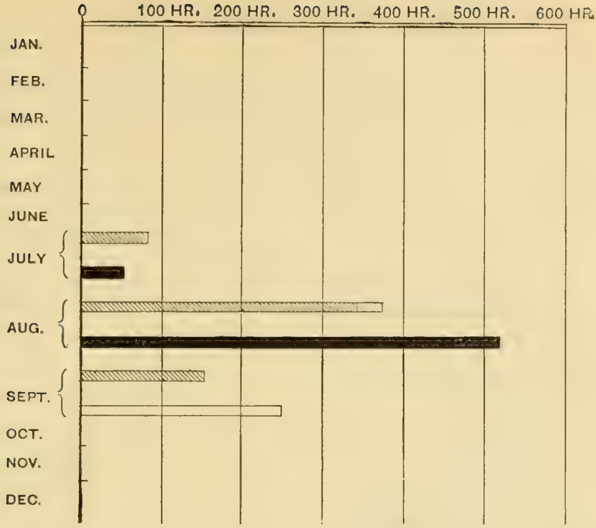
A third factor that prevents an equal distribution of farm labor is the kind of farming practiced. As was illustrated above, timothy farming requires about half of the labor in the month of July, or, in other words, half of the work must be done in one-twelfth of the year. Similarly, wheat producers, cattle growers, corn raisers, and other farmers producing one product have most of their work during a few months of the year.

Working only a few months of the year means high-priced labor. If a man works only one-twelfth of the time, his labor must be rated high. If 2400 hours constitutes a year's work, worth fifteen cents an hour, his labor is worth $360, but to pay $360 for a month's labor of thirty days, say of ten hours each, makes the cost of labor $1.20 an hour. Horse labor may be figured likewise. To feed, stable, and care for a horse for 365 days when he works only a few days, makes the cost of horse labor very high. (See Exercises 1 and 2.)

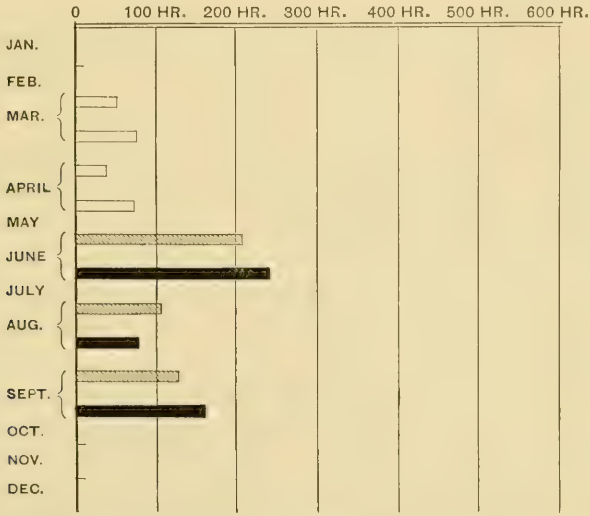
Distribution of Labor with Different Crops. — In the production of oats, April, July, and August are the busy months. Sowing time is in April, and July and August are the months of harvest. The following graphs give an idea of the distribution of horse and man labor in the cultivation of stated amounts of several crops:



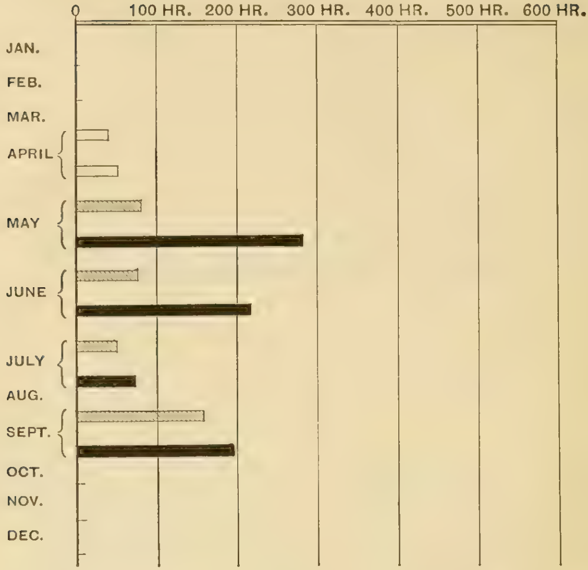
GRAPH 13. Hours of labor given to 23 acres of oats. The upper line in each month represents man labor; the lower, horse labor. The black and the gray lines represent time given to sowing, harvesting, etc.; the white, to threshing and plowing.



GRAPH 14. Hours of labor given to 23 acres of wheat. The upper line in each month represents man labor; the lower, horse labor. The black and the gray lines represent time given to harvesting, threshing, etc.; the white line, to plowing, etc.



GRAPH 15. Hours of labor given to 11 acres of potatoes. The upper line in each month represents man labor; the lower, horse labor; the black and the gray lines, time given to planting, cultivating, digging, etc.; the white, plowing and marketing.



GRAPH 16. Hours of labor given to 14 acres of silage corn. The upper line in each month represents man labor; the lower, horse labor; black and gray lines represent planting, cultivating, harvesting; white represent plowing.

From the foregoing graphs it will be observed that, in crop production, the greatest part of both man and horse labor is demanded in the summer months.

Farming is a seasonal occupation, an occupation that can be carried on better in one season of the year than another. It is important that the farm be managed so that every season shall have suitable and paying work.

Professor O. R. Johnson[1] has tabulated the man and horse labor requirements of common crops on the basis of hours for each acre production. And for the crops, oats, wheat, timothy, and corn he gives us the following interesting data:

[1] In *Bulletin No. 6* of the Agricultural College, Columbia, Missouri.

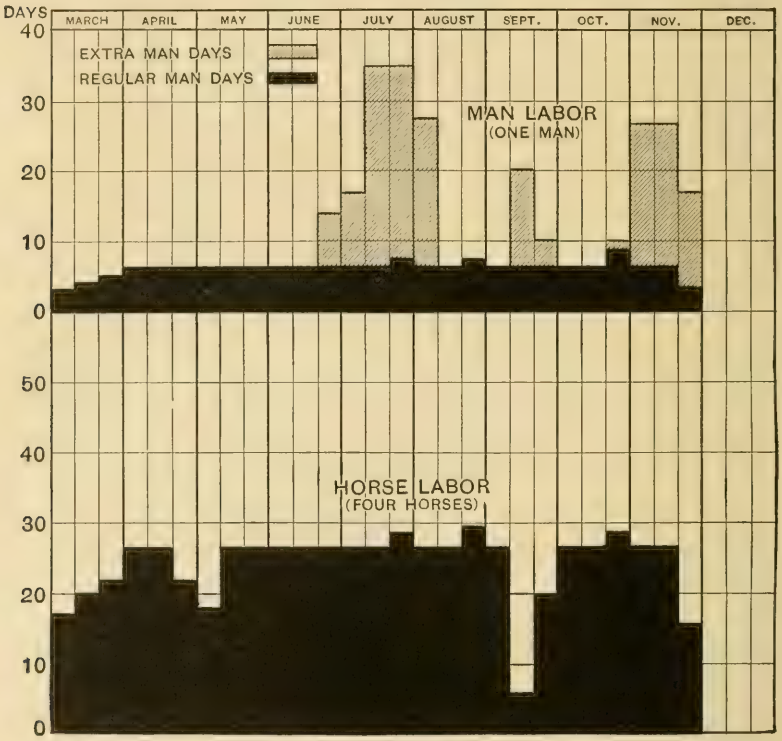
MAN AND HORSE LABOR REQUIREMENTS OF COMMON CROPS, PER ACREAGE PRODUCTION

	Oats		Wheat		Timothy		Corn	
	Man, Hr.	Horse, Hr.	Man, Hr.	Horse, Hr.	Man, Hr.	Horse, Hr.	Man, Hr.	Horse, Hr.
Jan. .							.55	.28
Feb. .							.48	.10
March .	2.92	6.65					.15	
April .	1.32	2.93					1.84	4.57
May .	.26	.79					6.38	14.09
June .	1.11	.87	3.2	3.2	.48	.63	6.72	10.91
July .	3.50	3.69	6.4	6.5	6.02	9.02	2.14	3.25
Aug. .	1.16	1.29	1.62	3.1			1.84	1.17
Sept. .	.17	.21	2.70	5.1			5.03	1.73
Oct. .			4.2	7.3			.78	.72
Nov. .			.26	.5			3.14	1.77
Dec. .							2.55	1.61
Totals	10.44	16.42	18.38	25.7	6.50	9.65	31.60	40.20

This table likewise shows the distribution of labor required to produce an acre of the crop indicated. Of course the amount of horse and man labor will vary with seasons, location, and type of implement used. But it may be concluded that with the production of the above crops neither horse nor man labor can be steadily employed. (See Exercise 3.)

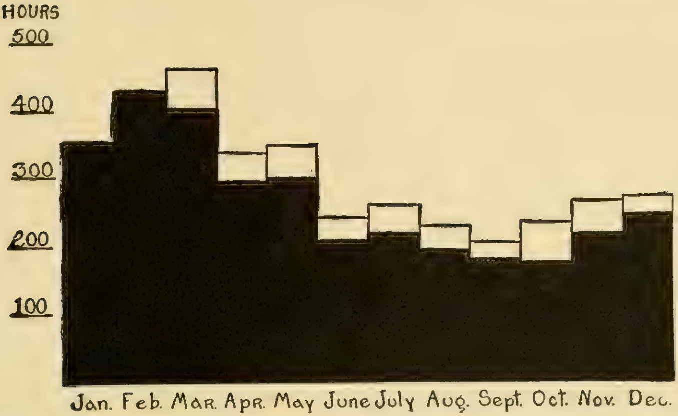
Two Examples of Fairly Constant Distribution of Farm Labor. — The first illustration is taken from the 1911 United States Yearbook of Agriculture. It shows the estimated distribution of labor on a 240-acre farm, where 80 acres each of corn, wheat, timothy, and clover hay are grown. (Graph 17.)

The months are divided into the ten-day periods. One man and four horses did all the work, except a little labor that was employed in June, July, August, September, and November as indicated. In the farm there were six fields of forty acres each, and the rotation was corn, corn, wheat, wheat, hay, hay. The constant distribution of farm labor will be noted.



GRAPH 17. Estimated distribution of labor on 80 acres each of corn, wheat, and timothy hay, and of clover hay in the latitude of Missouri. One man and four horses regularly employed. Extra man labor at harvest. Rotation: corn, corn, wheat, wheat, hay, hay.

The second illustration is taken from Warren's *Farm Management*. It shows the distribution of man labor on eighteen cows that are being milked, and eleven other cows. (Graph 18.)



GRAPH 18. Distribution of man labor on 18 cows and 11 other cattle. White is milk hauling.

From this graph it will be observed that dairying furnishes constant employment the year round. The conclusions that are drawn should pertain to farm labor.

Factors Helping in the Distribution of Labor. — The preceding paragraphs illustrate that diversification of farm operations tends to distribute farm labor.

Planning work and keeping a daily schedule of work helps distribute farm labor. A well-planned labor schedule will increase the efficiency of farm work from 5 to 10 per cent. As a rainy day schedule the following may be suggestive: clean grain, test seed corn and other seed for germination; repair gates, doors, windows; oil machinery, wagons, carriages, and harnesses; paint interior of buildings, hayracks; sharpen tools and implements; clean and whitewash poultry houses; prepare feeds; bring farm accounts up to date; and read agricultural papers and books.

The planning of work to cover an entire year is one of the greatest aids in the distribution of farm labor. With a well-planned "labor schedule" the congestion of certain seasons may be largely avoided.

A man who plans his work well does not have to get his plow sharpened or fixed on the day when he can plow. The binder, cultivator, and other tools will be ready for work when the right time arrives to use them. Seed corn will have been tested several weeks before it is to be used. Overhauling, repairing, and other work may be done at odd times and will not interfere with the work of planting, harvesting, and cultivating important crops. Preparing bins and granaries will precede their use a week or two. A work schedule will economize labor. Johnson says, "With a well planned labor schedule the manager will never send the men to cut brush along the fence rows when the binder must be overhauled for wheat cutting to-morrow, or the day after, or the granaries made ready for threshing. When planting time begins, the first day or two of good weather will not be wasted in getting seed cleaned or getting the machinery in running order."[1] (See Exercises 4 and 5.)

Summary. — Farm labor is often not well distributed. The fact that men and horses work so few hours during the year increases the value of their labor, but decreases the opportunities of the farmer to do a great amount of work. Most farm crops demand the labor devoted to them in the summer season. Dairying and diversified farming tend to distribute farm labor, and give constant employment — two desirable points in farm management.

LABORATORY EXERCISES

1. **Study of Farm Labor.** — Have pupils bring a statement of the actual number of hours a farmer worked for one week. If his labor is worth $360 a year, what is the value of his labor an hour according to the answer to the first sentence of this exercise?

[1] Johnson: *Bulletin No. 6,* Missouri Station.

2. An Estimate of the Horse and Man Labor Required to Till and Harvest Some Crop. — Pupils are to secure from some farmer an estimate of the number of days (reduced to hours) of both horse and man labor necessary to produce some crop per acre which he plans to raise the following year. The distribution of labor should be graphed by the pupils according to its distribution by months.

3. Estimating Cost of Man and Horse Labor to Produce an Acre of Different Crops. — If man labor is worth 18 cents an hour, and horse labor is worth 9 cents an hour, what is the cost of producing an acre of oats, of wheat, and of corn, according to Johnson's data?

4. Arranging a Labor Schedule for a Rainy Day. — Name six or eight things that may be done during a rainy day.

5. To Study the Distribution of Labor on a Dairy Farm. — If there is a dairy farm in the neighborhood, have the proprietor estimate by months the number of hours of man and horse labor required to care for it a year. The results should be illustrated by a graph.

CHAPTER XXXII

THE RELATION OF ANIMAL HUSBANDRY TO PERMANENT AGRICULTURE

THE virgin soils of our land have been exploited and robbed of their plant nutrients to such an extent that Conservation of Soil Fertility Congresses, our Agricultural Colleges and Experiment Stations, the United States Government itself, and all informed farmers have turned their thoughts and efforts to such farm practices as will prevent the further exhaustion of our soils. Some principles pertaining to the conservation of our soil have already been studied in the chapters on soils, field crops, animal husbandry, and farm management. It is not the purpose of this chapter to convey the notion that animal husbandry is the only way of maintaining soil fertility, nor is it urged that every farm should be a stock farm. For there are many other farm practices which help to conserve our soils, increase our crop yields, and tend to make our people happy and prosperous, and are conducive to permanent agriculture.

The purpose of this chapter is to indicate how animals tend to make American agriculture more permanent. Some of the benefits which may accrue from animal husbandry farming, and which make our agriculture more permanent, are the following:

1. Animals help in maintaining the fertility of the soil.
2. Stock farming tends to a better system of crop rotation.
3. Feeds that otherwise would be partially wasted are utilized.

4. Animals manufacture raw materials into a marketable product.

5. Stock farming gives more constant employment.

6. Stock often increase the profits.

7. The leading nations in their periods of greatest prosperity have been producers of animals.

8. Animal husbandry tends toward a progressive agriculture and more intelligent farming.

These topics will be discussed in the order named.

Animals Aid in Maintaining the Fertility of the Soil. — Every schoolboy or schoolgirl or farmer who reads this knows that constant cropping and selling the crops tends to make the soil less productive from year to year. Grain and hay crops, if sold from the farm, remove plant foods as follows:

Crop	Fertilizing Constituents in One Ton			Fertility Value per Ton	Manurial Value per Ton
	Nitrogen, Pounds	Phosphoric Acid, Pounds	Potash, Pounds		
Dent corn (grain)	32.4	13.8	8.0	$ 6.85	$ 5.48
Wheat	39.6	17.2	10.6	8.83	6.74
Oats	39.6	16.2	11.2	8.42	6.74
Timothy hay . .	19.9	6.2	27.2	5.20	4.16
Red clover hay .	41.0	7.8	32.6	9.36	7.49
Oat straw . . .	11.6	4.2	30.0	3.78	3.02
Corn silage . .	6.8	3.2	8.8	1.81	1.45
Cottonseed meal, choice . . .	141.2	53.4	36.2	29.63	23.70

From this table it will be observed that if two thousand pounds of dent corn be taken from a farm, 32.4 pounds of nitrogen, 13.8 pounds phosphoric acid, and 8.0 pounds of potash are taken from the soil. These ingredients sell at an average of 18.0, 4.5, and 5.0 cents per pound, respectively, when purchased in commercial fertilizers. At this rate a ton of corn removes $6.85 worth of soil fertility. It has been found by experimentation that when feed is fed the average animal, 80 per cent of the food nutrients in the feed are voided in the manurial product. The manurial value given in the last column of the above table is in each case 80 per cent of the fertility value of the food named. The manurial value of feed stuffs varies, as the table indicates, with the composition of feeding stuffs. The table deserves close study.

When animals or animal products are taken from the farm, much less fertility is removed; and especially is this true when the fertility value of the feed out of which the finished product is made, is compared to the animal product sold. This particular point is too difficult to present here. However, the fertilizing constituents of a few animal products are as follows:

	Fertilizing Constituents per Ton			Fertility Value per Ton	Manurial Value per Ton
	Nitrogen, Pounds	Phosphoric Acid, Pounds	Potash, Pounds		
Fat pig	35.4	13.0	2.8	$7.10	
Fat ox	46.6	31.0	2.6	9.96	
Milk	11.6	4.0	3.4	2.43	$1.94
Butter	2.4	0.8	0.8	.51	

Compare this table with the preceding one. A ton of pigs remove $7.10 worth of fertility and dent corn $6.85 of fertility. When the fact is recalled that it requires from five to six tons of corn to make one ton of pork, and that 80 per cent of its fertilizing value is returned to the soil, we may conclude that animal husbandry tends to maintain soil fertility. It has been summed up thus: "A farmer selling hay sells in the form of fertilizer value, one half as much as he receives; if he sells pork, he receives twenty times as much for it as the value of the fertilizers contained in it; if milk, forty times; and if butter, one thousand times."[1]

See the preceding chapters, and especially the chapters on dairying, swine production, and sheep raising, on the relation of animal husbandry to the maintenance of soil fertility. (Also read the chapter on barnyard manures.) (See Exercise 1.)

Stock Farming Tends to a Better System of Crop Rotation. — Where grain farming is practiced, only one or two crops are usually produced. Such a practice caused our soils to become less productive. The United States Yearbooks clearly indicate that the acreage yields of the leading American farm crops became less and less up to about 1900, and from then on our acreage yields have been gradually increasing. The increase in crop yields the last fifteen years has been due to better methods of seed selection, seed testing, better methods of cultivation, rotation of crops, etc. The decrease in acreage yields previous to 1900 was due to a system of grain farming in which only one or two kinds of crops were produced, sold off the farm, and nothing returned.

In any kind of stock production a liberal use of pasture crops makes for cheap gains. The liberal use of the leguminous crops in pork, mutton, beef, and milk production, taking one year with another, cheapens production. Many farmers are beginning to realize that it is expensive to import feeds. It is for this reason that farmers are studying and planning how they may grow crops, so that they will have a well-balanced feed, and at the same time not deplete the soil. The solution of this problem is a proper balance of grain crops to furnish the carbohydrate material, and the growing of clovers, alfalfa, soybeans,

[1] Burkett: *Feeding Farm Animals.*

and cowpeas, which furnish the protein of the feed. The latter crops tend to balance the grain ration, and at the same time restore nitrogen to the soil. Read the chapters on the leguminous crops, pasture grasses, the chapter on swine production, and the discussion in connection with the rotation of crops.

In Stock Farming a Great Deal of Feed is Utilized that would be almost wholly Wasted if Grain Farming were Practiced. — The grass that grows along streams, fences, and roadways would be lost if not consumed by grazing animals. Much land that cannot be tilled profitably is used as grazing land. Corn fields where the ears have been gathered, furnish a great deal of roughness for a month or more, to cattle, sheep, and horses. Straw stacks and the grasses and weeds in stubble fields will produce a fine product. The screenings at threshing time furnish excellent feed for the poultry for several weeks. A small flock of sheep are kept on many farms simply as plant scavengers. The large quantity of weeds they consume are transformed into wool and mutton. Goats, in many sections, help greatly in renovating pastures of sprouts and weeds. There are very few sprouts goats will not eat. Their services in renovating pastures may often be worth from 50 cents to $1 per acre. Turkeys roam over pastures and fields, eating grasshoppers and other insects. The dairy, the garden, the orchard, the field, and the roadside provide feeds which, if utilized, may bring a fair income and change the farm operation from a losing one to a profitable one. The small odds and ends utilized by animals may mean the difference between success and failure, for to a considerable extent the profits thus secured are almost pure profits. (See Exercises 2 and 3.)

Animals Manufacture Raw Materials into a Marketable Product. — As we have seen in the discussion of the preceding topic, animals transform many unsalable feeds into fine, salable products. The animal is a manufacturer. Not only are the cheap feed stuffs thus utilized, but the corn, silage, hays, bran, cottonseed meal, and various other crops and their by-products are used by animals, and converted into salable products. The following facts in a general way indicate the manufacturing capacity of various farm animals:

Animal	Feed	Amount of Product Produced	Approximate Value
Dairy cow	Corn silage 30 lb., alfalfa 10 lb., corn 6 lb., bran 2 lb., water 75 lb.	25 lb. milk, test 4.0% or one pound butterfat	35 cents
Swine	5–6 lb. corn	One pound pork	7½ cents
Sheep	8–9 lb. corn	One pound mutton	7½ cents
Steer	10–11 lb. corn	One pound beef	7½ cents

It should not be concluded from this table that one kind of animal produces meat more economically than others. The table is not recorded for that purpose. The table simply indicates that animals are manufacturers. When the fact is recalled that sheep consume feeds that hogs will not use, the conclusion may be drawn that sheep are the most profitable of all the animals, under certain conditions.

The raw products cannot always be shipped to market profitably. For illustration, the dairy cow utilized about 48 pounds of feed stuffs to manufacture one pound of butter. The raw materials have a low selling value per pound, but a pound of butter may sell for 35 cents per pound. The freight charges in transporting the raw materials would be extremely costly in proportion to the value of the product sent; while the finished product can be shipped at a comparatively low cost. Animals hold an important relation to permanent agriculture because they are manufacturers.

Stock Farming Gives More Constant Employment. — It tends to distribute labor. In grain farming all the labor is demanded in a short period. Stock farming causes a diversity of crops to be grown, and this of itself causes a more even distribution of

FIG. 187. — A Longhorn bull in poor condition. Bankers do not give loans on scrub cattle.

labor, and stock always needs attention. As was indicated in the previous chapter, all the labor in connection with timothy hay comes in about one month, or one-twelfth of the entire year Generally speaking, men get paid according to the time they work; one-twelfth time, one-twelfth pay. Read the chapter on farm labor. Our agriculture will not be nearly so permanent until the labor on the farm becomes more constant. Stock farming tends to give constant employment.

Stock Farming will often Increase the Profits. — This is especially true where young stock, stock of the proper conformation, quality, and disposition, are used, and where the farmer knows how to secure economic gains from them. Bankers seldom turn down a loan on young growing stock, especially if it is of the right kind. See the contrast in Figs. 187 and 188.

The Leading Nations in their Periods of Greatest Prosperity

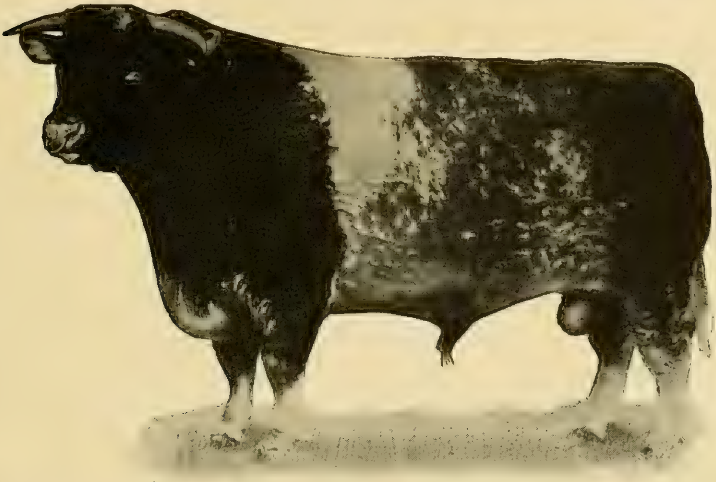


Fig. 188. — A Shorthorn bull in good condition. Bankers do not refuse loans on such cattle.

have been Producers of Animals. — The nations which are the leading and most progressive have been and are consumers of large quantities of meat and animal products. They likewise are consumers of vegetable products. Those nations which have a low state of civilization consume either meats alone or vegetable products alone. The barbarian uses either an entire meat diet, or an entire grain diet. The nations that consume either exclusively are usually in a low state of civilization. We need to refer only to China and Russia to illustrate this point. The Romans, Greeks, and Hebrews consumed meat to a considerable extent. From the first two races we received much in the way of laws and literature; from the Hebrews we received the Old and the New Testament, and Christianity. The Teutonic race, comprising the peoples of England, Germany, and America, contributed the democratic system of government, — all are and were liberal meat eaters.

Even the states of the United States that are the most progressive, as shown by their roads, schools, farm implements, and stock, are greater producers of animals than are those states more backward along these lines. On this point in connection with dairying, Professor Eckles states in *Dairy Cattle and Milk Production*, "If a list were prepared of our own states, selecting those where the average soil fertility is best conserved, the most intelligence found among the people, it would be a list of the leading dairy states." The American people are consumers of greater quantities of animal products per capita than are the peoples of any other nation. And where may a superior people, both physically and mentally, be found? Well-developed men and women, physically and mentally, are necessary for a permanent agriculture.

Animal Husbandry Tends toward a More Progressive Agriculture and More Intelligent Farming. — One of the simplest forms of agriculture was that practiced by the wandering shepherds described in the Bible. The shepherds drove their flocks to new pastures. Scarcely any skill was required. The cowboys of the West in pioneer days needed little intelligence and, in a way, exemplify simple agriculture. Tilling a one-kind crop from year to year requires greater intelligence, because the use of tools and implements makes it a little more complex. Growing two kinds of crops adds complexity to the operation, because the methods of soil preparation, seeding, cultivating, harvesting, and kinds of tools used vary somewhat with the two crops grown. Many farmers in the "corn belt" know how to grow corn, but do not understand how to grow alfalfa. A third kind of farming that requires still more skill and intelligence is a system of grain farming, where a rotation of crops is practiced and five or six different crops are raised. Rotating crops, so that the soil fertility will be maintained, so that insects of various crops are combated, so that labor is well distributed, and selling each crop at such a season that the most is realized, is a difficult system of farming indeed. But a fourth system of farming that is still more complex is one in which all the good points of the third system prevail, and in addition several different kinds of animals are produced. In animal husbandry farming, housing, feeding, care, and management, combating disease and enemies, selecting the types and kinds of animals that will prove profitable, — all of these points in connection with every kind of animal handled add greatly to the complexity of the farm operations. Animal production requires additional skill for its successful operation.

Animal husbandry causes men to become more sympathetic. The man who hammers steel from day to day deals with an inanimate thing. The producer of plants notices the response of the soil and the plant to his kind treatment. But the man who handles sheep, horses, cattle, — the shepherd, the horseman, the cattleman, — note the instinctive reaction of the animal kindly treated, until the mental attitude of both animal and man are greatly improved. The dairyman has long since learned that kind treatment brings economic returns. The shepherd well knows that his voice is known by every sheep. The horseman fully realizes that if he commands his horse intelligently, the horse will respond in like manner. This intelligent, harmonious, responsive spirit of soul, heart, and head of animal and man are prerequisites to permanent successful agriculture.

Summary. — Animal husbandry farming helps in maintaining the fertility of the soil, tends to a better system of crop rotation, utilizes feeds that otherwise would be partially wasted, manufactures raw materials into a marketable product, gives more constant employment, and often increases profits. The leading nations have been and are producers and consumers of meat and meat products, and animal husbandry promotes a progressive and intelligent agriculture. Animal husbandry farming sustains important relations to the permanency of our American agriculture. And it behooves the schools, the farmers, and the consumers to study the close relation of animal husbandry to permanent agriculture, in order that here as elsewhere the old saying that "education is the safeguard of our nation" may be fully realized.

LABORATORY EXERCISES

1. **Recommendations for Handling Unresponsive Soils.** — Are there any farms in your locality that do not readily respond to the husbandman? If there are, will you kindly write in three paragraphs three reasons why the soil does not respond readily? Make three recommendations you would suggest to make the soil more responsive. These three recommendations should be written in choice English and in three well-formed paragraphs.

2. **The Study of Waste Farm Products.** — Name ten products that would be waste products that may be utilized either by swine, beef cattle, sheep, or poultry.

3. **Suggestions on the Utilization of Some Waste Products.** — Do you know of any field, garden, orchard, or pasture in which insects, grass, weeds, sprouts, or other plants are found which might be well utilized by some farm animal? What suggestions have you to offer regarding their utilization?

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