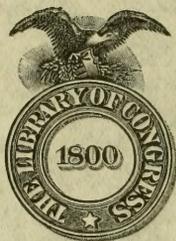


Making
Soil and Crops
Pay More

by
A V-C Farmer



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Book N5

1918a

Newman, Clifford Lewis

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Making Soil and Crops Pay More

By a
V-C FARMER

Who Has Made a Life's Study of How to Get Most Out of Soils
and Crops in Various Sections of this Country

ILLUSTRATIONS

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PREFACE

The author of this book has endeavored to lay out a groundwork of facts sufficiently complete to indicate the nature and needs of soil and crops, hoping thereby to serve the farmer as well as the student of Agriculture for thoroughly preparing themselves to comprehend the subject of plant nutrition, and to form some accurate idea of how and to what extent crops depend upon the soil for the elements of their growth.

For the sake of comprising within a reasonable space that information which may most immediately and practically serve the agriculturist, some interesting details have necessarily been omitted, which, however, we feel will not render this book less practical or less valuable.

The object of this little book is to more than instruct, it is to teach the subject of plant-food and its relation to soil and crops so thoroughly that the reader may readily and practically comprehend and apply the information contained herein to his lasting benefit and profit.

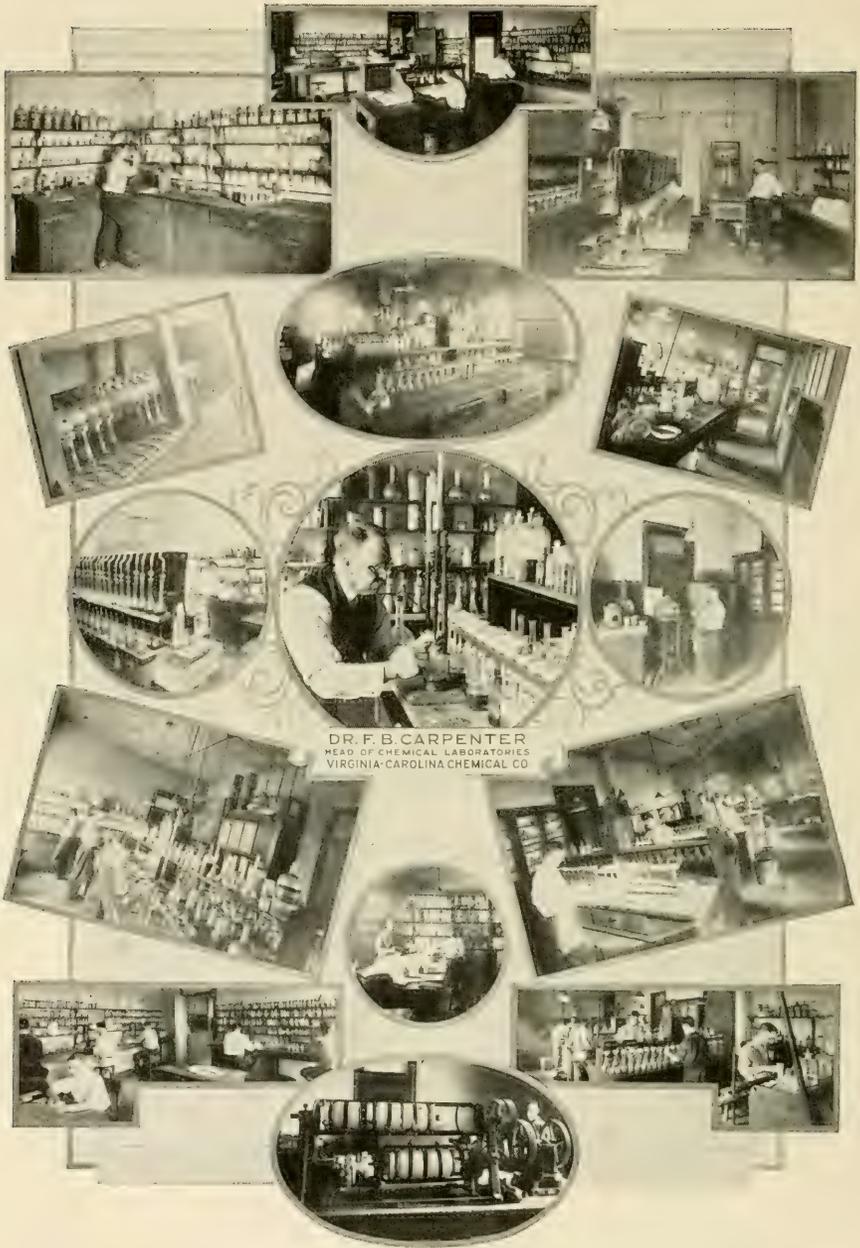
Every practical man knows that we earn more only as we learn more. May this information contained herein act as a guide to those who desire to learn how to increase and improve the productiveness of their soil and crops by supplying the soil with the lacking elements of fertility, and growing thrifty fields of crops economically and profitably.

The more the farmer knows the more he can do. The progressive Agriculturist now sees that Chemistry has opened a splendid future for the Art that has always been and always will be the prime support of all Nations—Agriculture.

The publishers of this book have spent large sums in acquiring beneficial and practical Agricultural information for the purpose of placing it at the disposal of those interested in better crops and greater prosperity on our farms. It is certain if this information is applied practically, a revolution could be brought about on the farms of this country, which would result in an era of prosperity such as has never been known.

Richmond, Va.

The Publishers.



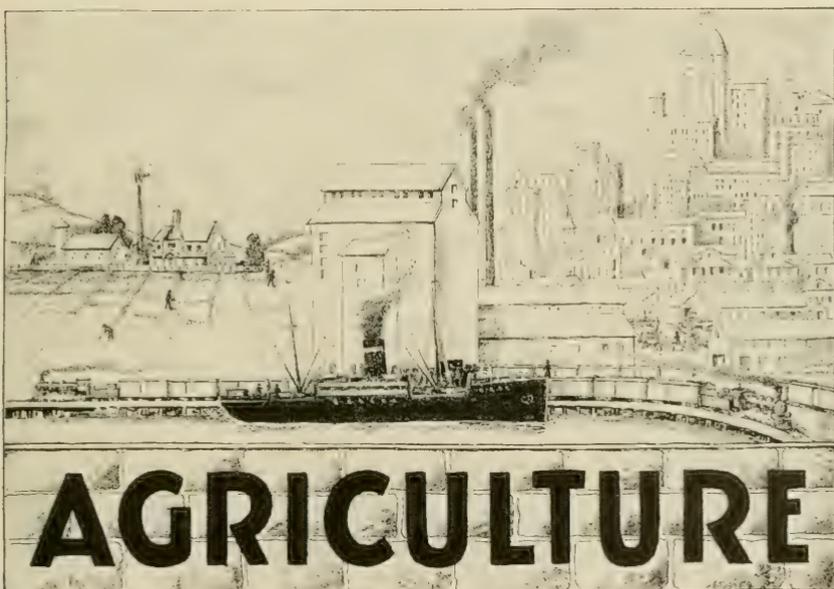
DR. F. B. CARPENTER
 HEAD OF CHEMICAL LABORATORIES
 VIRGINIA-CAROLINA CHEMICAL CO.

Many thousands of Samples are analyzed each year in these Laboratories, representing many millions of tons of V-C Fertilizers which have been used in improving and increasing the crops of thousands of farms throughout the United States, Porto Rico, and Cuba.

Agriculture the Foundation of Our Industrial Existence

Farming is the biggest business of America, the biggest business of the Earth. Without farming, the trusts, the railroads, the banks, all business, all industries would crumble.

It will take years, a decade probably, possibly more than a decade, for the Agriculture of Europe to be restored to the condition in which it was before the war. The world must look to America, the nearest and largest depot of supply, for food. America must not alone feed itself, it must feed Europe now and for years to come.



The Big Business of America is directly dependent upon Agriculture for her existence. Although the farm and the city are sometimes separated by miles; their interests are identical and without Agriculture our Commerce would crumble.

Mr. George E. Roberts, of the National City Bank of New York, a wise and conservative observer, said: "The prosperity of the farmer is best secured by an increase in the yield of his fields. How to accomplish this is not alone the farmer's problem; it is everybody's problem. Agriculture must find increasing prosperity, as other industries do, in a larger output at a lower unit of cost. We will have a Peace prosperity greater and more satisfactory than the prosperity based on War."

America's opportunity lies in mobilizing her Agricultural energies and pushing production to the maximum. We should all assist in adding to the material welfare of our country by encouraging more abundant crops, for Agriculture is the foundation of our industrial existence.

The Soil Is the Farmer's Workshop

The soil is really the farmer's factory, for it is the workshop of his crops. Through the soil alone can the farmer influence the amount of vegetable production, for the atmosphere, light and heat of the sun are beyond his control. Hence, the product and value of the farmer's fields lie principally in the quality of the soil. As the soil is really a crop factory, this factory requires the same sound, business-like management as any other successful factory.

The manufacturer whose factory is well equipped with machinery, can not successfully operate this machinery without the necessary power. No more can the farmer operate his crop factory successfully and profitably unless he has the necessary power, and that power is the proper amount of the right kind of plant-food. His soil must be full of this crop-growing power if he wants an abundant and profitable output from his factory.

Since the soil is the source of wealth, it remains for the farmer to co-operate with Nature in order to secure from the soil the full benefit of its fertility, and at the same time prevent depletion. A well cultivated and fertile soil is a storehouse of unlimited wealth. This wealth is only obtainable through the crops grown in the soil. As these crops grow they take from the soil some of its fertility, hence, the soil must be supplied with fresh stores of nourishment or plant-food after its supply has been tapped, so that succeeding crops will find the necessary nourishment for their proper growth and maturity.

The maintaining of the productiveness of the soil means that there shall be preserved or stored within the soil sufficient quantities of soluble plant-food to produce maximum crops. In other words, the soil must be kept in good physical condition, and the total supplies of the various elements must be maintained if the soil is to remain permanently fertile. A system by which the available plant-food is indefinitely maintained is the permanent system of Agriculture.



WOODROW WILSON
President of the United States

Our Land Should Yield More Per Acre

President Wilson, that great disciple of conservation, has always been a keen observer, and though not a farmer like Washington and Jefferson were, he fully recognizes the needs of the farm and the farmer. That in order to supply food to our increasing population of the future we must see to it that we increase the productiveness of our farms, and how this can be done he tells us in very few words, as evidenced by the following:

“It is necessary that our land should yield more per acre than it does now. Production per acre, with its coincident valuation, increases in direct proportion to the plant-food furnished it.

“We have got to increase the product at every point where it is susceptible of being increased. We have got to study how to assist nature by making the most suitable use of our several and various soils. The pine barrens of our Southern coast need not be barren at all, that if we add a single additional chemical element we can make the sand blossom and produce crops, and that if Nature is only questioned closely she will yield us her richest products for our own assistance and for the assistance of the rest of the World.”

What Luther Burbank Sees In Plant Life

Ex-Governor Pardee of California said: "Burbank, like Columbus, has shown us the way to new continents, new forms of life, new sources of wealth, and we, following in his footsteps, will profit by and from his genius." Let us now see if we, too, can not profit by what Burbank has done. This is what he sees:

"We have in our own hands the power of making literal 'New Creations' in plant life. What has been already accomplished is but the beginning of horticultural achievements that will surpass the most sanguine expectations of even a decade ago. In the hands of the plant breeder rests the future destiny of all mankind."

"Abundant, well balanced nourishment and thorough culture of plants will always produce good results."



Luther Burbank—Plant Breeder

Very Foundation of Our Industrial Existence Overlooked

Secretary Houston, head of the U. S. Department of Agriculture, in one of his recent Reports to the President of the United States, among other things, said:

"Agriculture has made marked progress in a number of directions, but as an Industry it has not kept pace with the other activities of the country.

"We have been so bent on building up great industrial centers; on rivaling the nations of the world in manufacturing and commerce.....that we have overlooked the very foundation of our industrial existence....."

"The aim of Agriculture must be..... to establish supremacy in the production for each acre.



Hon. D. F. Houston, Secretary
U. S. Department of
Agriculture

“The profits of agriculture ultimately depend on the intelligent cultivation of the soil and the preservation of its fertility.”

At the present rate of progress now being made by our Department of Agriculture and the various State Agricultural Institutions, it will not be a long time before there will also be a marked improvement in our Agricultural Industry.

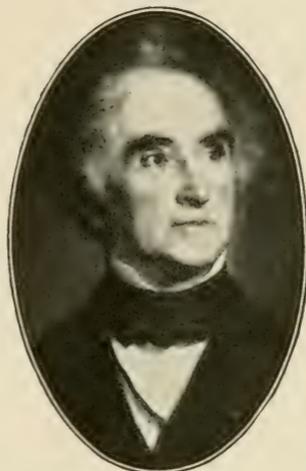
Under the terms of the Smith-Lever Bill there will be ample funds provided to make this possible. The funds thus available increase from year to year until the States appropriate annually a total of \$4,500,000 and the Government a like sum. By 1923 this fund will have accumulated to the sum of \$9,000,000.

The Man Who Discovered How Plants Feed

Baron Justus von Liebig surprised the world with the statement that crops or plants do not derive their nourishment from humus alone. It was this noted scientist and chemist who established a laboratory in Germany for the researches in organic chemistry and the application of chemistry to Agriculture, and in 1840 he announced his first scientific discovery, in which he applied the principles of chemistry to Agriculture by a scientific method of feeding plants.

He showed wherein crops and plants feed from the chemicals in the soil, and if these chemicals were not present in the soil, available to the growing crops or plants, that there could be no crops or plants.

He clearly demonstrated and proved where and how crops and plants get their food; how crops depleted the soil, and how wornout soils could be restored to fertility and productiveness by the application of artificial or chemical fertilizers. This great and wonderful discovery of von Liebig's was indeed an epoch-making discovery by which all mankind has benefited. To what extent von Liebig's discovery is today being applied by farmers throughout the civilized world is evidence of its practicability and necessity, though too many farmers in our own land have not as yet learned the great value of same, but those who have appreciate and value the use of Commercial Fertilizers on their soils and crops.



Baron Justus von Liebig
Scientist and Chemist

Henry Ward Beecher's Farmer's Creed



Rev. Henry Ward Beecher.

It was Beecher who said: "He that would look with contempt on the pursuits of the farmer is not worthy of the name of man." Beecher's Farmer's Creed of many years ago is as appropriate today as it was then. Though Beecher was not a farmer, the following indicates that he knew what was good for the farm and the farmers:

"I believe that the soil likes to eat as well as its owner, and ought, therefore, to be liberally fed.

"I believe in large crops which leave the land better than they found them—making the farmer and the farm both glad at once.

"I believe that every farm should own a good farmer.

"I believe in going to the bottom of things and, therefore, in deep plowing and enough of it."

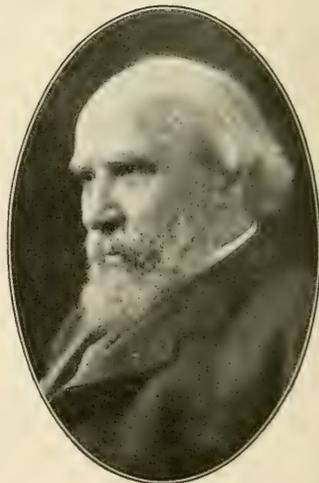
"He Doubled the Yield of His Crops in One Season"

The late James J. Hill was indeed one of the most progressive men of the day. Besides being a builder of railroads he was also a most successful builder of prosperous farms and farmers.

As a boy he labored on his father's farm. In later years, by his unlimited and sincere confidence in the future of farming, he brought prosperity to many thousands of farmers.

His belief in the possibilities of greater farm development was expressed in his extensive work in promoting more profitable methods of farming, to meet changing conditions of soil depletion.

He proved by practical demonstration to thousands of farmers, that there is no surer profit than that which comes from the development of fertile land.



James J. Hill—Farm Builder

He builded wisely and strongly, and his works remain to bear witness that he turned a wilderness and barren lands into productive and prosperous farms. To what extent his methods proved of value may be gathered from the following account of his practical demonstrations conducted by him on some of his own farms:

“On 150 farms Mr. Hill demonstrated that by the use of fertilizers he could double the yield of his crops in one season. His average production of wheat, barley, and oats was more than double the average production of the states in which his farms were located.

“His wheat showed an average gain of 11.41 bushels per acre; barley a gain of 16.38 bushels per acre, and the crop gain in oats was 22.17 bushels per acre.”

Indeed, James J. Hill did much to make his great country greater, and those in it happier, more contented and more prosperous.

A Great and Necessary Institution

There are few men who have made a more careful and persistent study of soils and crops than C. L. Newman, Professor of Agriculture at the North Carolina State College of Agriculture and Engineering, Raleigh, N. C. Prof. Newman is a practical farmer who has made a life's study of soils and crops. He sums up the needs of plant-food for soils and crops as follows:

“The ideal fertilizer for a crop growing in a soil is that fertilizer which contains plant-food elements in appropriate proportions and in forms that are available to the crop grown. Not only must the contents of a fertilizer represent plant demands and soil deficiencies, but be available in quantities and proportions to suit the needs of the crop as the needs develop.

“Fertilizers must fit the soil and fit the crop, such fertilizers are the *best*, and no others are as good. Fertilizers are not only a great institution but a necessary one.”



Prof. C. L. Newman of N. C.
State College of Agriculture
and Engineering

Productiveness With Permanency

A prominent member of a Western State Advisory Committee on Soil Investigations most admirably points out the future greatness of Agricultural development in these words:

"The only way to supply an abundance of good to the increasing population of the future is by increasing the productiveness of the land; and the only way to increase the productiveness of the land is the application of scientific principles to the art of Agriculture. The problem of the past was production; our problem today is *productiveness with permanency*.

"Plants will not properly mature when insufficiently fed any more than will animals when not properly nourished.

"It is a duty to ourselves that we get as much out of the soil as possible, that we may be better able to reach the physical comforts and enjoyments which belong to a higher development. But it is a greater duty to posterity that we leave these lands richer than we found them.

"The productive power of our normal well drained and well cultivated land depends almost wholly upon the power of the soil to feed the crops."

Farming Is a Business Demanding the Best Men and Women

Prof. G. I. Christie formerly of Purdue University, LaFayette, Ind., now an assistant to the Secretary of the U. S. Dept. of Agriculture, is one of the foremost Agricultural Educators in the United States. In a recent address, entitled: "The New Agriculture," he took for his text these words of Garfield's:

"At the head of all the Sciences and Arts, at the head of civilization and progress, stands—not Militarism, the Science that kills; not Commerce, the Art that accumulates wealth—but Agriculture, the mother of all Industry and the maintainer of human life."

The following statements made by Prof. Christie are decidedly instructive, as they point the way to better Agriculture and greater prosperity:



Prof. G. I. Christie
asst. to Secretary
of U. S. Dept. of
Agriculture

"Agriculture stands as the basis of the prosperity of this country. The development of all other resources and the big business of our cities depend upon the food stuffs which must come from the soil. Lessons from older countries teach us that it is impossible to remove plant-food continually from year to year without returning part at least.

"I believe, as the Agricultural work develops, more and more attention will be paid to commercial plant-food. The better farmers of the country today are the largest users of commercial plant-food.

"Why are we turning such unanimous and universal attention to the subject of Agriculture? When you come to study the problem a little and when you come to see it in its several phases, it is readily understood. The population of this country has been doubling practically every twenty-five years. It is increasing now at the rate of about two million souls annually. To feed these two million hungry mouths requires about seventy-five million bushels of cereal producing food-stuffs.

"We are told by government officials that if we take in all the land that may be irrigated, all the land in the South that some day may be drained, we have less than 750,000 square miles of additional land for Agricultural purposes. Last year alone, 35,000 square miles of that land was taken up, so it will be only a short time until all the land is brought under the plow. One of our statesmen, who has given considerable thought to the subject, predicts that if our present rate of increase in population continues, we will have 150,000,000 people by the year 1950. The great question in the minds of our people today is, how are we going to feed them?

"Production and consumption are beginning now to equalize with the result that high prices are here and here to stay. The day has come when we have to work to get the increase in food supply to meet the increased demand of an increasing population.

"Up in northern Indiana there is a tract of land known as the muck area. Our experiment station was appealed to for aid In an experiment the station men put on about 300 pounds of muriate of potash per acre, and in the four years that the experiment was running they harvested 96 bushels *more* of corn where the land had been treated than where it had not been treated.

"In the soils of the southern part of Indiana it was found that another element was lacking—phosphorus. When an application of phosphoric acid was made it was found that the yield of wheat, was running along 6, 7, and 8 bushels per acre, was soon turned into a yield of 14, 16, 18 and 20 bushels per acre.

"The importance of securing an increased yield is readily recognized. An increase of five bushels per acre on the 60,000,000 acres of wheat now grown in the United States would result at one dollar per bushel in an increased wealth of \$300,000,000.

"Farming is not mere drudgery, but a business demanding and paying for the best brains and efforts of the best men and women."

Washington Preached the Value of Fertilization

When Washington died, besides his wife's estate and the Mount Vernon property, he possessed 51,300 acres, exclusive of town property. He was one of the wealthiest Americans of his time, and it is a question if a fortune was ever more honestly acquired or more thoroughly deserved.

Washington's greatest pride was to be thought the first farmer in America. Early and late he preached to his overseers the value of fertilization. During the career of George Washington, the first President of the United States, he acted several important parts, but in none did he find such pleasure as in farming, as evidenced by his statement:

"I think that the life of a husbandman of all others is the most delectable. It is honorable, it is amusing, and, with judicious management, it is profitable. Agriculture has ever been the most favorite amusement of my life. I shall begrudge no reasonable expense that will contribute to the improvement and neatness of my farms; for nothing pleases me better than to see them in good order, and everything trim, handsome, and thriving about them. I am lead to reflect how much more valuable to the undebauched mind is the task of making improvements on the earth than all the vain glory which can be acquired by ravaging it."

One of the Foundation Industries of the World:

The editor of the "Manufacturers Record" points out clearly the necessity of proper fertilization of the soil in the following:



George Washington
The First President of the
United States

“One of the foundation industries of the world is the manufacture of fertilizers, for without the proper fertilization of the soil there would be a steady deterioration which would gradually exhaust all soils and ultimately lead to the agricultural ruin of any country, and that would mean the ruin of all its industries. Of recent years we have been learning more and more about the restoration of soil fertility and the necessity of increasing the yield per acre in order to reduce the cost of farm products.”

Do Fertilizers Injure the Land?

Ex-Director Arthur Goss of the Purdue University Agricultural Experiment Station of LaFayette, Ind. answers this often asked question as follows:

“The following table offers about the best answer to this question obtainable. The experiment cited is being conducted at Rothamsted, England, and has been in progress more than 50 years. No results covering anything like so long a period of time are obtainable in the country.

TABLE I

Continuous Wheat Experiment, Rothamsted, England, from 1852 to 1902

	Pounds of Fertilizer applied annually			Average Yield	Yield
	Ammonia Sulphate	Acid Phosphate	Potash	1852-1902	1902
Commercial Fertilizers	600 lbs.	350 lbs.	200 lbs.	37	45
Manure	14 tons annually			36	42
Unfertilized				13	13

“By referring to the table it will be seen that the application of a very large quantity of Fertilizer to wheat each year for 50 years has not only *not* injured the productiveness of this soil, but has, in fact, actually increased the average annual yield from 13 to 37 bushels per acre. It will also be noted that the yield on the fertilized plats the last year was 45 bushels per acre, while the yield on the unfertilized plats the same year was only 13 bushels per acre.”



Ex-Director Arthur Goss,
Purdue University Agricultural
Experiment Station

Director Goss further points out in Circular No. 10 of the Purdue University Agricultural Experiment Station some interesting facts concerning experiments made in this country on Southern Indiana Soils by the Purdue University Agricultural Experiment Station. We quote from him as follows:

"Investigations have been in progress at the Experiment Station for a number of years past, with a view of ascertaining the methods of fertilization best adapted to the different soils and crops of the State. In this connection tests have been made on practically all the important soil types, and have involved the use of such materials as:

Dried blood	Iron sulphate
Nitrate of soda	Iron hydrate
Bone	Magnesium sulphate
Acid phosphate	Magnesium carbonate
Dicalcic phosphate	Sodium sulphate
Rock phosphate	Copper sulphate
Muriate of potash	Carbon black
Sulphate of potash	Muck
Carbonate of potash	Clay
Ashes	Straw manure
Slaked lime	Legume crops

Ground limestone

"It may be said in a general way that while occasionally soils are found that do not respond to Fertilizers, usually some combination has been found that has produced handsome profits and not infrequently enormous returns. There is for example no question that the application of potash in considerable quantities on muck soil is very profitable in connection with the growing of corn and other crops. It also seems certain that the liberal use of Fertilizers on the potato crop is highly profitable, and that Fertilizers will usually pay well on the wheat and corn crops, if used in the proper proportions and right amounts. The work that has been done emphasizes the fact however, that in order to receive the best results it is necessary to understand the needs of the particular soil and crops to be used. It is a very easy matter to waste a large amount of money in the use of Fertilizers through the application of unnecessary elements and improper forms of plant-food, and the only wonder is that such satisfactory results are secured under the present haphazard system in vogue. There is not the slightest doubt that a large and profitable increase in crop production could be brought about in the State by a more systematic and intelligent use of Fertilizers.

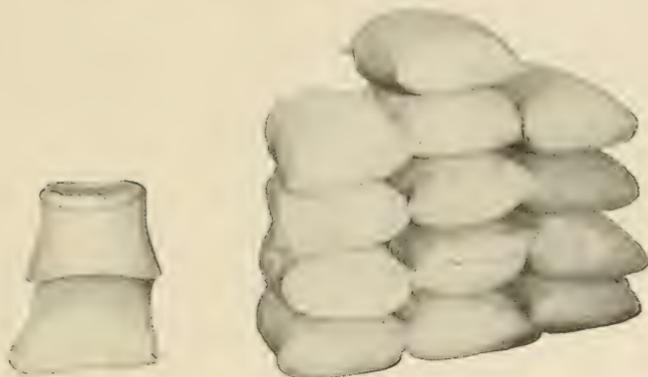


Figure Two

“In Figure 2 is shown the amount of wheat recovered on the unfertilized plots and on the plots receiving the complete Fertilizer in the Scott County experiment. While this is perhaps rather an extreme case, which could not be duplicated every time, it is the result of a carefully conducted experiment, and shows the yields actually secured on this soil.

“The Fertilizers applied to the KPN* plat consisted of 60 pounds of dried blood, 200 pounds of acid phosphate and 30 pounds of muriate of potash per acre, and cost at prices prevailing at the time this experiment was conducted, \$3.20 per acre. The increase in yield due to the Fertilizers was over 26 bushels of wheat per acre.”

Marvelous Possibilities of Soil Building:

There are few men better posted on the actual needs of the soil and crops in the South than President Andrew M. Soule of the Georgia State College of Agriculture. The able work he has done in developing Agriculture and Agricultural Education in the South is well known. To what extent he recognizes the need of proper plant feeding is indicated by the following when he declared:

“There were marvelous possibilities of soil building, and that the farmer who would not feed his soil was like the man who bought a fine horse, put it in the stable and refused to feed and water it, and let it die.

“If you are going to fertilize, fertilize *right*. Feed the plants liberally. Don't compel the plants to kill themselves hunting for and chasing after beggarly little plant-food.”

*KPN means potash, phosphorus and nitrogen, a complete fertilizer.



Dr. Bradford Knapp, Chief,
Office of Extension Work in the
South, U. S. Department
of Agriculture

The System of Agriculture Which Will Be Most Permanently Profitable:

Few men in the United States have done so much to improve conditions on our farms as Dr. Bradford Knapp, Chief, Office of Extension Work in the South, U. S. Department of Agriculture. Dr. Knapp succeeded his father, the late Dr. Seaman Knapp, as the head of the Boys' Club Movement under the auspices of the U. S. Department of Agriculture. To what extent he recognized the importance of permanent soil fertility is shown in the following statement made by him:

"The wise and judicious use of Fertilizers is an element of profitable farming. Such practices in the use of Fertilizers as bring the best results will in the long run be followed by farmers. A complete cropping system which aids in building up soil fertility, coupled with the wisest and best use of Commercial Fertilizers will, in the end, be the system of Agriculture which will last longer and be the most permanently profitable."

The Need of Greater Agricultural Efficiency

With Increased Production Profits Not Wanting:

Are we prepared to meet the situation which confronts us by producing enough food for our own use and also a considerable amount for other countries? Under existing conditions it would be unpatriotic not to fertilize when we know we can help our country and our people by the proper use of Fertilizers. With a net return of one to five dollars for each dollar judiciously invested in fertilizers, the profits are certainly not wanting. Let us see what other countries have done.

Why the U. S. Is Not At the Top:

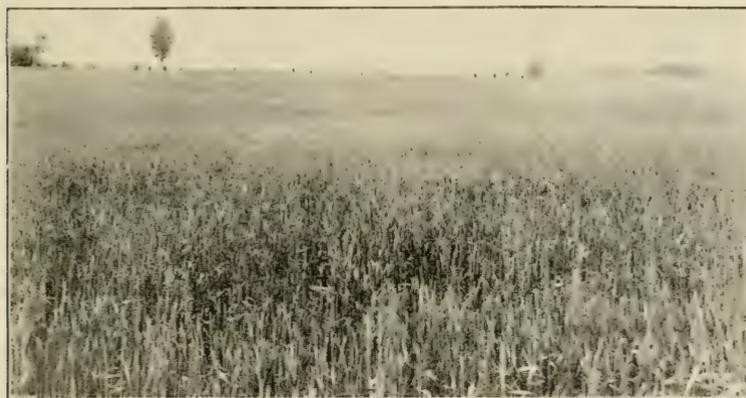
Thirty years ago the soil of Germany and of France was, as revealed by official crop statistics, about equally productive, but during the three decades Germany's crop-yield per acre has nearly doubled while that of France has increased but a tenth. In 1881-1886 the average yield of wheat per acre in Germany was 19 bushels, and in France 18 bushels. This increased in 1911-13 to 33 bushels for Germany and 20 bushels for France.

It is interesting to note the yield of certain crops in various countries compared with the U. S. as shown in following.

<i>Country and Year</i>	<i>Bushels Per Acre</i>				
	<i>Wheat</i>	<i>Rye</i>	<i>Barley</i>	<i>Oats</i>	<i>Potatoes</i>
Germany, 1913.....	33.0	30.4	40.9	61.0	235.4
Russia, 1912.....	10.1	14.3	16.1	23.6	121.3
Austria, 1912.....	22.3	23.2	29.7	36.1	148.7
Hungary.....	18.8	18.4	25.8	28.9	125.3
France, 1912.....	20.5	16.4	26.9	35.9	142.7
Canada, 1912.....	20.3	19.1	31.0	41.7	172.0
United States, 1913...	16.0	16.2	23.7	29.5	90.2

Such returns as these from soil cultivated for hundreds of years in climate inferior to ours for grain production, tell the whole story of American Farm methods.

Let us increase our Agricultural Efficiency, as the farm is the base of our National pyramid of wealth. We should be at the head of this list, not way at the bottom, and—we will.



When the American Farmers use Commercial Fertilizers they can produce record crops. The above illustration shows a wheat field that yielded 50 bushels to the acre. This splendid yield was secured by the liberal use of V-C Fertilizers.

Belgium 243 Pounds, U. S. 31 Pounds:

However, the Belgium farmers produce the highest yields of wheat, and use more Commercial Fertilizer per acre than is used in any part of the world. They use an average of 243 pounds of Fertilizer per acre on all cultivated lands not including animal manures, and get in return an average of 37½ bushels of wheat per acre. Germany, the second highest user

of Fertilizers—where the farmers apply 149.52 pounds per acre aside from animal manures—gets the second highest yield of wheat; 33 bushels per acre. In the United States we average only 31 pounds of Fertilizer per acre on our cultivated lands, and do not average one-fourth that on our wheat lands and get in return only 16 bushels of wheat per acre.

Good Reason for Greater Farm Production:

There is a good reason why the production on our farms should be increased. Our urban or city population has increased much more than the rural population. The movement of population in the U. S. appears in the following table:

Increase in total population, 1880-1910.....	83.3%
Increase in urban population, 1880-1910.....	188.5%
Increase in rural population, 1880-1910.....	39.4%

Food Production Not Keeping Pace With Population:

That our food production has not kept pace with the growth of our population is evidenced by the following which shows per capita production of wheat in the United States thirty years ago in comparison with that of today:

Year	Population	Average Annual Wheat Production	Annual Per Capita Production
1876-1884	50,156,000	426,922,000 bu.	8.5 bu.
1906-1914	91,972,000	712,474,000 bu.	7.7 bu.

To have had the same per capita production in the last nine years as in the earlier period would have required an annual production of 73,600,000 bushels *more* than was actually produced.

30,000 New Mouths to Feed Every Week:

Some idea may be formed as to the growth of our population when it is known that every week brings more than 30,000 new mouths to feed, for it has been estimated that we grow in the United States at the rate of 4433 folks a day. At this rate our growth in a few years hence will be at the rate of 10,000 a day. These newcomers must all be fed and clothed. Every addition to our population adds new responsibilities and demands upon the farmer, for it is on him most of all that civilization depends for sustenance.

Business of Farming Bound to Increase:

America has doubled its population within the last 40 years, and during the next like period may be obliged to meet the needs of fully 200,000,000 people. The farmer not only feeds the world but saves it, and to maintain the productivity of our farms is the ultimate problem of America and the foremost question confronting us.

Small But Great is the United States:

Our country covers less than 6% of the earth's area and numbers about 5% of the earth's population. It produces 76% of all the corn grown in the world; 70% of the world's oil; 59% of all copper, 43% of the pig iron; 37% of the world's coal; 35% of its tobacco; 26% of its silver; one-fourth of all its wheat; 21% of its gold; and contains more than a third of all the wealth of the civilized world. The wealth of the United States is now about \$240,000,000,000, which is more than the combined wealth of England, France and Germany.



Although our area and population are small in comparison with the rest of the world, the above diagram illustrates well the greatness of our industrial and agricultural production.

“The wealth of the United States will be greater a year from now than it is now, and still greater at the end of each succeeding year. Improvements will go on, not so fast perhaps as in time of peace, but houses will be built, farms will be improved, industrial equipment will be increased and savings will grow.

“The South is likely to grow more of all crops in the future, and the work being done everywhere for a productive Agriculture is giving promise of valuable results. The country is being awakened as never before to a realization of the fact that all industries are dependent upon Agriculture.”

(Bulletin National City Bank, New York.)

The Power and Profit of Soil Fertility

No Surer Profit Than Fertile Land:

Never in the history of our country have such efforts been made to improve conditions on the farm; never has the need been so recognized of applying more profitable methods on the farm; and never have our farmers recognized and appreciated the real value of making and keeping their land fertile. As the late James J. Hill said: "There is no surer profit than that which comes from the development of fertile land well adapted to some staple crop."



America produces more than three-fourths of all the corn grown and a crop like the above is by no means uncommon where Commercial Fertilizers are used. 500 lbs. of V-C Fertilizers were used per acre on this field and the yield averaged more than 80 bushels to the acre. Soil Fertility Pays.

American Farmer Produces Most Wealth:

If asked to name the most valuable minerals of the United States, most persons would promptly suggest gold, silver, iron, lead, zinc and copper. Yet the American farmer mines more wealth from the soil in a single year than has been taken from the gold mines of the United States in all the years since Columbus discovered America. It is literally true that our most important mineral deposits are the elements of plant-food contained in our soils. The soil is the only mine known which under proper management and liberal fertilization will not run out. But too many farmers are yet "mining" their soil by taking everything out and putting nothing back. A nation built upon Agriculture will perish when the soil can no longer yield its harvest.

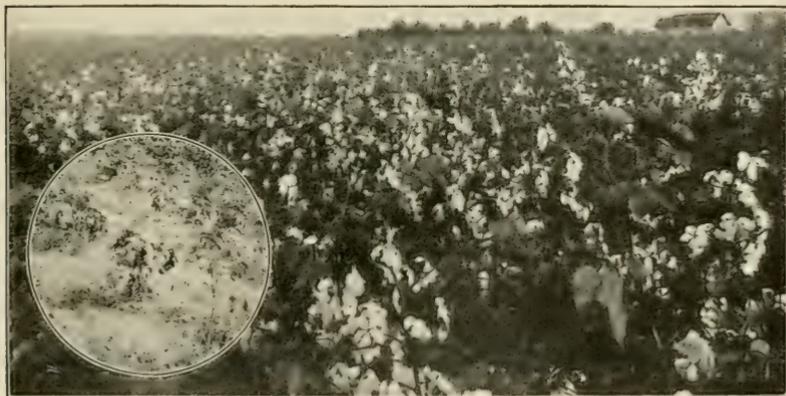
Soils Originally Had Plenty of Plant-Food:

Our best soils originally contained from 6,000 to 8,000 pounds of nitrogen, from 2,000 to 3,000 pounds of phosphorus, and from 30,000 to 45,000 pounds of potassium to the acre in the first twelve inches, but continuous cultivation, heavy cropping, surface washing, and leaching have reduced the store of plant-food in most soils much below these amounts. It is evident that if most soils are to produce heavy yields, either the food they contain must be made available more rapidly than it is in the average soil, or the crops must be helped with Fertilizers.

Bigger Crops at Less Cost by Fertilization:

A prominent captain of industry of the Middle West said:

"Fertilization dovetails with diversification. It is one of the principal objects of diversification. It produces bigger yields per acre, thereby reducing the cost of production per acre. The problem in a nutshell is to provide a bigger profit for the producer, and lower prices for the consumer. In what better manner can a bigger profit be assured than through the production of bigger crops at proportionately less cost? That is what intelligent fertilization will accomplish."



What happens to Cotton when no Fertilizers are used is well illustrated in the above. The insert shows the results where Fertilizers were not applied. On the other field 500 lbs. of V-C was applied per acre and the results speak for itself.

Larger and More Thrifty Crops:

In the Bureau of Soils Bulletin No. 48, issued by the Department of Agriculture in Washington, a most interesting and significant fact is pointed out which should be of special interest to the farmers of the Southern States who have neglected their opportunity by not growing small grain on some of their land. We quote from the above mentioned bulletin as follows:

“It is significant that the sandy soils of the Norfolk and Portsmouth series collected from the Southern States, where wheat is seldom grown, have produced, on an average, larger and more thrifty wheat plants by the application of a Complete Fertilizer and lime than have been produced by the same or other treatment on soils of the Marshall or Miami series from Wisconsin, Ohio, Indiana and New York *where wheat does well.*”

Therefore, why should the farmer of the Southern States not plant more wheat and other small grain on his land? Hasn't he depended upon Western and Northern grain long enough and paid a big price for doing so? The single State of Illinois grows about 130,000,000 bushels *more* of oats than is grown in all the Southern States combined.

Manure Not a Balanced Fertilizer:

The “Indiana Farmer” points out a few pertinent facts concerning the value of Commercial Fertilizers and barn manure. It is a well known fact that the West and Middle-West farmers have an idea that by using barn manure on their soil and crops it is all that is necessary. That this is a fallacy the “Indiana Farmer” points out as follows:

“Manure alone is not a balanced Fertilizer. It is deficient in the mineral substances which all plants demand. To get the most out of our manure we should supplement its use with Commercial Fertilizers carrying plenty of phosphorus and potash. All experience proves that Fertilizers are most profitable when used judiciously in connection with barn manures and green manures. Barn manures must undergo chemical changes in the soil before the plant-food in them can be used by the growing plants. Commercial Fertilizers contain readily available plant-food. This may be assimilated and used at once by the plant to give it a good start while the manure is being worked over in the soil to help out later on. There is no danger in using plenty of Commercial Fertilizers providing the ground is not allowed to run down and lose its vegetable or organic matter.

Fertilizer Experiences of Successful Corn Growers:

"The fertilized rows had larger ears and fewer soft nubbins. The corn was drier and more solid, so that a later weighing would show a greater difference in favor of the Fertilizer. The fertilized rows yielded at the rate of $46\frac{1}{2}$ bushels per acre, the unfertilized not quite 36 bushels, a gain of $10\frac{1}{2}$ bushels due to the Fertilizer. At only 60 cents per bushel of corn, the price at husking time, the increased yield is worth \$6.30. The cost of Fertilizer was \$1.20 per acre. The judicious use of Fertilizers practically guarantees a net return of 400%. It hardly need be said that Fertilizers can be used to good advantage on practically every farm in the State."

Richest Agricultural County in the U. S.:

And where do you suppose this richest of Counties is situated? Not in California or the South where the crop growing season is longest, neither is it the much talked of Lancaster County in Pennsylvania, nor some of the great Counties of the Middle West. It is a County situated at the most extreme northeastern boundry of the United States; stuck way up into Canada and surrounded on three sides by Canada; where the mercury frequently goes as low as forty degrees below zero and stays there for days and weeks at a time. A County that is almost as large as the whole State of Massachusetts.

Aroostook County, Maine, is now said to be the richest Agricultural County in the United States today. It produces between 17,000,000 and 25,000,000 bushels of potatoes a year. The great wealth produced by the farmers of Aroostook County is simply the result of intelligent farming.

Though this County has only 14 banks, last May these banks held deposits of more than \$15,000,000. Fortunes have been made by the farmers of Aroostook County, many farmers having sold \$40,000, \$50,000 and in some cases as high as \$100,000 worth of potatoes as the result of their season's work.

The farmers of Aroostook County began buying automobiles and electric light plants; not the cheap and small automobiles, but the kind that range in price from \$3000 to \$5000 each. One manufacturer of automobiles shipped a trainload of 53 box cars loaded to the doors with his product to Aroostook County, and within two weeks after arrival every automobile in the shipment had been sold. Besides buying automobiles the farmers of Aroostook County made heavy purchases of farm machinery. One single manufacturer of Agricultural Implements sold 60 carloads of plows, harvesters and tractors there.

The Nation's Greatest Asset Must Be Conserved

An Investment for a Definite and Profitable Return:

The wise and prudent farmer not alone plans to get results immediately from his soil, but get the maximum results, as well as establishes a permanent soil fertility. The wise farmer knows that soils that are not properly handled and fertilized become so poor that they will not produce profitable crops. Whether or not a soil contains an abundance of the essential plant foods is not so important as whether the plant foods are available. If they are not the soil containing them is no better than a barren soil. No one denies that when an abundance of good fertilizer is wisely added to a soil the returns from it are improved. It is a simple matter of investment for a definite return to use fertilizers that come back to you in profitable crops.

Enormous Soil Fertility Depletion:

A noted professor of economics at the University of Berlin aptly brought out to what extent our soil fertility is depleted by the following statement:

"In every million bushels of wheat that we purchase from America there are 1,575,000 pounds of phosphorus, nitrogen and potash, worth in round numbers about \$267,000, at pre-war prices."

Think what this means to soil fertility depletion on a wheat crop of 1,025,801,000 bushels such as we had in 1915. A loss of just \$274,288,867 on the above basis. Since the nation's greatest asset is the soil, we must conserve it, place it on a permanent soil fertility basis and keep it there year in and out. We must not rob our soils of its wealth producing properties. The soil is a better wealth producer than all the mines put together—with proper management. So don't rob your own bank by taking out and putting nothing in.

Multiplying Productive Capacity Pays:

With big profits, industry expands rapidly; with small profits it stands still; with no profits it declines. This applies to the farmer as well as to the manufacturer.

In various lines of manufacturing, tremendous profits were realized in the past few years. Examination shows that much of the greater part of these profits went back into the business, thereby increasing capacity, multiplying productive capacity. The same method or process of multiplying productive capacity

can be applied on the farm. As the farm increases its productive capacity, it also decreases its productive capacity in diminishing the soil fertility, the crop producing properties. The farmer must also put some of his profits back into the business—the soil, so that his next crop will produce still further profits.

The Stimulus of High Prices:

In normal times every bushel of wheat contained 30 cents worth of soil salts; these soil salts, extracted by the growing wheat, must be replaced by fertilizers. We dare not, in fact we can not afford to, continue to deplete our soil without restoration. Our wheat growing has mined our soil in a manner that no other nation would allow. From a yield of 40 bushels to the acre in virgin fields, our average has dropped to 15 bushels from the nation and 10 or 12 bushels in worn-out states. The farmer must not only restore the soil salts extracted this year, but restore those extracted in the last decade, if we are to meet the agricultural demands which the world will put upon us.

The laws of chemistry, of plant growth and of agricultural economics are inexorable. To have enough bread to stave off famine is the all important first consideration, both for ourselves and for the whole world, which will be dependent upon our foodstuffs during the next years as never before. During the last three years the world has made unprecedented demands upon American industries. They met that demand because they were allowed the stimulus of high prices. Should not the industry of agriculture have an equally great or even greater stimulus since in the next two or three years the world's demand is going to fall upon our agriculture as never before? For upon the industry of farming depends the welfare and existence of *all* industries and mankind.

A Sound Agricultural Policy Needed

It is high time the farmer and his interests should have that consideration which a progressive age entitles them to. At last it seems to be dawning upon this country that the most important thing for us at the present time is the creation and pursuit of a sound agricultural policy, a system of encouraging farm production. In some way the disorganized farmers must organize so they will have that collective strength which has come from corporate or associated effort in other fields of production.

In the midst of a worldwide depletion of agricultural production, a depletion which cannot be made good within at least five years after the close of the war. Between 40,000,000 and 60,000,000 men have already been withdrawn from agricultural production and thrown into the war or into business connected with the war and not connected with agriculture. Millions of those men have been killed, millions more crippled, still other millions so disused to agricultural life that they will never return to it.

Take the matter alone of skilled agriculturists who have perished. This place cannot be taken by men from other vocations, even if these men were forced to go to the farm. Farm life is exceedingly varied; it requires a strong physique, years of training and practice to make a good agriculturist.

The fields of Europe have for more than three years gone almost without fertilizers. The salt of Europe's soil has been mined. It will take many years to replace the fields in that old state of fertility, even if the usual labor power of tilling them were in existence.

Today, right now, America has an unexampled opportunity and an unexampled obligation. If there is not to be a worldwide famine, both now and after the war, we must step in and prevent it. And we can step in in no better way than to establish and pursue an agricultural policy upon which the progress of civilization in the next ten years or more will largely depend. Progressive civilization is not possible without progressive agriculture, and we will not have progressive agriculture unless we establish and pursue a sounder agricultural policy than now exists or has ever existed.

Crops Increased Over Two Billion Dollars:

The U. S. Census Map following page 25 clearly indicates the expenditures for fertilizers in 1909. Each dot equals \$5,000 spent for fertilizers. This indicates what a big field of possibilities exists in our country for an increased consumption of fertilizers, and how much a more liberal application of same will mean to the future prosperity of our farms and our country.

The last U. S. Census reports that "in the country as a whole, only 28.7 percent of the farms bought fertilizers. Of the total of 878,798,325 acres, only 478,451,750 acres were improved."

In ten years the farmers of the United States increased their expenditures for fertilizers 115 percent, and in these ten years the farmers increased their crops from an aggregate of \$2,998,-

704,000 to \$5,478,161,000, showing an *increased* crop value of \$2,488,457,000. The value of all crops for 1917 reached the enormous total of \$13,580,768,000."

This increase is not due entirely to the increased use of fertilizers, but can it not be well imagined what the increased crop value of all farms would be if 100 percent of the farmers, instead of only 28.7 percent, used plant-food on their soil and crops.

In the so-called "Cotton States" the greatest increase in the use of fertilizers is shown, and here the total value of crops increased 112.7 percent.



This neck-high Cotton is concrete evidence that it pays to Fertilize and Fertilize well. V-C Fertilizers applied at the rate of 1000 lbs. per acre produced two bales to the acre on this field.

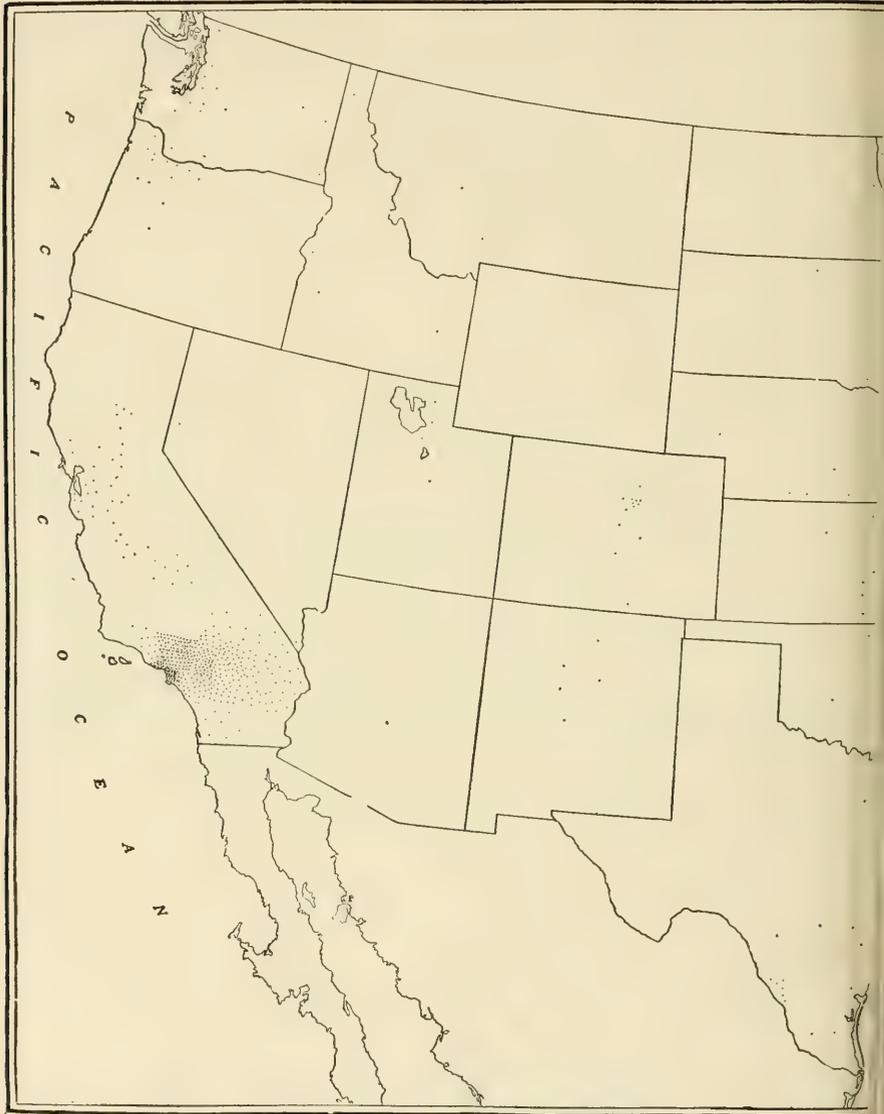
\$1.30 or 4 Cents Worth of Fertilizer to the Acre:

The compilers of the last United States Census made the following discovery concerning the value of plant-food and its resultant benefits and profits:

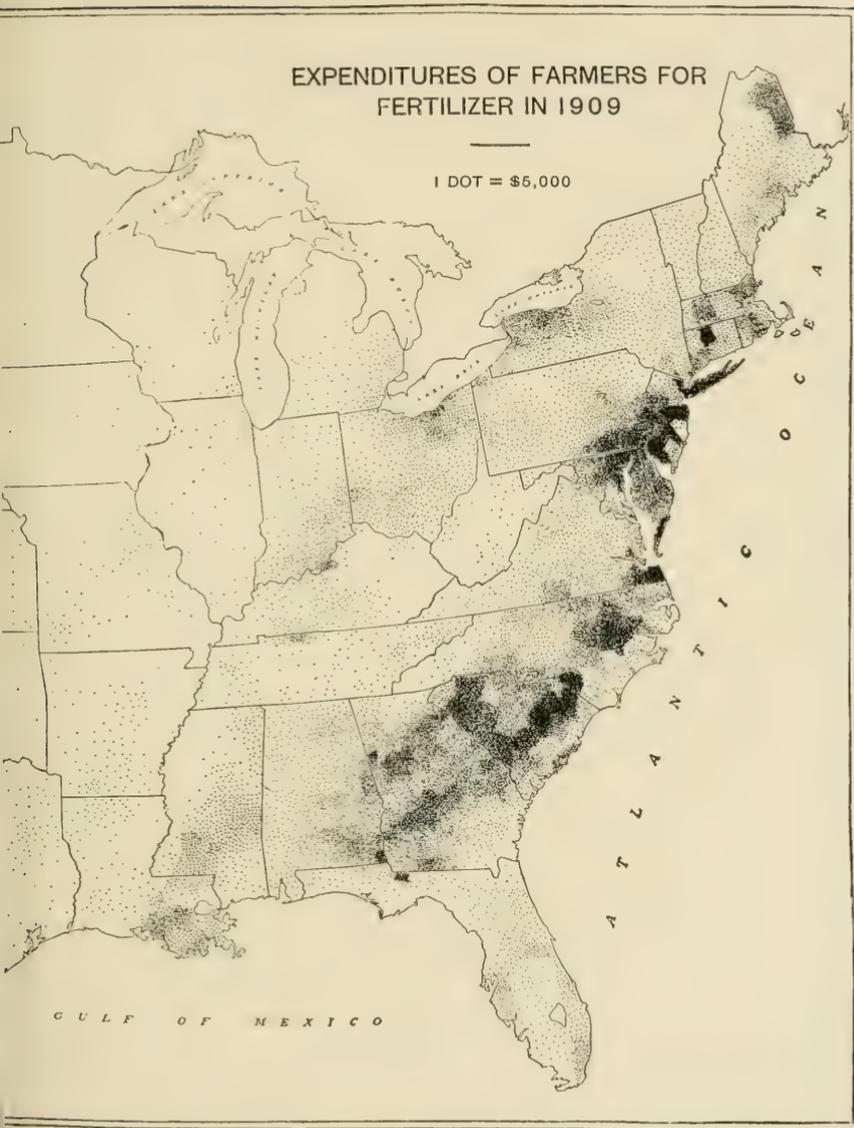
"The 'worn-out' and 'barren' farms of New England produce on an average *more* corn and wheat to the acre than is grown in the famous *more* corn and wheat belt States of the Middle-West, as the following proves:"

New England States used \$1.30 worth of fertilizers to the acre on its farms.

Middle-West States used 4 cents' worth of fertilizers to the acre on its farms.



Each dot on the above illustration means that \$5000 has been spent for Fertilizer. It will be readily seen that as yet the Farmers of the West have



not awakened to the worth of Fertilizing their fields. The day will come however, when they will get increased yields per acre.

New England	produced	44	bushels	of	corn	to	the	acre.
Middle-West	“	29	“	“	“	“	“	“
New England	produced	23	bushels	of	wheat	to	the	acre.
Middle-West	“	17	“	“	“	“	“	“

Does this not prove conclusively the great value and advantage of using plant-food and an abundance of it on soil and crops?

Over \$1,700 Net Profit Annually on One Acre for 18 Years:

It used to be said that no one could support a family on less than 100 acres, but some of the European farmers who have settled in various parts of the West have known that this is a long way from being true.

A notable example of their intensive methods is that of a Belgian, who on a *single acre* of land in Nevada has for 18 years made an average annual net profit of more than \$1700, while rearing and educating a family of eight children.

It is a well known fact that the farmers of Belgium use more commercial fertilizers per acre than are used in any other part of the world. They use an average of 243 pounds of fertilizer per acre on all their cultivated lands, not including animal manures. In the United States we use only about 31 pounds of fertilizers per acre on our cultivated lands.

Well drained, well cultivated and well fertilized land will produce maximum results per acre. The soil and crops need good care and good nourishment if the best results are desired. What this progressive Belgian farmer has done in Nevada can be done elsewhere if the same methods are applied.

Making the Farm an Efficient and Profitable Workshop:

Never before has there been such a broad discussion and consideration as to our problems of agricultural education as now. The children destined for the farm must have in their schools a broad training that will give them understanding of the scientific principles as well as skill and enthusiasm for the work itself. We will then be assured of having less soil robbery and a greater and also better production on each acre of tilled land. And as our standards rise on the farm, our agriculture will rise accordingly, so that for future generations our soil fertility will be conserved on a firm and permanent basis. We must cease this present agricultural process of mining. We need this new education so that the farm may become an efficient and profitable workshop, furnishing a field for skilled and trained labor, intelligent management, and the profitable employment of capital.

A Few Interesting Facts for Farmers

A Millionaire Farmer's Views:

The Hon. James M. Smith, a millionaire farmer of Georgia, who died only a short time ago, had the following to say with reference to the use of fertilizers on farm crops:

"The use of fertilizers has become one of the most important factors in Southern agriculture. It is a powerful agency in producing an increased yield... a thing we should desire and work for. We certainly believe in the use of commercial fertilizers, but we also believe in the turning under of vegetable matter the growing of legumes and the saving of all barnyard manure. The up-to-date farmer will not consider one of these, but all four of them, in trying to increase his farm crops."

Why \$140 an Acre Profit When Others Make \$1600?

That intensive farming and liberal fertilization pays well is best illustrated by comparing the truck farmers, methods employed abroad and in this country. The market gardeners near Paris, who supply the city with fresh produce, average in extent from one-half to two acres each. There are about 1200 of these small truck farms which produce crops valued at \$1600 an acre each year, whereas the truck farmers on Long Island produce \$140 an acre. This high yield is obtained by the French gardeners by the wise and liberal use of fertilizers and intensive methods of cultivation. However, simply applying fertilizers to the soil will not make a good farmer out of a poor one. Fertilizers will prove effective only in proportion to the amount of intelligence the farmer uses with it. He must understand the laws of the soil and plant life and the fundamental principles of agricultural practice. Then will fertilizers prove most effective.

Greatest Grin-Producers in the World:

One of the progressive and prosperous farmers in Indiana has discovered the great value of properly applying commercial fertilizers on his farm. This is what he says:

"One of the things I do to boost my crops is to fertilize. Crops must be fed the same as stock. Fertilizers is what I call my "crop insurance." By the judicious use of fertilizers,—in other words, by feeding crops according to their needs and handling the soil according to its deservings, you will have insurance on the greatest grin-producers in the world—bumper crops."



This surely is a grin-producing crop. Errickson and Patten of Freehold, New Jersey, secured a yield of 350 bushels of American Giant Potatoes per acre. V-C Fertilizers were applied at the rate of 1500 pounds per acre to produce this splendid crop.

How a 50-Cent an Acre Farm Made Good:

On a sandy farm in one of the Southern States, which had been abandoned by its original owner and sold for fifty cents per acre, a little barnyard manure and heavy applications of fertilizer made another farmer rich. This farmer used \$15 worth of fertilizer per acre and raised 1,400 pounds of seed cotton per acre. This was about a bale per acre on the entire farm. This investment in fertilizers and good breaking and cultivation netted the thrifty farmer more than \$50 per acre when cotton was bringing a high price. This farm can not *now* be bought for 50 cents per acre.

Farmers Must Make Good Profits:

A prominent manufacturer of fertilizers in the South indicates the attitude of the manufacturers to the farmers in the following expressions:

“We feel we will help ourselves in helping others. Through co-operation can the greatest success in any industry be achieved. The fertilizer industry can not succeed unless the farmers who consume the fertilizers make good profits from their use. Can any one with good sense and judgment imagine that the industry

could survive if fertilizers did not yield a profit considerably in excess of their cost to the farmers?"

How Much Is a Billion Dollars?

We have heard much of late years about billions of bushels and billions of dollars. Yet how many of us stop to think what a billion really is, it is almost beyond comprehension, for it is such a tremendous sum. Prof. Sprague of Harvard University, in conversation with Mr. Peter W. Goebel, President of the American Bankers' Association, made this very interesting remark:

"If you want to bring the greatness of a billion dollars to the attention of the average audience, tell them this: Supposing at the birth of Christ, somebody, or some system, had started to deposit into the treasury one dollar a minute for every minute of the twenty-four hours of the day and continued until today, he still would not have quite a billion."

Multiply this seven times, and you then may form some idea as to what a stupendous amount our Government borrowed when on April 23, 1917, it authorized the Secretary of the Treasury to borrow seven billions of dollars.

125 Years to Count a Billion Bushels:

We now think and talk in billions. Some one has figured it out that it would take 102 years to count a billion silver dollars at the rate that the expert money counters of the United States Treasury count money. These expert money counters can count 4,000 silver dollars an hour, or 32,000 a day. At this rate it would take over 125 years to count the number of bushels of wheat of a single year—1915, which consisted of 1,025,801,000 bushels, which was the largest wheat crop this country has ever known.

What a good thing it is that the wealth of the United States which is now about \$240,000,000,000, does not have to be counted in silver dollars. At the rate of counting 4,000 dollars an hour it would take 24,480 years to count this enormous wealth, if it were all in silver dollars. A billion is certainly a whole lot. The money value of all the crops produced by the farmers of the United States that same year was \$6,652,000,000. Some business for that one year. Surely the men that produced it should be entitled to a good margin of profit on it.

How Plants Add to the Wealth of the World:

The wealth of the world consists of:

- a. Land or Soil.
- b. Products of Mines, Quarries, etc.
- c. Members of the Animal Kingdom.
- d. Members of the Plant Kingdom.
- e. The conversion of crude into finished products by the process of manufacture, construction, etc.

Soil tillage for the production of plants and animals employs more people, supplies more of the world's necessities and creates more wealth than many other vocations combined.

The corn crop of 1914 amounted to nearly four billion bushels. If this corn had been placed in bags two feet long with two bushels in each bag and these bags placed in lines around the earth at the equator they would have encircled the earth 58.5 times. The wheat crop of 1914 placed in two bushel bags two feet long would have encircled the earth very nearly 64 times and the oat crop 22 times. The world annually produces more than 1,000 billion pounds of the six most important cereals—wheat, corn, oats, rice, rye and barley. This is 500 million tons. If these grains were loaded into freight cars of average capacity they would encircle the earth at the equator 7.75 times. If one crop of potatoes, beans, peas, sugar, fruits and vegetables was all loaded into freight cars of average capacity more cars would be required than for the six great cereals. If all the cotton grown in the world in 1914 had been packed into 500 pound bales five feet long they would have if placed in line at the equator just about reached around the earth, making a line of bales 25,000 miles long and the bales touching. If the market value of these crops was set down in figures showing the millions of dollars of wealth they represent, the human mind could not grasp them. No one can fully realize the vast value of the crops of the world. Should all crops fail for one year more people would die of starvation than have been killed in all the wars of a thousand years. The population of the earth is increasing annually by millions of souls that must be clothed and fed, and the great economic problem of the future will be where with all shall the people of the world get their food and raiment. This problem must be solved by the farmer and the solution will be reached through "How to Make Soil and Crops Pay More."

How Plants Supply Food, Clothing, Building Material, Medicine, Etc.:

But few people realize the extent to which plants add to the necessities, comforts and pleasures of man. Every part of every plant that grows may serve some useful purpose to man. The variety of uses to which plants are put and may be put is almost inconceivable. They contain every element of nutriment for the best sustenance of man or beast and in cheap, palatable, nutritious and appropriate forms of food. Root, stem, bark, leaf, flower, seed furnish more than three-fourths of the sustenance of man and practically all that sustains man's domestic animals. Practically all the clothing used by man is either directly of plant origin or indirectly, coming from the animals sustained by plants. The medicines in their infinite variety and marvelous curative power come from plants far more than from all other sources. The books and newspapers are made from plants and the ink with which they are printed. More than all other things do plants contribute to man's necessities. Should plants for one short year fail to give their bounty famine would do more the following year to destroy civilization than all agencies combined for two thousand years have done to establish it. Is it not then our duty to minister to these God-given plants that they may better serve the purpose God intended them to serve?

Miles of Roots and Millions of Mouths

Roots by the Mile:

It will no doubt be a surprise to many to learn to what extent roots of plants grow. The roots of a corn or sunflower plant fill a cubic yard of soil with tiny rootlets. The roots produced in a season by a wheat plant, if placed end to end, would extend a third of a mile. A pumpkin vine may produce 15 miles of roots in one season. Alfalfa roots have been known to go down into the soil 30 feet. Grapevine roots have been found 22 feet below the surface. The total length of all the roots of a water plant was found to be about 268 feet, of a rye plant 385 feet, and one corn plant had a total length of 1452 feet of roots. And if these roots find no plant-food to feed them, what happens to the plants? They die of starvation.

A Few Great Drinkers:

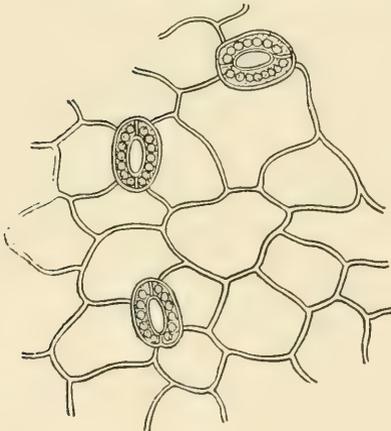
In more than half the area of the United States there is not enough water available in the average season for a maximum

yield of crops. In the central part of the United States agricultural plants, on the average, take about 450 pounds of water from the soil for every pound of dry matter produced. By careful experiment the pounds of water which under ordinary conditions are drawn from the soil for every pound of dry matter manufactured by certain plants has been ascertained to be as follows:

	Pounds		Pounds
Alfalfa.....	1068	Wheat.....	507
Canada Field Peas.....	800	Potatoes.....	488
Rye.....	724	Sugar Beets.....	377
Sweet Clover.....	709	Corn.....	369
Oats.....	614	Sorghums.....	306
	Millet.....		275

Alfalfa, by reason of its deep rooting habit, feeds through a greater area than other plants, and is therefore among the last to suffer. The large amount of water used by alfalfa explains why crops that follow alfalfa, such as corn, often suffer for lack of sufficient moisture. In poor soil plants manufacture little or nothing for long periods, although the water passes from their bodies all of the time. High fertility, therefore, means more rapid production and consequently cheaper farming. Plants must be rushed at their work.

Leaves with Millions of Mouths:



Stomata or leaf mouths as seen through a powerful microscope. These stomata are on the underside of the leaf, and it is through these openings that the plant breathes.

In the surface layer, or epidermis, of the leaves of plants there are many small pores through which the water passes to the outside air. These pores are known as stomata (stoma, singular, meaning mouth). The stomata opening is surrounded by a pair of surface cells, known as guard cells. In dry weather the guard cells are usually affected so as to close the opening, and in damp weather, so as to leave it open. The number of stomata on the leaves varies on an average from about 24,000 to 180,000 a square inch, although there are plants, such as the olive tree, in which the number runs as

high as 375,000 a square inch, and in rape the enormous number of 429,000 a square inch is reached. It is said that an average leaf of rape contains as many as 11,000,000 stomata, and that a large sunflower leaf has 13,000,000. It is estimated that if all the water given off by the plants of a wheat field in the growing season could be put back on the land again, it would cover the ground to a depth of about four and a half inches, while that given off from the plants of a field of oats would cover the ground to a depth of five inches. This shows that a wide margin of safety exists for a farmer who handles his land so as to conserve the water.

What Agricultural Educators and Experiment Stations Have Found

General Tendency Is to Use Fertilizers in too Small Amounts:

Prof. Lucius L. Van Slyke of the New York Agricultural Experiment Station, in his valuable book entitled "Fertilizers and Crops," among other facts of interest, points out the value of soil fertility and plant-food. We quote in part as follows:

"The general tendency among not a few farmers is to use fertilizers, if they use them at all, in too small amounts. While the usual purpose in using fertilizers is to supplement the soil's supply of plant-food, there are two points of view in mind: (1) helping crops to start, and (2) helping them throughout their entire period of growth.

"An ideal soil for raising good crops should possess qualities such as an abundance of plant-food, good physical condition, abundance of organic matter and calcium carbonate and good drainage. On soils which are more or less deficient in qualities characteristic of fertile soils, the use of fertilizers will generally be necessary from the start to insure good yield and quality."

Three Hundred Trillion Cells in One Day:

"We may regard an ordinary living plant as a chemical laboratory or factory, containing immense numbers of small rooms, which we call plant-cells, each of which contains everything essential for its work of production, and in which there is at one time or another intense industrial activity.

"In some cases, one cell divides into two cells every 30 minutes; that is, passes through its cycle of life from birth to reproduction; if such a rate were kept up for 24 hours the one cell would multiply into more than three hundred trillions (300,000,000,000,000).

Great Waste on the Farm:

"The methods pursued by the American farmer in drawing upon the readily available plant-food supplies deposited for their use by the accumulations of long ages have been wasteful if not yet exhaustive.

"One-third of the plant-food value of the manure produced by the different kinds of farm animals in the United States is lost by carelessness, a loss equivalent to \$700,000,000 a year."

"The conditions of soils that are recognized as best suited to crop production are the one which best furnish available plant-food.

"The agricultural value of a fertilizer is measured by its crop-producing power from the standpoint of the farmer.

Eight Billion on Pinhead:

"It is only within recent years that the science of the microscopic life of the soil has developed. Those tiny forms of life are found in great abundance in the soil. Scientists have discovered that some of the bacteria are so small that 8,000,000,000 of them could be placed on the head of an ordinary pin."

What Constitutes Good Farming:

Director Edward B. Voorhees, of the New Jersey Agricultural Experiment Station and Professor of Agriculture at Rutgers College, clearly points out the value of soil fertility as follows:

The Reliability of Commercial Fertilizers

"Commercial fertilizers are widely distributed, are easily obtained, and can be purchased in any desired amount and at any convenient time. There is an advantage in being able to obtain the same mixture from year to year, when it best suits one's needs, and to feel assured of having the same kinds of plant-food materials in the same proportions. Generally speaking, the same brand of fertilizer, especially in case of the large manufacturers, has been found very uniform from year to year. It is possible for manufacturers to prepare fertilizers so that they are evenly and thoroughly mixed, finely ground, dry, and in condition for convenient use. The manufacture of commercial fertilizers today is, on the whole, more carefully managed, and the products more reliable in uniformity, than at any previous time.

"There is no question of greater importance to the practical farmer than that of soil fertility. To produce profitable crops

and at the same time to maintain and even increase the productive capacity of the soil may rightly be termed 'good farming.'

"The agricultural value of any of the fertilizer constituents is measured by the value of the crop increase which its use may be expected to produce. The fertilizer when used in connection with a crop possessing a greater market value may prove highly profitable, since the monetary return secured from the crop increase is much greater than the cost of the fertilizer."

Profits Within Farmers' Control:

"The profit from the use of fertilizers is measured to a large degree by the perfection of soil conditions which are entirely within the power of the farmer to control. The production possible from a definite amount of plant-food can be secured only when the conditions are such as permit its proper solution, distribution, and retention in the soil.

"It should be the aim in the use of commercial fertilizers to supplement the plant-food derived from the soil itself in such a manner as to make possible the most profitable returns. Farming will thus be more successful, because profitable crops are secured, while fertility of the soil is at the same time increased.

"Commercial fertilizers are mainly valuable because they furnish the elements—nitrogen, phosphoric acid, and potash—which serve as food, not as stimulants. A definite system or plan should be adopted in the use of fertilizers; 'hit or miss' methods are seldom satisfactory, and frequently very expensive."

Fertile Soil and Bumper Crops for 4200 Years:

The late Prof. F. H. King, D. Sc., formerly Professor of Agricultural Physics at the University of Wisconsin, and Chief of Division of Soil Management U. S. Dept. of Agriculture, in his interesting history of "Farmers of Forty Centuries," points out how the farmers of the Orient have successfully applied plant-foods, good tillage and crop rotation to their intensive methods of farming.

Prof. King relates how for hundreds of centuries these Oriental soils have been tilled to the limit and produced exceptional crops. For 4200 years the fertility of these soils has not decreased but increased, and today are producing crops four and five times as much as we produce on our own soils here in the United States. These Oriental farmers never "mine" their soils, but year after year see to it that the fertility of the soil is regularly maintained and increased, not robbed as is done so much in this country.

Feeding Apple Trees Pays:

Some interesting experiments were conducted by the Massachusetts Experiment Station in determining the value of fertilizers on an apple orchard. The cost of fertilizers was about \$12.00 per acre per annum. Between the trees hay was grown for four years which was worth \$270, which in itself more than paid for the cost of fertilizer. The total yield of these trees for 20 years was as follows:

	Barrels per Acre	
	Fertilized	Unfertilized
Gravenstein.....	267.5	89.2
Baldwin.....	819.1	50.4
Russets.....	566.2	114.4
Greenings.....	341.3	96.9



Fertilizer Results on an Ohio Orchard. The two rows of 12 trees each are of the same variety, received the same treatment in mulching and spraying, yet note the difference in the yield. The row on the left was fertilized and yielded 30 barrels. The row on the right, unfertilized, produced 3 barrels of apples. The difference of 27 barrels of apples was due to Fertilizer which was applied at the rate of 10 pounds per tree.

Increased Yields Per Acre Did It:

Dean Homer C. Price, College of Agriculture, Ohio State University, Columbus, writing on "Increasing the Food Supply of the Nation," as published in the *Scientific American*, says:

“A nation’s food supply may be increased either by increasing the area cultivated or by increasing the yield per acre. In America we have been using the former method, and in Germany the latter method has been used. Within twenty years the cultivated area of grain in Germany has not increased over 5 percent, but within this time the total product has increased over 60 percent, due to the increased yield per acre. This increase has been due to the application of science to the practice of agriculture, and has resulted from a better cultivation and handling of the soil, from the more abundant and intelligent use of stable manures and commercial fertilizers, and from the selection and breeding of more productive varieties of crops.”

Two Interesting Comparisons:

It will be of interest to compare the increase of five principal crops in the United States with Germany’s increase. Official records for 20 years in Germany and 18 years in the U. S. show the following:

*Increase in Yield in Five Crops of Germany in 20 years,
and Same in U. S. in 18 Years:*

	<i>Germany</i>	<i>United States</i>
Wheat.....	47.8% increase	15.7% increase
Rye.....	70.0% “	29.2% “
Oats.....	68.6% “	13.3% “
Barley.....	51.8% “	8.8% “
Potatoes.....	71.6% “	32.3% “

Commenting on this showing Dean Price further says: “The German is more careful in the selection of his seed, and his stand of the crop on the ground is more perfect. He has also learned how to feed his crops with fertilizers.”

Why Home Mixing Is Not Best:

In Bulletin No. 167 of the Texas Agricultural Experiment Station is clearly pointed out the advantage of having fertilizers well mixed, and why the manufacturer of fertilizers can do this best. We quote as follows:

“The fertilizer manufacturer has the advantage of purchasing his materials in large quantities at wholesale prices. He also has the advantage of possessing the necessary machinery and appliances for mixing at a lower cost per ton than the home mixer.”

Indiana Farmers Found It Profitable:

Purdue University Agricultural Experiment Station in its Circular No. 49 emphatically points out to what extent commercial fertilizers have helped the Indiana farmers in increasing their crops and profits. We quote as follows:

"At the present time there is no Agricultural subject in which there is more general interest than that of soil fertility. The farmers of Indiana have found it profitable to spend \$3,-400,000 a year for commercial plant-foods among the 215,485 farms.

\$5.00 Worth of Commercial Fertilizer Gave Greater Increase Than Ten Tons of Manure

"One application of 207 pounds of muriate of potash to the acre on muck soil gave an increase of 82 bushels of corn in four years, while an application of 10 tons of barnyard manure to the acre only increased the yield 51 bushels during the same period. In this experiment an application of potash costing \$5.00 gave a greater increase in crop than an application of 10 tons of manure. Contrary to the general opinion, farm manures are not well balanced fertilizers for most soils."

Indiana Shows 187 Percent Increase:

In Bulletin No. 174 of the Purdue University Agricultural Experiment Station, we learn to what extent the Indiana farmers have increased the use of commercial fertilizers on their soil and crops in recent years, as follows:

"Total amount of fertilizers sold in Indiana in 1913 was 193,899 tons, having a retail value of \$4,516,404.81. The sale in the spring amounted to 84,769 tons, valued at \$2,068,649.13, and in the fall of 109,130 tons valued at \$2,447,755.68. Compared with the 67,672 tons sold in 1904, ten years previous, shows an increase of 126,277 tons, equivalent to 187 per cent."

What 30 Years' Experiments Proved:

The Pennsylvania State College of Agriculture has made some very interesting and conclusive experiments on various crops with the use of fertilizers. After 30 years of experiments it found that the judicious use of fertilizers increased the yield per acre on four crops as follows:

Wheat	made	a	gain	of	74	percent	in	yield	per	acre.
Hay	"	"	"	"	54	"	"	"	"	"
Corn	"	"	"	"	36	"	"	"	"	"
Oats	"	"	"	"	31	"	"	"	"	"

Fertilized Wheat 94 Percent Plump, Unfertilized Wheat 51 Percent Plump:

The Ohio Experiment Station made some interesting experiments on wheat. It reports that where the wheat was grown on soil which was not fertilized, the sample of grain showed 49 percent shriveled wheat and 51 percent plumb wheat. Whereas, the wheat which received a judicious amount of the correct plant-food, the sample of grain analyzed 6 percent shriveled and 94 percent plump. Is this not conclusive evidence as to the value of proper fertilization?

The Value of a Knowledge of Farm Management Principles:

Many American farmers are getting less from their labor than they are entitled to because they fail to recognize certain fundamental principles which underlie successful farm management.

One of the important lessons we have learned from the science of farm management is that the great majority of American farmers must make their living from the production of ordinary field crops and standard live stock products. It has also taught us that in order that the farmer may be duly rewarded for his time and energy he must work a considerable acreage of land. The ideal American farm is of a size that will give the average farm family an opportunity to utilize their full earning power at all seasons of the year.

One of the worst faults of American farming, and particularly of farming in the cotton belt, is the fact that the system followed leaves much of the year either wholly idle or poorly occupied. A man's time is not worth a great deal when he is following one six-hundred-pound mule down a cotton row. The cotton farmer should at least produce on his own farm all the feed and food needed by those who live on the farm, and where there is a good local market for food and feed products it is a good plan to produce a surplus of these for sale.



Dr. W. J. Spillman,
Chief of the Office of Farm
Management.

Another very important lesson which the science of farm management has taught us is that yield per acre is one of the largest factors in the farmer's profits. *A farmer whose yields are low can add more to his income by giving attention to building up soil fertility than he can in any other way.*

Another important fact developed in farm management studies is that farm land, because of the remarkable security it offers as an investment, is usually held at a price that causes the income from it to represent a very low percentage of its value. On the other hand, when money is invested in work stock, implements and the like, it brings a very high rate of income under average conditions. It is not uncommon for landlords to obtain an income of 4 percent or less on their real estate while their tenants make an income of 15 percent to 30 percent on their working capital.

The important lesson from this is that the young man starting out with very small capital can make more as a tenant on a farm of considerable size than he can as an owner on a small patch of land. Yet the advantages of ownership are so great that just as soon as the tenant is able to save enough to make a first payment on a good sized farm it is important that he become an owner.



Dr. Seaman A. Knapp
Late head of the Boy's Club movement
of the U. S. Department of Agriculture

2,000 Boys Produce Over 200,000 Bushels of Corn:

One of the most revolutionary and evolutionary pieces of work ever accomplished in the United States is that which was done through the Boys' Corn Clubs. This work was organized some years ago by the late Dr. Seaman A. Knapp, and Dr. Knapp's conception of the work marked a new era in crop production in the South. Dr. Knapp's idea was to *Make Soil and Crops Pay More*, and to have boys demonstrate how this could be done. How well the demonstrations were carried out is shown by the records of more than 25 boys who produced more than 200 bushels of corn per acre and more than 2,000 boys who have produced more than 100 bushels of corn per acre.

In 1916 the average yield of corn (U. S. Census) in the fifteen Southern States was 20.91 bushels per acre. In the same

year the average yield per acre by all of the several thousand members of the Boys' Corn Clubs was 46.94 bushels per acre, 26.03 bushels per acre in favor of the boys. The average yields per acre by the Boys' Corn Club members was 124 per cent more than the average yield of all the 15 Southern States. The boys acres averaged five bushels more than twice as much as the average per acre for the 15 Southern States. If the men farmers of the South follow the lead of the Boy's Corn Club members the South will more than double its yield of corn.

By following scientific instructions the Corn Club Boys in fifteen states have shown that the yield of corn may be more than doubled by giving timely attention to good soil preparation, good seed, appropriate feeding and frequent shallow cultivation. Had the farmers in these states done as well as the boys the total yield of corn in 1917 would have been about 2,000,000,000 bushels instead of a little over 900,000,000 bushels.

State	Average Yield in Bushels in 1916		Total Annual Production in Bushels	
	By Boys' Corn Club	By Whole State	1909	1917
Alabama.....	36.25	12.00	30,696,000	77,200,000
Arkansas.....	37.02	17.70	37,610,000	67,200,000
Florida.....	42.00	15.00	7,024,000	13,875,000
Georgia.....	41.60	15.50	39,375,000	72,000,000
Kentucky.....	65.10	28.00	83,348,000	122,850,000
Louisiana.....	46.00	21.00	26,010,000	42,246,000
Maryland.....	62.10	39.00	17,924,000	28,080,000
Mississippi.....	42.47	14.00	28,429,000	84,050,000
North Carolina..	54.80	18.50	34,063,000	60,000,000
Oklahoma.....	35.87	13.50	94,283,000	33,150,000
South Carolina..	42.60	15.50	20,872,000	43,947,000
Tennessee.....	51.57	26.00	67,682,000	111,150,000
Texas.....	36.60	19.00	75,499,000	77,825,000
Virginia.....	54.09	28.00	38,295,000	72,275,000
West Virginia....	56.10	30.50	17,119,000	25,020,000
	46.94	20.91	618,229,000	930,868,000

Boys' Average 46.94 bushels per acre.
 15 Southern States Average 20.91 bushels per acre.

Increase by Boys 26.03 bushels per acre.

The above states produced 312,639,000 bushels more corn in 1917 than in 1909.

The Business of Farming a Banking Proposition

It is a well known fact that no matter what crops may be grown, every crop consumes plant-food from the soil, and this plant-food supply is no more inexhaustible than your bank account. Every prosperous and successful farmer has learned this great truth and fundamental principle.

The reliability and strength of a bank is measured by its deposits and investments, as well as good management. In this respect a farm is like a bank, for it too must have good management, and when the farmer realizes that his land is measured by the reliability and quality of its deposits—available plant-food properly applied, he will awaken to the fact that his soil and crops are as much a money-making factor as a bank, if not more so, for is it not true that if the farmer stopped producing crops the banks would have to close and go out of business?

Hence the farmer can make his business more prosperous by making his soil and crops pay *more*; by making his land and what it produces more productive; by increasing and improving his yields per acre; and by making his soil permanently fertile. If he does that he will have the best bank account he could possibly possess.

We will now let a few prominent and successful bankers give us their views on the relationship between banking and farming, and the necessity of soil and crop improvement. Every farmer will be interested in the answer Mr. Oliver J. Sands, President of the American National Bank of Richmond, Va., gives to the question:

Why Are Your Soil and Crops Like a Bank Account?

“Because both will be useless if not properly fed. The bank account is an ever present help in time of need, but it must be constantly nourished by deposits of cash to replace that which has been withdrawn, and the greater deposits the greater the bank account.



Mr. Oliver J. Sands,
President of the American National
Bank, Richmond, Va.

“Just so with your soil. You can not continue to draw on it forever without depleting it of those qualities which are necessary for it to have if it is to meet the demands which you have a right to expect of it.

“Again the bank account grows from the intelligent use of money, the practicing of well recognized rules of thrift in the handling of one’s affairs. So it is with the intelligent use of proper methods in building up the soil, for when properly fed it will yield greater returns and its value will increase.

“The soil is the basis of all wealth, for when it is made to yield a proper return all business prospers.”

“Soil and Crop Improvement Are More Important to the People of the United States Than Our Gold Production”

The above statement was made by the representative of the largest banking institution of the United States, Mr. F. C. Schwedtmann of the National City Bank of New York City, in his address before the National Fertilizer Association at Hot Springs, Va., July 10th, 1916. The following extracts from this able address can not help but be of interest and value to all the farmers and bankers of this land:

“To double the crops of the United States would add tremendously to the wealth and contentment of our people. There is a possibility of not only doubling them, but quadrupling them. Secretary Houston states that only 40 percent of the tillable land of the United States is under cultivation, and this 40 percent is not bringing the return it should. The average yield per acre of wheat in this country was $15\frac{1}{2}$ bushels for 1912 and 1913, as compared with 34 bushels in Great Britain and 35 bushels in Germany. During the same period potatoes yielded 100 bushels to the acre in the United States as compared with 235 to 500 bushels in Germany. Other crops follow more or less the ratio of these two. Increasing the yield 100 percent per acre would still leave us considerably below the best performance of



Mr. F. C. Schwedtmann, National City Bank, New York City

European soils—some of which have been cultivated intensively for centuries without signs of exhaustion.

“The money value of all the crops for the United States in 1915 was \$6,652,000,000. Doubling the tillable soil and doubling the yield per acre would bring this value to \$26,608,000,000 annually. The value of the gold production in the United States during 1915 was approximately \$99,000,000, and of the whole world for 1914 approximately \$456,000,000. Compare these figures and you will find that the value of our crops is about 67 times the value of our annual gold production and about 15 times the value of the gold production of the whole world, and that by proper effort we can increase the crop value to 260 times the value of our own gold production and 60 times the value of the gold production of the whole world. It is evident, therefore, *that soil and crop improvement are far more important to the people of the United States than our gold production.*

“There are indications of crop improvement in our country. The average yield of wheat per acre has been increased from 13½ to 15½ bushels, or 20 percent in ten years, but during the same period wheat production in Germany has increased from 24½ bushels per acre to 35, or 39 percent.

“We have much to learn in the rotation of crops and in the proper chemical preparation of the soil—this, too, in spite of the excellent work of education and demonstration carried on by you and the various experimental stations. The study of the chemistry of the soil which you gentlemen have adopted as your profession is, in my opinion, destined to become one of the most important callings of the day and age.

“The census figures of the fertilizer industry in the United States show the value of the products of all the fertilizer manufacturing establishments of the United States for which figures are available from 1870 down to date. The total value of the output recorded by the census of:

1870 was \$	5,851,118,
1880 was	23,650,795,
1890 was	39,080,844,
1900 was	44,657,385,
1910 was	111,871,481,
1915 was	168,388,405 (approximately).

This very rapid increase in production, especially in recent years, demonstrates the increasing recognition by the farmers of the United States of the need of a proper care of our soils.

The total output of this line of manufacture increased over 130 percent in the decade of 1900-1910, while the value of all manufacturers in that period increased only about 80 percent.

"There is a particular reason why governmental departments, State and Federal, should give a helping hand to the further upbuilding of this industry; for the increase of foodstuffs in the United States is not keeping step, by a long way, with the increase in population. Those countries have succeeded best in the intense cultivation of the soil, in which Government, manufacturers and bankers have worked in constructive harmonious co-operation with the agriculturists and with each other."

\$1,000 for Fertilizers But *NOT* for a Barn

Few men understand the relationship between banker and farmer better than Mr. William Ingle, who when Chairman of the Board, Federal Reserve Bank of Richmond, Va., said:

"The farmer, or rather his labor, is the source of the greater part of our wealth. Nearest related after the land itself, possibly, is the fertilizer manufacturer.

"With the passage by Congress of effective Rural Credit laws, the farmers will have at their command an agency which in its use will permit them as readily to finance their essential operations as merchants are now able to do with comfort in availing themselves, through their banks, of the provisions of the Reserve Act.

"The farmer is essentially a manufacturer, but one who, as commonly is the case, in having practically all of his assets tied up in his land is without the means to purchase his fertilizers and other supplies on a cash basis. Carrying costs under the old system, that is, the difference between a spot cash price and the figure actually paid in settlement of supply bills at the end of the season, is probably as much as 20 percent of the cash price of the material used. If this could be saved to the farmer, he could afford either to be more liberal to his land under treatment or to add to his acreage.

"We can not lend the farmer a dollar on paper made to build a barn, but we can lend him \$1,000 with which to pay his fertilizer bill.



Mr. William Ingle,
President Baltimore Trust Co.,
Baltimore, Md.

"We must have the assurance when we take a farmer's note, the banker must tell us in effect, that that loan is not made to build a barn, but to pay a fertilizer bill."

Is this not ample proof to what extent the bankers value fertilizers? There is safety and security in fertilizers, and the banker will help the farmer who needs money for fertilizers, so his soil and crops will pay *more*.

The Banker and the Farmer

By Mr. John K. Ottley—Vice President
Fourth National Bank, Atlanta, Ga.:

"The soil is the basis of all wealth. Therefore the relation between the farmer, whose business is handling the soil, and the banker, whose business is handling the money, is vitally important.

"The farmer who is not making a profit is not a good credit risk. The farmer who is operating on diminishing crops and too high costs is in the hazardous class so far as credit goes. When the farmer prospers, everybody else prospers with him. Whatever affects him unfavorably is bad for general business.

"Two elements enter into the question of the farmer's profits, viz.:

- (a) The cost of crop production.
- (b) The yield per acre.

Yield per acre is the factor that controls the cost per unit of every crop the farmer plants. The greater the yield per acre, the smaller the cost per pound or per bushel of producing the crop. Profits depend upon the amount of money received for the crop over and above its cost to produce and to market. This is elementary to the economist, but it is the A B C that the farmer needs to learn by heart.

"The farmer's big task, then, is to make the land yield him the very utmost that it is capable of yielding.

"This brings us to our much-admired, but little-practiced, theory of *cultivation*. I regret to say that it is little practiced; but the figures show that notwithstanding all the eloquence that has been expended on the subject, the true meaning and import of *intensive* cultivation has not yet dawned upon large sections of our agricultural territory.



Mr. John K. Ottley,
Vice-President Fourth National
Bank, Atlanta, Ga.

"The human machine must be 'fed up' with its proper nutrients. Body proteins and minerals and carbohydrates and fats require severally their fuel of like elements to maintain health, to build tissue, muscle, bone and brawn. Precisely so, to repair the waste, must the land be supplied with the restorative and nutritive elements that will keep it in condition and up to standard. The most efficient body is the best-nourished, that is to say, the most scientifically nourished body. If the soil is to yield the best of which it is capable, it too must be supplied with such food as will challenge it to its utmost performance. Research in the laboratories of the chemist has revealed the secrets of this food. We have men today who can tell us what elements must be supplied to certain soils to make them do certain things. The government, the colleges, the banks are endeavoring to connect the farmer with these golden secrets. Here and there, he is waking to the magical possibilities of his business. Fertilizer experts are demonstrating the value of intensively cultivated and well-fed land. Figures that are pitiless in their statements of facts show an amazing total of money that might be saved this country if our farmers were alive to the necessity of getting out of their land all that it ought to yield. I am tempted to cite one example:

"The average potato crop of the United States for the seasons of 1910, 1911, 1912, was 367,526,000 bushels, grown on 3,666,285 acres. At the German average yield of 220 bushels per acre this crop would have been produced on 1,670,574 acres. The average cost of production for the United States, exclusive of the cost of fertilizers, was \$25.75 per acre. Multiplying the difference in acreage, of 1,995,711 acres, by \$25.75, we arrive at \$51,389,558, which the American farmer might have saved had he used the intensive method of the German farmer. On potatoes, wheat and oats, the total saving would have been \$504,143,833, which at an average price of \$25.00 a ton would have bought 20,165,753 tons of fertilizers—a heavy application to equal German results—and still leave a splendid profit to the American farmer.

"The best thing the banker can do for the farmer, as I see it, is to encourage him in every possible manner to get most out of his land and thus to depress the cost of production so that profits may be greater and credit correspondingly stronger."

When the farmer gets it into his mind that his calling demands the admixture of real business methods with the usual processes of his specialty, then he will begin to take his place among the independent producers of the world's wealth. But so long as he

clings to the tradition that the earth will yield her increase without any particular encouragement on his part beyond the old-time plowing and planting and cultivating methods, he is losing potential riches for himself and for his Nation.

The Greatness of Our Country and Its Farming Industry

When we realize that the United States covers considerably less than one-sixth of the earth's surface, and contains only about five percent of the earth's population, the following will give us some idea of the greatness of our own country.

The value of our principal farm crops in 1917 reached the enormous total of thirteen and one-half billions of dollars, exceeding by almost four and a half billions of dollars the value of the 1916 crop, which was the previous banner value year in the crop history of the country.

Corn: In the Department of Agriculture's December, 1917, Crop Report it bases value on December prices on corn as follows:

Production of 3,159,494,000 bushels is worth \$4,053,672,000, the largest and most valuable crop ever grown in this country. It exceeded the crop of 1916, which was the largest previous value crop by more than \$1,700,000,000. In only one other year has the corn crop been over 3,000,000,000 bushels, and that in 1912, when it was 3,124,746,000 bushels.

It is interesting and no doubt valuable for the farmers to know that the corn crop was especially short and of poor quality in the area including Michigan, Wisconsin, Minnesota, Iowa and North Dakota, where the farmers have not as yet learned to know the necessity and great value of plant-food, as the Southern farmers have long ago learned and profited by. On the other hand, in the Southern States, where fertilizers are used extensively, the corn crop showed an increase.

Wheat: The 1917 wheat crop was also a record-breaker and was valued at \$1,307,418,000, which is \$287,450,000 more than the 1916 crop.

Oats: Another bumper crop in both production and value, representing 1,587,286,000 bushels, over 300,000,000 bushels better than 1916. Its value is estimated at \$1,061,427,000, or \$400,000,000 more than the 1916 crop, which was the former record value crop.

Other crops such as potatoes, tobacco, rye, buckwheat, rice, hay, cotton and barley were also record crops.

The approximate value of the principal crops in 1917, according to the U. S. Department of Agriculture, follow in the order of their respective value:

Corn.....	\$4,053,672,000	Apples.....	\$ 213,057,000
Cotton.....	1,517,558,000	Kafirs.....	121,842,000
Hay.....	1,359,491,000	Peanuts.....	105,950,000
Wheat.....	1,307,481,000	Beans.....	102,426,000
Oats.....	1,061,427,000	Rye.....	100,025,000
Potatoes.....	543,865,000	Sweet Potatoes.....	96,121,000
Tobacco.....	297,442,000	Rice.....	68,717,000
Barley.....	237,539,000	Peaches.....	61,245,000

The following table will give you a good idea as to how the American farmer is doing his bit toward feeding the world. The figures in the first two columns represent the 1917 and 1916 acreage. The third and last columns show the 1917 and 1916 production respectively. The figures are those of the U. S. Department of Agriculture as published in December, 1917.

CROP	ACREAGE		PRODUCTION	
	1917	1916	1917	1916
Corn, bus.....	119,755,000	105,296,000	3,159,494,000	2,566,927,000
Wheat, bus.....	45,941,000	52,316,000	650,828,000	636,318,000
Oats, bus.....	43,572,000	41,527,000	1,251,837,000	1,251,837,000
Barley, bus.....	8,835,000	7,757,000	208,975,000	182,309,000
Rye, bus.....	4,102,000	3,213,000	60,145,000	48,862,000
Buckwheat, bus.....	1,006,000	828,000	17,460,000	11,662,000
Rice, bus.....	964,100	869,000	36,278,000	40,861,000
Potatoes (Round), bus.	4,390,000	3,565,000	442,536,000	286,953,000
Potatoes (Sweet), bus.	953,000	774,000	87,141,000	70,955,000
Hay (Tame), tons....	53,516,000	55,721,000	79,528,000	91,192,000
Tobacco, lbs.....	1,446,600	1,413,400	1,196,451,000	1,153,278,000
Cotton, bales.....	33,634,000	34,985,000	10,949,000	11,449,930
Beans (6 States), bus.	1,832,000	1,107,000	15,701,000	10,715,000
Peanuts, lbs.....	2,084,400	1,076,350	60,222,000	35,324,500
Apples, lbs.....			58,203,000	68,194,000
Peaches, boxes.....			45,066,000	37,505,000

With such crop production is it any wonder that America today contains more than a third of all the wealth in the world? Yet how much greater will be our wealth when the farmers of our country learn the real value of applying an abundance of plant food on their soils and crops and to what extent Permanent Soil Fertility will aid in increasing prosperity on their millions of acres of cultivated lands. And not until the farmers of America realize this will our prosperity be as great as it might be.

Making Soil and Crops Pay More

Part Two

Questions & Answers

Which Will Help Every
Farmer to Make His Soil
and Crops Pay More

Answers to Questions Which Will Help Every Farmer Make His Soil and Crops Pay More

Question: WHAT ARE PLANTS?

Answer: Because plants are not noisy as animals are, few people realize that plants are living things, full of life. Plants do not roam about like animals do, nor shout, nor bellow on the fields as animals do, but, nevertheless, they eat, sleep, drink, breathe and breed, and do other things that we are accustomed to associate with animals.

Plants are organized structures, the more common forms of which have roots, root hairs, root bark; stem, branches and bark; leaves, blossoms and seeds (fruit). A plant belonging to the lower forms may consist of but one cell, but higher forms are composed of billions of cells. Plant cells vary in size and shape and contain protoplasm, a substance which may be said to be the "physical basis of life." It is through these cells and through the cell walls that plant-food enters and passes to the various parts of the plant aided by protoplasmic functions.

Question: HOW DO PLANTS LIVE?

Answer: Because plants are alive they must have food, air and water, and the right place to grow in. Under-feeding or improper feeding is as harmful to plants as it is to animals or human beings. A robust, healthy, vigorous plant needs nourishing food and plenty of it, also good water and good light and air. If you doubt this, take any plant, place it in a dark, poorly ventilated room without nourishment and sunshine, and it will not live under such conditions any more than you would, or your dog, horse or cow.

Then too, plants are really more particular what they eat than most people or animals are. We know that an animal is alive when we see it breathe, eat, grow and move. Just so with plants, for they too breathe, eat, grow and move. The plant is never a lazy worker, for it works in all its parts, the roots, the stem and the leaves.

Since plants, unlike animals, are usually fixed and rooted in one spot, it is impossible for them to go in search of food, hence the food must be brought to them where they can readily assimilate.

late it and nourish themselves. The roots of plants immediately start to fix themselves in the soil for the purpose of obtaining nourishment to enable them to grow abundantly, and when these roots fail to find the necessary food they simply die for lack of proper nourishment, for they can not roam about like animals can and forage for food.

Question: HOW DO PLANTS REPRODUCE?

Answer: The means by which plants naturally reproduce their kinds are seeds, spores, tubers, roots, bulbs, corms, root-stocks, stolons, suckers, etc. Nature provides means for the perpetuation of all species of plants, and many of them vary very widely. The most common means of reproduction is by seeds. Many plants, however, will not reproduce their kinds by seeds and Nature has provided other means for their increase, and man has become expert in the employment of various natural and artificial means of the different kinds best adapted to the multiplication of our many crops. Thus corn, wheat, cotton and tobacco are grown from seeds; grapes from cuttings or layers; Irish potatoes from tubers; sweet potatoes from roots; apples from grafts; peaches from buds; strawberries from runners; and mushrooms from spores. Many of our crops do not come true from seeds. Seeds develop from the exercise of sexual functions, and crossing or hybridization is very common with many of our crops. If pollen, which is the male part of plants, fertilizes the pistil or female part of another kind of plant, the resulting seeds will be crossed and many of them will produce plants different from either parent. Hence, no matter how a plant is brought to life or in what form it is placed in the soil, all plants need plant-food—nourishment.

Question: HOW DO SEEDS GERMINATE?

Answer: Seeds are living things which have the power of reproducing the plants from which they came. Stored in each seed are the inherited potentialities which enable them to become links connecting thousands upon thousands of generations of plants created so that the earth may be made fit for man.

That seeds may germinate they must have moisture, heat and air in appropriate supplies. Water is absorbed, the seed swells, starch and fat become soluble, sugar is formed, new tissues and cells are formed, and the rootlets push through the seed coat and start downward into the soil; the stem and leaves start upward to air and sunlight, and a new plant has sprung into being. Enough food is stored in the seeds to support the young

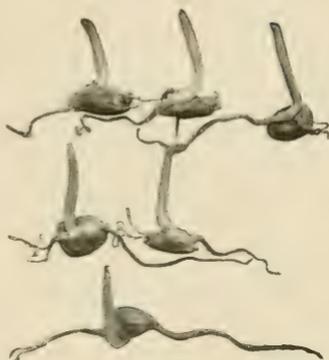
plant until its leaves feed from the air, and its roots feed from the soil. Some seeds will germinate at a temperature a few degrees above freezing, while others require 60 or more degrees Fahrenheit. Eighty degrees is about the temperature most favorable for the germination of most seeds. The oxygen of the air is necessary for the germination of all seeds. A well prepared seed-bed gives the best conditions for germination by aiding in securing the right quantity of air and water and the desired degree of temperature.

Question: HOW DO PLANTS GROW?

Answer: The first sign of life a plant will make when the seed sprouts is to spread its roots into the soil and starts downward for its store-house of food supply; then comes the stalk and leaf part which starts upward towards light and air, for it must eat and drink and breathe just as all living things do.

Plants grow by forming new cells. Plant cells of various sizes and shape make up the structure of all plants. New cells

are formed by division of older ones, and by the plant extending its stem, branches, leaves and roots, the plant grows. To do this it must be supplied with food, water and air. The food must contain the material of which the plant is made, and in quantities and proportions in which they are to be used by the plant. The carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium and iron which are found in all plants must be in the



These young corn plants must push their way through the soil to the air and sunlight and the roots must multiply and spread in all directions seeking nourishment. That the plant may best do this the soil must be fine throughout the depth to which it has been plowed. A well prepared seed bed insures prompt germination and healthy plants, increases the soils capacity for holding water and gives the growing crop easy access to the plant food in the soil.

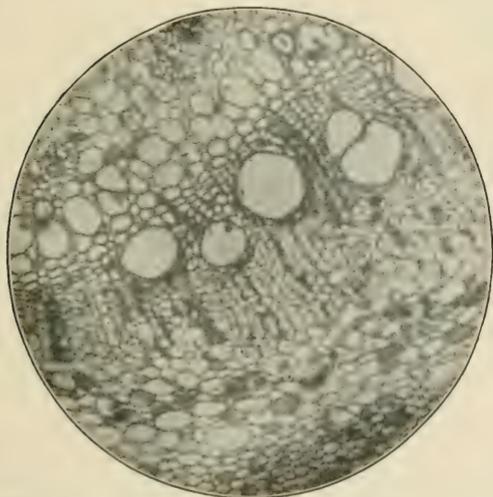


Photo. Micrograph of cell structure of Potato Vine, greatly enlarged. The various cell shapes and forms can be clearly seen.

right forms or combinations for the plant, and must be where the plant can get them or it will not grow. All of them must be present and usable, since the absence of any one of them will prevent the plant from growing, and the smallest quantity available of any one of these elements will be a controlling factor in the growth of the plant. When the plants in a field or in a part of a field are not growing well, either the conditions and materials necessary to good growth are not supplied or the materials are not in suitable form.

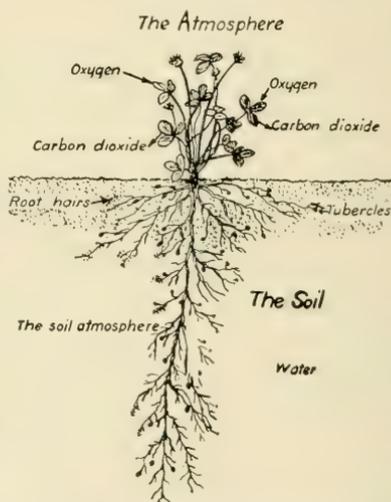
Question: WHAT MUST A PLANT HAVE IN ORDER TO LIVE?

Answer: That plants may live they must have:

Temperature that is neither too high nor too low, Changes of temperatures that are sudden seriously interfere with their growth. Some plants thrive best in low and some in high temperatures.

Water, which by weight composes the bulk of all growing plants, must be constantly and abundantly supplied while plants are growing. Either too little or too much water is disastrous to nearly all economic plants, though many of them by nature grow in water. Drainage and irrigation are the means employed by the farmer to get rid of excess of water and to secure the proper supply when there is a deficiency.

Food builds the plant. Plant-food is taken from both the air and the soil, entering the leaves from the air and the roots from the soil. The food which comes from the soil must be in solution or dissolved in water before the plant can take it up. Water is the vehicle which conveys the soil-food into the plant and is the distributing agent which takes it to such parts of the plants as need food. Air is the medium in which the above-ground parts of the



A clover plant, showing its parts in relation to the soil and atmosphere. From the atmosphere and water the plant derives oxygen, carbon, and hydrogen. From the soil the mineral plant-food elements are taken.

plant live, just as the soil is the medium in which the underground parts of the plant live.

Carbon, next to water, is the most abundant material of the many which enter the plant. Carbon comes from the air and passes into the plant through the pores of the leaves. Carbon Dioxide of the air is decomposed when it enters the plant with the air, the carbon remaining and the oxygen going back into the air. Thus plants take carbon out of the air and liberate oxygen, while animals take oxygen from the air and liberate carbon.

Soil Conditions that are congenial to plants are important factors in the lives of plants. There are many conditions of the soil that are favorable, and many that are unfavorable, and a knowledge of these conditions will enable the farmer to plant certain crops where certain conditions most favorable to them are present and avoid unfavorable conditions. Drainage, plowing, cultivation, organic matter, lime, air, water, temperature, sunshine, bacteria, insects, manures and fertilizers change soil conditions, and enable plants to live or interfere with their growth, as the case may be.

Insects and Diseases of many kinds and in vast numbers are ever laying in wait for their attack upon plants, and the farmer must be alert at all times so that he may avoid or destroy them.

Nature supplies the necessities of plants only in part, and by Divine command man is responsible for the good care and abundant feeding of the crops he grows. Man must protect his crops from their enemies, and supply them with their needs if his crops are to give abundant harvests.

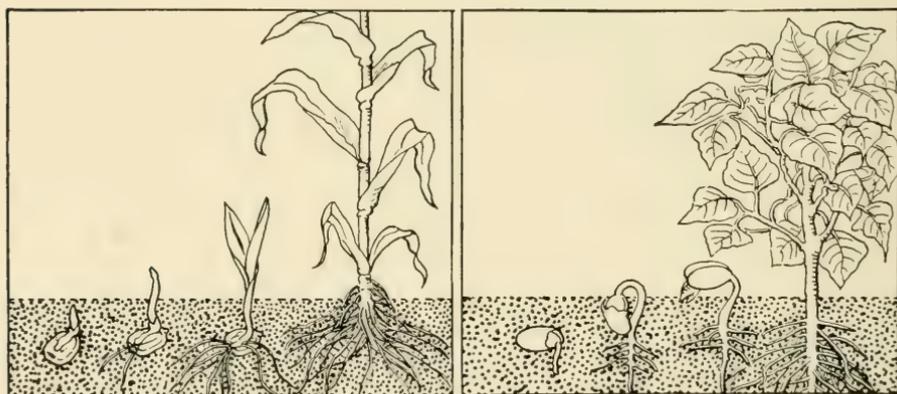
Each plant is endowed with life, with its own peculiar anatomical structure, and performs in its own way its nature-given physiological functions. In living its life, each plant employs natural laws and sciences from the germination of the seed on through to the final goal of reproduction; and solution, absorption, capillarity, osmosis, diffusion, adhesion, cohesion each performs its necessary functions in enabling plants to live and grow, to reproduce and ripen. The growing of plants is intimately associated with nature's benign mysteries, and man has much to learn from them. By the slow processes of evolution, the more rapid processes of breeding, and the employment of artificial nutriment, plants have made the world a better place to live in. And still better will the world be when the farmer

knows his soil and knows his crops so that he may best treat his soil and best feed his crops, which in a great measure is the mission we hope to fulfill with this little book.

It was the great scientist Darwin who likened the roots of plants to the brain of animals on account of their great discrimination and ingenuity. Their tiny finger-like rootlets go feeling their way into the soil for nourishment as well as to fix the plant which is to sprout from its roots perfectly secure in its abiding place.

Question: WHY ARE THERE ONE-SEED-LEAF AND TWO-SEED-LEAF PLANTS?

Answer: All of the important farm crops fall under two classifications and their separation into these two groups naturally follows the differences in their habits of growth and their structure. One-seed-leaf plants germinate from their seeds by sending up one leaf first, while two-seed-leaf plants send up two leaves. Corn, wheat, grasses, etc., are samples of the one-seed-leaf class, and cotton, beans, cabbage, etc., are examples of the two-seed-leaf plants. One-seed-leaf plants grow from the in-



The germination of Corn (one-seed-leaf plant) and Bean (two-seed-leaf plant) showing progressive stages from germination to mature plant.

side, have no bark, their leaf veins are parallel and they have no tap root. Two-seed-leaf plants grow by additions to the outside, have a distinct bark, their leaf veins are netted, and they

have a distinct tap root. The difference in the root systems affects the manner of growing of these two classes of plants, since the tap rooted crops feed deep and the fibrous root crops feed shallow. The rotation of these two classes aids the farmer in his efforts to conserve his soil's fertility and produce each crop more economically and more profitably.

Plant Nutrition

Question: WHAT ARE THE ORGANIC AND INORGANIC SUBSTANCES?

Answer: The several materials or substances which the plant takes into its structure are of two classes; inorganic or mineral; and organic, or vegetable and animal.

The inorganic portion of the food of plants is in all soils in varying quantities and varying proportions and varying combinations. They are silica, iron, aluminum, soda, magnesia, lime, potash, phosphoric acid and sulphur. We know that all of these substances are plant-foods since they are found in the ashes of all plants when the ashes are analyzed. If only one of the elements essential to plant growth is not present, plants will not grow. Most of them are present in all soils and in quantities sufficient for the needs of large crops. Since, however, all of them are necessary to plant growth the absence of one or even the presence of a too small amount of one will proportionally limit the growth of a crop. To correct these defects it becomes necessary to apply to the soil the elements that are deficient or wanting. This is done by applying good commercial fertilizers—plant-foods.

The organic portion of the food of plants is also found in all soils and most of them in quantities sufficient for the needs of the largest yields of crops. The organic elements are oxygen, hydrogen, carbon and nitrogen. The first three are always available for the fullest development of any plant, but only occasionally is there enough nitrogen present.

These inorganic and organic substances are plant-foods, but all of them must be present in abundance and in a form available to the plant to be grown, otherwise the plant cannot grow.

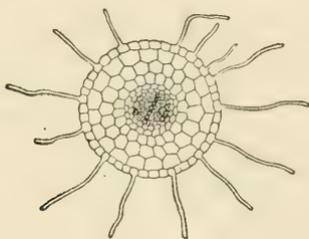
Question: WHAT IS PLANT-FOOD?

Answer: Plant-food is the materials taken from the soil and air by means of roots and leaves, and is transformed within the

plant into cellular structures which make the many parts of the plant. Plant-food is the material of which plants are made, entering the plant either dissolved in water or as a gas. Different parts of plants and different products of plants vary widely in composition. An onion, a sugar beet, a tomato and a pepper plant may each be growing in a tobacco field under identical conditions, living upon the same food, yet each will develop its characteristic size, shape, color, flavor, odor and composition. The superlative value of plants comes from the fact that they can take from the soil and air the same raw materials, manufacturing a variety of products not equalled anywhere else in Nature. Each plant in its own way is a chemical laboratory where a certain class of products is manufactured, and every genus, every species of plant has its own proprietary products manufactured from the same raw materials. These raw materials are plant-food. How necessary it is that these raw materials, in both kind and quantity, be within reach of each plant in a field so that all may best serve man as Nature intended they should.

Question: WHERE DO PLANTS GET THEIR FOOD?

Answer: Plants get their food partly from the soil in which they grow and partly from the air surrounding them. The young roots push their way through the soil and form many root branches. The tip of each root is armed with strong cells



Cross-Section of a Single Root Hair

so clustered as to make the tip sharp-pointed. As the cells multiply and enlarge behind the tip it is pushed forward into the soil. Just back of these tips the surface cells of the young roots develop a multitude of very minute thread-like projections

called root-hairs. These act as mouths, through which the food enters the plant. Other plant-foods come from the air, entering the plant through openings in the leaves.

Plants are prolific feeders or eaters, for they eat constantly, not only three times a day as you and I do. Hence, as they take food from the soil's larder we must replenish this larder so that the plants will not starve.

Question: SHOULD THE HOME OF PLANTS BE A CONGENIAL ONE?

Answer: Animals may move from place to place in search of food, but plants must depend upon the limited area of the soil in which they live for all they get for their growth. Consequently the soil is the home of the plant, and if we expect a good crop we must make the homes of the plants which make up a crop congenial homes. Plants, like animals, if not satisfied with their surroundings will show by their growth and other behavior that conditions are not favorable to their full development.

A congenial soil is one that is deep, well pulverized, through which water circulates in every direction freely and uniformly, in which there is a good amount of organic matter undergoing decomposition, and in which there are always present the plant-food constituents necessary for the development of the plant. In addition to the natural conditions of the soil, favorable to plant growth, there are changes which must be made by plowing, harrowing, cultivating, drainage, and other means, all of which aid in making the soil a congenial home for the plant. The farmer must know what natural and artificial conditions the soil must possess, and he must see that these conditions are present. No plant will find the soil a congenial home if there is not an abundant supply of plant-food in the proper form demanded by the plant and available for its use.

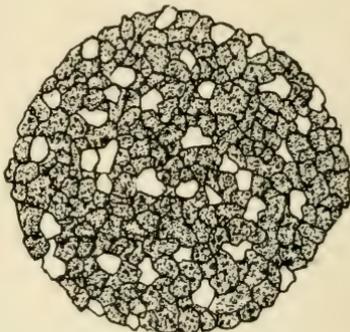
Soil

Question: WHAT IS SOIL?

Answer: Soil is made from the disintegration of the earth's surface, and to be soil proper in the agricultural sense, it must contain in addition to air, water and soluble mineral elements, a good supply of organic matter undergoing decomposition. No soil is a good soil without decomposing organic matter or humus

for it modifies extreme conditions which might affect the plant; makes the soil friable and loose, and enables it to hold more moisture. It also supplies plant-food in its best form for the best growth of the crop.

Soils are divided into two broad classes. One controlled by the chemical composition of the soil, the other by its physical properties. There are hundreds of different kinds of soil, each varying in characters and composition. Thus, a soil may be a sandy soil, a clay soil, or a lime soil, depending upon which of these materials predominates; or, it may be a coarse soil, a fine soil, or a gravelly soil. Again, soils may be classified into light soils, if they are easily worked, heavy soils, if they are worked with difficulty. Either extreme is objectionable, and the addition of an abundance of organic matter in the form of farm manures or plants plowed into the soil will make a heavy soil lighter and light soil heavier.



Section of soil showing Soil Particles and Air Spaces.

Question: WHAT IS SUBSOIL?

Answer: Soil proper is the thin surface which represents the depth to which a field has been plowed and the depth into which organic matter has been incorporated. Just under this strata lies the subsoil, in the position it was left when formed from the original rock from which it came. The subsoil is a great storehouse for mineral plant-food, and it may be formed into new soil by bringing it to the surface a little at a time, so that water, air, temperature, and the dissolving influences of organic matter undergoing decomposition may crumble it and liberate the plant-food it contains. Many fields produce poor crops on account of the soil being too shallow. This may in part, at least, be remedied by deeper plowing, so that the depth of the soil may be increased and the crop have ample room for the spread of its roots in search of food and water.

Question: ARE THERE MANY KINDS OF SOILS?

Answer: There are two larger groups of soils, and these are: sedentary and transported. The first lies over the rock from which it was formed or has not been moved, and the second has

been moved by water, glacier, wind or gravity. Soils may be residual, cumulos, alluvial, glacial, aeolian-loess or colluvial, according to their origin. The kind of rock from which soils are formed make different soils, and if these are mixed their classification becomes complex. Each of the above may be further classified accordingly to the size of the soil particles. Clay soils are composed of the finest particles, clay loam next, and then silt loam, loam, fine sandy loam, sandy loam, fine sand, sand, coarse sand, gravelly loam and gravel. Each of these have their peculiar properties, varying in character and composition.

Knowledge of soils is important, since such knowledge aids greatly in determining what crops will grow best on the soil of a farm and how the different soils should be cultivated. A knowledge of the character, composition and condition of a soil aids greatly in determining how each should be treated and what fertilizers will give the best results when applied to them.

Question: HOW ARE SOILS FORMED?

Answer: The natural processes of soil formation have been going on since the beginning of the world. The presence and activities of plants and animals have contributed a great deal to soil formation. There are many agencies at work in making soil. Every root and every insect or other animal that enters the soil aids in the admission of air and water. Air and water are



The soil as shown in the bottom of illustration has been formed by the disintegration of the rock above. This process of disintegration is continuous and is caused mainly by the action of air, water, and temperature.

the two great altering influences operating to change the inert surface of the earth into soil possessing conditions suitable to plant growth. Every drop of water and every breath of air entering the soil have the power of changing it so that it may be more suitable to plant growth. Change of temperature, especially freezing and thawing, crush and loosen soil particles, thus exposing new surfaces for the action of air and water. This process has been going on since the beginning of time and will continue until the end of time. Accessory to these influences we have the action of animals and plants in their various ways, all of which tend to aid in the formation of soils. Even the dead bodies of animals and plants give out juices or chemicals which have dissolving power, and assist, still further, in reducing the inert and dead soil so as to make it better and better each year for supplying food to plants and through plants to animals.

Question: DO CROPS FIND ENOUGH PLANT-FOOD IN THE SOIL?

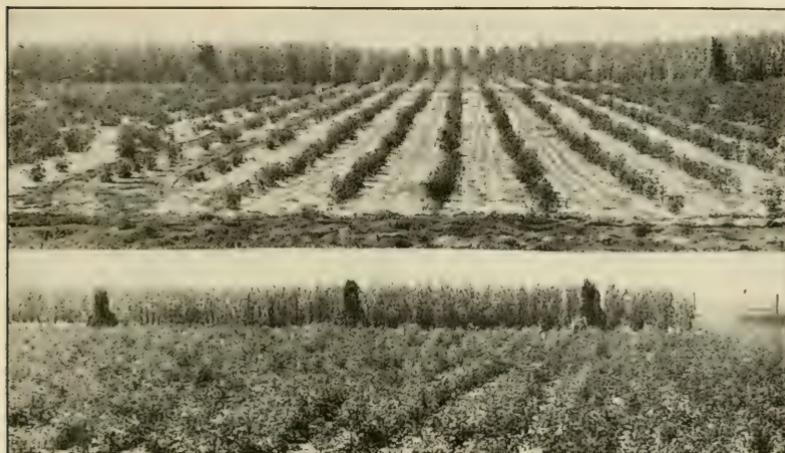
Answer: Soils are formed from rocks which are broken up or disintegrated by several natural agencies. The resulting soils contain the materials of which the rocks were formed, and since there are many kinds of rocks of extremely variable composition, the compositions of soils vary with the compositions of the materials forming them. It follows that many soils are deficient in some of the necessary plant-food elements. Soils are also subject to erosion by rain-water, and portions of plant-foods are washed away and other portions are dissolved by water and lost. When crops are grown they take from the soil varying quantities of plant-foods and these foods are removed in the crop. The yield of a crop is a measure of the plant-food available in the soil in which the crop grows. If there is an abundant supply of plant-food the crop will be a good one. If the plant-food is deficient the crop will be poor in proportion to the deficiency.

Question: WHAT IS A FERTILE SOIL?

Answer: A fertile soil is a congenial home for plants to live and grow in. It must be deep, well pulverized, contain a great variety of soil particles, have an ample supply of organic matter, permit air to pass into it and circulate through it, and permit water to pass into it and circulate freely without stagnating. Above all a fertile soil is one that in addition to the possession of desirable physical qualities contains an ample supply of all the plant food necessary to plants for their growth.

Question: WHAT IS A POOR SOIL?

Answer: There are many things that may be responsible for a soil being poor or infertile. Some soils naturally are hard, harsh and uncongenial to crops and may contain insufficient quantities of plant-food. Such soils must be appropriately treated to develop a good physical condition, and must have plant-food added if they are to produce profitable crops. Soils may be deficient in phosphoric acid, nitrogen or potash; they may be deficient in one or in two of these elements or they may



The upper field, without fertilizer, yielded but 8 bushels of potatoes and 6 bushels of corn per acre. The lower field, treated with fertilizer, produced two fine clover crops, the second crop being turned under and furnishing fertility for an 87 bushel per acre crop of potatoes and a 57 bushel per acre yield of corn.

be deficient in all three. The element of plant-food present in the smallest quantity becomes a limiting factor. Some soils become poor through unwise or neglectful management. This may result from surface washing, shallow plowing and absence of a sufficient amount of organic matter in the soil to keep it in a wholesome condition. Such soils may be restored to a high degree of fertility by judicious plowing, thorough pulverization, the addition of organic matter and proper plant-food. No soil can be fertile if it is supplied with any one of these three elements in an amount insufficient to supply the demands of the crops to be grown on it.

Fertility

Question: HOW MAY SOILS BE MADE FERTILE?

Answer: Since physical condition and chemical composition are responsible for soils being fertile or infertile, it naturally follows that making a soil fertile must be preceded by a knowledge of its present condition. Soils may be made fertile by increasing their depth, by pulverizing their particles, by increasing their power to hold water, by controlling leaching and soil wash, by the addition of organic matter, by rotation of crops, and by judicious and appropriate application of available plant-food.



Corn to which no fertilizer has been applied. Compare this crop with that on page 69 and see what a difference the application of Complete Fertilizer makes in a crop.

Question: HOW ARE SOILS DEPLETED?

Answer: Soils are depleted of fertility or made poor by tillage, by leaching, by washing, by the removal of plant-food in the crops taken from the land, and by the failure of the farmer to keep up the supply of humus and plant-food found in the soil when it was in its virgin state.

Question: HOW DOES TILLAGE DEplete SOILS?

Answer: The virgin soils in forests or prairie contain the maximum amounts of plant-food and an abundant and annually-added-to supply of humus making materials. When brought into cultivation not only is this annual supply of organic matter stopped, but the accumulations of many years decomposes and is leached or washed away. Thus tillage or growing crops depletes the soil of fertility or makes it poor by dissipating or destroying its good physical properties and by loss of plant food.

Question: HOW DOES CONTINUOUS CROPPING
DEplete SOILS?

Answer: The continuous cropping of a field in one crop or closely related crops, and especially if the crop or crops demand clean culture will rapidly deplete a soil of its fertility. Some crops draw heavily upon the soil's supply of phosphorus, others draw heavily upon the supply of nitrogen and others upon the supply of potash. This exhausts most soils. Continuous croppings subject a soil to the same treatment year after year and untoward excesses and abuses follow, diseases and insects accumulate and the soil becomes depleted of its plant-food supply, it loses its good physical properties and becomes poor.



This corn has had the necessary plant-food elements supplied by an application of Complete Fertilizer. Corn such as this will bring big returns.

Question: HOW DOES THE REMOVAL OF CROPS FROM
THE SOIL DEplete IT?

Answer: The growing of crops and their removal from the land to a high degree impoverishes soils, since each pound, bushel or ton of crops taken from the soil carries from it a definite quantity of all the elements of fertility. The quantity of plant food removed from the soil is proportionate to the yield or quantity of crop removed. If an acre of land produces 30 bushels of corn that acre loses 30 pounds of nitrogen, 5.1 pounds of phosphorus, and 5.7 pounds of potash. If the acre was made to grow ten crops of corn there would be removed from it

300 pounds of nitrogen, 51 pounds of phosphorus and 57 pounds of potash. The Missouri Experiment Station grew corn alone on the same land for seventeen years and at the end of that time the yield had been reduced to 11.8 bushels per acre. The same station, with corn in a rotation with legumes and with the addition of plant-food, secured 77.8 bushels of corn at the end of the seventeen year period.



This potato patch on farm of Mr. Dell Ross, Rural Point, Va., was not fertilized and as a result the crop was very poor.

Soils may in many ways become depleted of their fertility but the two main causes of soil poverty are due to soil wash and the removal of plant-food in the crops taken from the land.

A fertile soil is a soil maintained in a good physical condition and containing an ample supply of plant-food for the crops that it is expected to produce. If a soil is not maintained in a good physical condition and does not contain, or is not given, the plant food necessary for profitable crops it is a poor soil.

Question: HOW ARE DEPLETED SOILS RESTORED?

Answer: Soils should not be allowed to lose their fertility. When a soil becomes poor something is wrong with its owner or with those who have been responsible for its care. The time may come when there are no poor soils. Something is lacking when a soil is poor. In China lands that have been cultivated for forty centuries are now maintained at a high degree of fer-

tility. In Europe lands that have been cultivated for hundreds of years are now producing twice to four times as much as the comparatively new lands of many of our American States. It should be a crime to wear out soil. Not only the present generation, but all future generations own it. We of the present generation are but keepers of this "divine heritage," the soil. If we neglect or abuse it we are not only exercising poor citizenship and wasting our talents and sustenance but we are recreant to a divine trust.



This is the same field on Mr. Ross' farm. Note the fine appearance of this Potato Field. This crop followed the one shown on page 70 the same season. Mr. Ross fertilized the second crop liberally with V-C Fertilizers and as a result has a fine Potato crop. V-C points the way to greater Soil Fertility and Increased Yielding per acre.

Question: HOW DOES GOOD TILLAGE CONSERVE AND RESTORE FERTILITY?

Answer: Good tillage that conserves the qualities and composition of soils will aid in the restoration and maintenance of fertility. Deep plowing done at the right time and in the right way and thorough pulverization of the soil are the foundations upon which productive soils rest and accompany or precede other means by which depleted soils are restored and maintained.

Question: HOW DOES ADDING PLANT-FOOD TO THE SOIL CONSERVE AND RESTORE FERTILITY?

Answer: Depleted or poor soils are restored or made fertile by restoring the elements of plant-food that have been lost or re-

moved. These elements are phosphoric acid, nitrogen and potash and one of the greatest triumphs of science is the discovery of means and methods by which these indispensable plant-foods conveyed by fertilizers may be returned to the soil and not only restore its lost power of production but make it more fertile than when it was in its virgin state.



Clover on right was fertilized with manure, limestone and rock phosphate, that on left with manure alone. The two patches received the same seeding. Manure alone is not a balanced fertilizer, as the above clearly shows.

Though we may practice the best systems of farming, only a small part of the plant-food taken from the soil in crops can be returned to it. Railroads groan under the loads of farm products that daily leave the farms. There is a shortage the world over in ships for carrying abroad the products of farms. Every pound of these millions of tons of farm products carry from the farm its precious plant-food and year after year this drain increases.

“Any system of farming that does not provide for the return to the soil of as much plant-food as is removed by the crops will deplete the fertility of the soil.” *H. J. Waters.*

A bale of cotton with its accompanying seed contains 33 pounds of nitrogen, 13.1 pounds of phosphoric acid and 13.9 pounds of potash.

Twenty-five bushels of corn with its accompanying stover contains 40.5 pounds of nitrogen, 16.5 pounds of phosphoric acid and 27 pounds of potash.

To restore the plant-food removed by a bale of cotton and its accompanying seed will require 200 pounds of nitrate of soda, 82 pounds of 16% acid phosphate, and 110 pounds of kainit; total 392 pounds of fertilizer.

To restore the plant-food removed by 25 bushels of corn and its accompanying stover will require 250 pounds of nitrate of soda, 104 pounds of 16% acid phosphate, and 211 pounds of kainit; total 565 pounds of fertilizer.

To restore the 93 pounds of nitrogen, 19 pounds of phosphorus and 63 pounds of potash contained in two tons of cowpea hay would require 581 pounds of 16% nitrate of soda, 120 pounds of acid phosphate and 504 pounds of kainit; total 1205 pounds of fertilizer.

The same data may be worked out for all crops and nothing is more evident, in the premises, than that continued taking from, without giving to the soil will deplete it; and, that restoring the removed plant-food together with good farm practices will maintain the soil's fertility indefinitely.

Question: WHY IS IT MORE PROFITABLE TO OWN AND CULTIVATE FERTILE FIELDS?

Answer: It requires as much preparation, cultivation and other care for growing a crop that will produce say 15 bushels of corn to the acre as it does for the production of 30 bushels per acre. In the first case the crop merely pays for itself, and in the second it gives 100 per cent profit over the cost of production. It costs a certain proportion or per cent of each crop to bring it to maturity, and the yield in excess of the cost of production is profit. In addition to this great advantage which fertile soils have over poor soils is the fact that quantity and quality of crops grown on poor soils is greatly reduced and the opportunity of the farmer is materially limited. Fertile fields not only help to increase yields per acre but also increase the quality of crops, as well as assuring an earlier maturity of crops, which is often so essential and profitable.

Drainage

Question: IS GOOD DRAINAGE ESSENTIAL TO GOOD CROPS?

Answer: Too much water standing for any considerable length of time on or near the surface of a soil destroys ordinary farm crops. While water is of prime necessity to plants, nevertheless they may drown in too much water. Man must have water if he is to live, but he too may drown in water. Many millions of dollars are annually lost by farmers who attempt to cultivate land that is too wet, and millions of acres of the best

cultivated lands in the United States were once too wet to cultivate, and there are millions more of the best land in need of drainage which will be unproductive until drained. Drainage removes surplus water, deepens the soil, prevents too great dilution of plant-food; improves the quality and texture of soils by making them porous and friable; admits air with its food-making and purifying oxygen; enables plants to stand drouth better, to send their roots deeper; it warms the soil and extends the period of plant growth; it checks winter killing of crops; crops start growing earlier in the spring and continue longer in growth in the fall; it aids in the healthful development of beneficial bacteria; seeds will germinate better in drained land; crops rot less and are more easily gathered from drained land than from land in need of drainage; and good drainage also improves the health of the community as well as the crops.



Undrained land showing standing water, which makes crop production impossible. This condition is common in many sections of the country.

Question: WHAT ARE THE INDICATIONS OF THE NEED OF DRAINAGE?

Answer: The need of drainage is often very evident, while in many cases it is not so evident. Not knowing that a field or a part of a field needs drainage, farmers often cultivate it for years

at a loss, while proper drainage would enable them to reap rich profits. The need of drainage is indicated by water standing on the land after rains, by the cracking of the surface when it dries, by clods and harsh soil texture when plowed, by the growth of plants commonly found in wet places, by the water table being near the surface of the soil, etc. After a wet season irregular areas in fields often show their need of drainage by the slow growth and poor color of growing crops, because the plant-food has been washed away. Lands showing any of the above indications of an excess of water, though they be shown for but a short while, are in need of proper drainage.



The same land as on preceding page, after tile drainage. Cowpeas and Corn are now grown with excellent results as the illustration shows.

Question: HOW MAY WET LANDS BE DRAINED?

Answer: The drainage of wet lands is an old practice and like other old practices was at its beginning primitive. There are various ways in which land may be drained so that it may be free of surplus water. Open ditches and underground drains are for the removal of water. If large quantities of water accumulate on the surface or are brought from adjacent areas, open ditches may be best employed, but wherever they can be replaced with tile this should be done. The open ditch is always changing its course, filling in places, taking up land which should grow crops and divides fields; they are unsightly and grow up with weeds and bushes that harbor insects, noxious weeds and plant diseases. They require constant attention and are expensive to maintain. Other materials like stone, poles, plank, etc., may sometimes be used in its place, but nothing is so desirable, effective and durable as drain tile made of burnt clay. Any one with ordinary intelligence will find no difficulty in following instructions for locating ditches for tile, digging them and laying the tile, and instructions may be had of any of the State Experiment Stations or of the National Department of Agriculture. Tile may be put down at seasons of the year

when there is not much work to be done on the farm and when crops are not on the land.

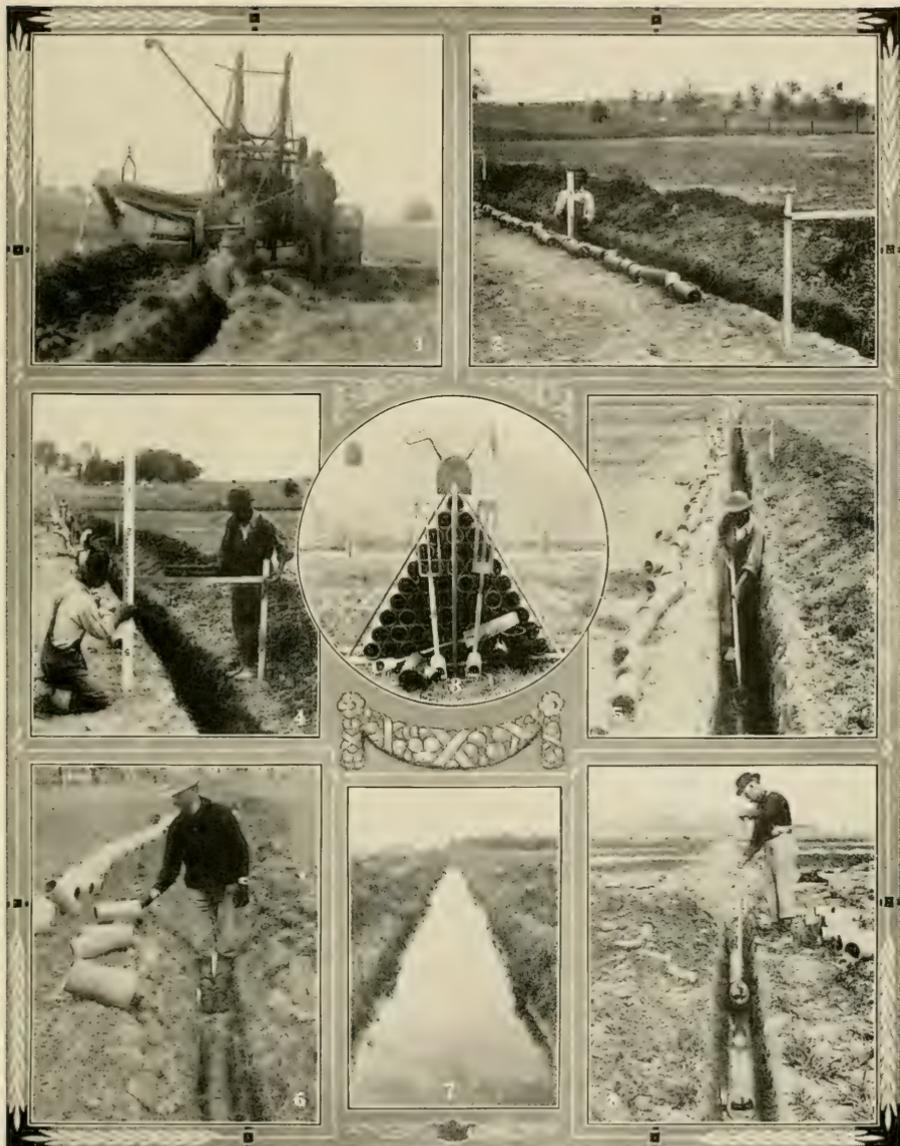
Question: HOW DOES SOIL WASH DEplete SOILS?

Answer: One may find enormous areas of abandoned land almost anywhere through the upper coastal plain or the Piedmont section of the Southern States, through many sections of the Middle and New England States and even in the Middle and Far West. This is particularly noticeable in the upper portions of the Southern States where the land is rough and rolling.



Fields scarred with gullies and bare from neglect are too common in many States. The criminal neglect of land has been called "the crime of gulying." It is an inexcusable neglect and a criminal waste. Had this land been wisely cared for, this picture could not have been made. Good farming will prevent such waste of land. The time has come when the whole world needs the bountiful fruitfulness of every acre and these wasted areas should be put to work. They are wasted, poor and starving, they need good care and abundant nourishment.

This wholesale impoverishment is very largely due to a lack of control of rain water. When rain falls faster than the soil can take it up it will accumulate on the surface after the soil has become saturated. Then, if the land is not level, this water will flow in the line of least resistance to some stream. When soil is saturated with water the weight of the particles of soil is greatly reduced or the particles are buoyed and nearly float; the water which surrounds them lubricates them, and with a slight fall to the land the surplus water washes soil, plant-food, organic matter, and fertilizers into the streams below. The natural agencies previously spoken of are constantly operating in making soil, and if the surface washing carries soil away as fast as it is made the land necessarily becomes poorer and poorer. Not only will its good physical properties be destroyed but the plant-food which it contains will also be carried away.



VARIOUS STEPS IN TILE DRAINAGE.

1—Trenching machine. Man in rear laying tiles by hand. 2—Testing grade of trench by use of grading line and rod. 3—A pile of drain tiles and tools used in laying tile. 4—Levelling cross bar to support grading line in making drain trench level. 5—Finishing grade with tile scoop. The scoop levels the bottom of trench so the tiles will lay properly. 6—Laying tile by hand. 7—Open drain ditch for tile outlet. 8—The use of tile hook in laying tiles. This is one of the best methods.

The greatest cause of soil depletion is erosion or soil wash. Especially is this true on soils that are rolling or soils of rough topography and when clean-culture crops are grown. Many soils in the South lose more fertility by the washing away of the soil than by all other causes contributing to the loss of fertility.

Question: HOW DOES LEACHING DEplete SOILS?

Answer: When plant-food leaches from the soil it is carried away by its being dissolved in water, the water having passed to a depth beyond the reach of the roots of crops. The shallow soils which are so common in many sections of the country, and the worn soils and the over-cropped soils are all more subject to leaching than are better soils. Deep, well-pulverized soils, and especially soils that are filled with humus, are less affected by leaching than soils in a poor condition. In the better soils the water is retained and utilized to a greater extent, consequently more plant-food is taken up and plant-food which would have been leached is held in the soil, partly in new combinations and partly stored in the crop. A soil that is subjected to leaching loses each year a part of the plant-food which it contains, thereby becoming poorer and poorer. To restore a soil that has been impoverished by leaching is often a slow process, but can be accomplished by deep, thorough preparation, good drainage, the addition of humus to the soil, by appropriate rotations, by adding Commercial Fertilizers and manures, and by protecting the surface from washing.

Question: HOW DOES THE CHECKING OF LEACHING AND SOIL WASH CONSERVE AND RESTORE FERTILITY?

Answer: Leaching of plant-food and the washing away of the soil itself are prevented or at least reduced to a minimum by the control and utilization of rain water. Deep plowing, thorough pulverization of the soil, abundant organic matter in the soil and growing crops all tend to cause increased quantities of water from heavy rains to enter the soil and be held by it. Leaching and washing are best prevented by treating the soil by every means possible that will induce it to take up and hold the greatest amount of water. Nothing is more necessary to plant growth than water and often the available water supply is the limiting factor in crop production. Water, the most necessary thing for the utilization of plant-food by the crop, may be the cause of the loss of more plant-food than all other losses from all other causes and the first and most necessary means for the

restoration of a soil depleted of fertility is water control. A field deeply plowed, finely pulverized and well filled with humus will hold many times more water than a field with a shallow, hard, compact soil with little humus in it. Thus, depth of soil, fineness of its particles and a high humus content checks leaching and washing and restores lost fertility.

Some fields are so steep or have such a fall that all of the water falling during a heavy rain cannot be taken up by the soil. In such cases it is all the more necessary that these fields be maintained in crops that cover the ground well and fill the soil with their roots and thus check both washing and leaching. A bare soil suffers more from washing and leaching than a soil covered with a crop. Another highly efficient and often necessary means for controlling the run-off of heavy rains is the terrace. Terraces are banks thrown up with a depression above



A Magnum Terrace in North Carolina. Terraces such as the above control the flow of rain water and prevent fields from washing and leaching.

them for holding surplus water. The terraces are made at intervals and preferably should have a fall that will enable the surplus water to slowly pass away. The more slowly it drains away the greater the quantity that will soak into the ground; and that which does flow from the field is in such decreased quantity and goes off at so reduced a velocity that but little damage can be done. King estimates the soil materials annually carried by the Mississippi River to the Gulf of Mexico to be so great that it would cover seventy-two sections of land to a depth of four feet. The erosion of fields in cultivation east and south of the Appalachian mountains is enormous. In the

South where cotton and tobacco are important crops the most momentous farm management problem is soil wash and a more rational system of farming will restore hundreds of thousands of depleted acres to a fertility they have never known.

Surface washing may best be prevented by so checking the flow of water which passes off over the surface so as to rob it of its power to do harm. This may be done by the following means: deep plowing and subsoiling which will open, loosen, and pulverize the soil so that it will take up and hold more water; the addition of organic matter in the form of stable manure or plants plowed down; the sowing of broadcast crops, especially those which occupy the ground for a year or more, by judicious rotation, and by mechanical means such as terraces and hillside ditches which collect the water at intervals and carry it off slowly in broken quantities rather than allowing it to pass rapidly in large volumes.

Crops requiring cultivation such as cotton, tobacco, corn and many others, especially when these crops are cultivated on beds or ridges are responsible for a very large portion of the loss of fertility by soil wash. This is especially true when these intertilled crops are for two or more years in succession grown on the same land. The avoidance of such practice and the following of a wise system of rotation with appropriate fertilization will check soil wash and conserve soil and plant-food.

Sun, Air and Water

Question: HOW DOES THE SUN BENEFIT SOILS AND CROPS?

Answer: The sun is both a vitalizer and a disinfectant. Its heat and light makes the earth habitable. The sun is the giver of rain and dew, and causes the air to move. The sun as a direct source of energy stores carbon in plants, and when their carbon is taken into the animal system as food it supplies the animal with heat and energy. Growing plants draw their food and water from the soil, which passes on to the leaves where, with the combined action of the green principle (chlorophyll) of plants and of sunshine, the food materials become digested food and returns to the various parts of the plant to become leaf, branch, bark, root, flower or fruit. If the sun is to do its work well plants must have an abundance of plant-food at their base or in their storehouse.

The soil gets its heat from the sun. Without sunshine soils become uncongenial to plants. Crops will not thrive without

sunshine. Too much direct sunshine may temporarily injure soils that are plowed wet and left in a cloddy condition. The sun aids the oxygen of the air while this most active of all elements is doing its duty in the soil or in the plant. Starches and sugars would not be formed were it not for the glorious sunshine, nor would flowers have their color and fragrance, nor fruit its blush and flavor.

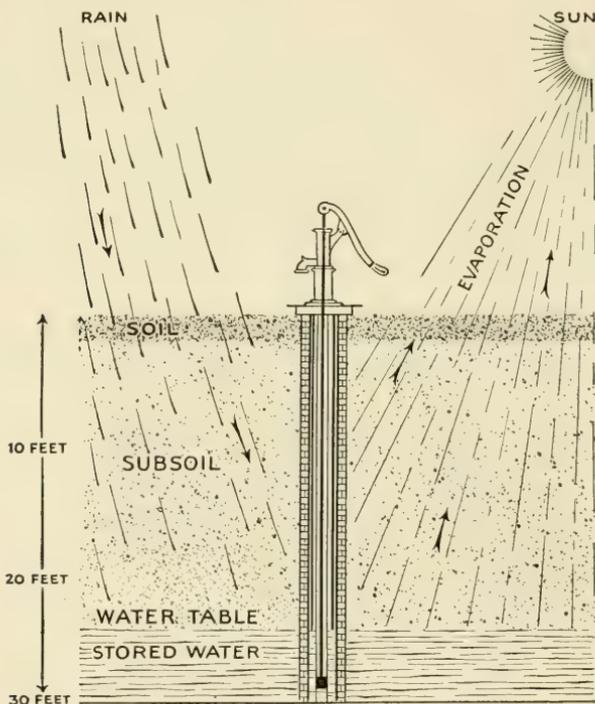
Question: HOW DOES AIR BENEFIT SOILS AND CROPS?

Answer: The atmosphere or air is composed of about four parts of free nitrogen to one part of free oxygen. Nitrogen is the most expensive element that plants are composed of, and oxygen probably is the least expensive. Oxygen is the most active, the most important and one of the most abundant substances in nature. It is found in combination with nearly every other element. It is actively engaged in the development or growth of living tissues, and is largely responsible for the breaking down by decay or burning of all tissues. It is the most active and hardest worked element in nature. Air also contains carbonic acid gas diffused through it, and this enters the plants through their leaves, and, by the action of the sunlight and the green parts of the leaves the oxygen is separated and goes back into the air. The carbon becomes a part of the plant, the main part, since live plants contain more carbon than any other one thing except water, while dry plants are often half carbon. The nitrogen of the air through the instrumentality of bacteria inhabiting the roots of legumes, enters into combinations in the legume and nourishes it.

Question: HOW DOES WATER MOVE IN THE SOIL?

Answer: When rain-water falls it continues to soak into the ground until all the spaces between the soil particles are filled. If, after the soil becomes filled with water, rain continues to fall faster than it sinks deeper into the ground, the surplus water will flow off. The water in the soil will continue to sink deeper and deeper until it has drained out from between the surface soil particles down to where water stands permanently in the soil. The depth down to this permanent water measured from the surface represents the distance of the water table from the surface. This water table rises when considerable rain falls and becomes lower in dry weather. Water is constantly travelling, one might say, from the water table upward to the surface where it passes into the air or is evaporated. Water moves by

crawling over the surface of the particles of soil, consequently, the amount of water that moves and the rapidity with which it moves depends to a great extent upon the number of particles composing the soil and the nearness of these particles to each other. Roots of plants penetrate the soil passing between its particles, and the movement of water keeps them supplied with this important part of their food.



The above diagram shows how water moves in the soil. Water goes into the soil by gravity, and circulates throughout the soil by the capillary action of the soil particles. A part of the water in the soil returns to the air by evaporation.

Question: HOW DOES WATER CARRY PLANT-FOOD?

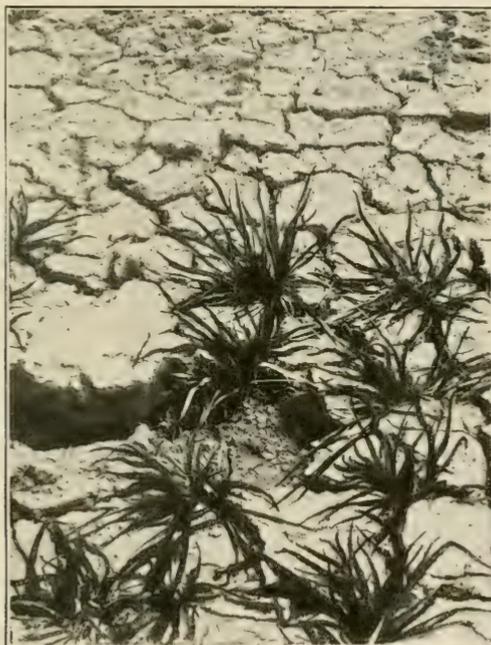
Answer: The food that plants take out of the soil enters the plant in solution or dissolved in water. If you will place a teaspoonful of sugar or of salt in a glass of water and stir it the sugar or salt will be dissolved or passes into solution. Since water forms the function of both dissolving or taking into

solution plant-food and of carrying plant-food, one can appreciate better the importance of an abundance of water for supplying readily the roots of plants with all the food that they are capable of taking up. Plant-foods in solution occupy equally all parts of the liquid in which they dissolve, thus giving every tiny rootlet an opportunity to choose in quality and quantity the plant-food it needs.

Treating the Soil

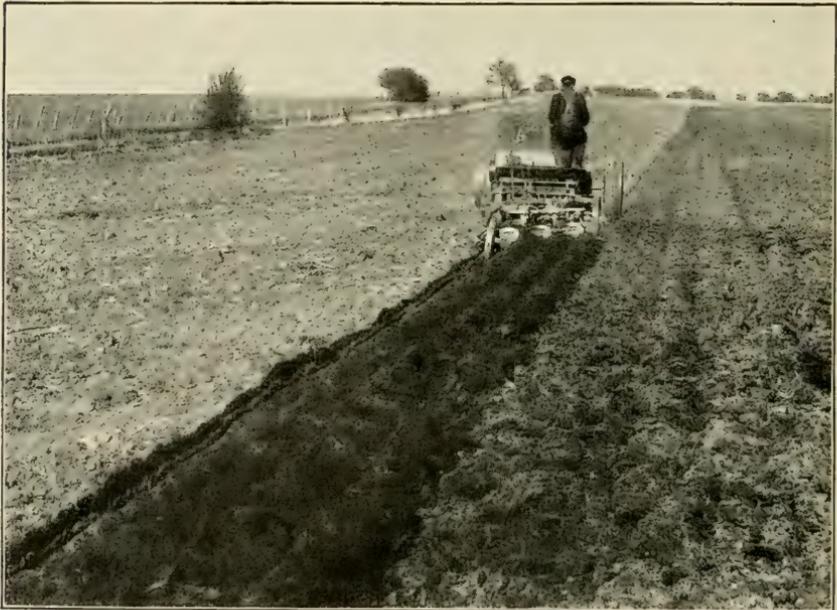
Question: ARE ALL SOILS IN GOOD PHYSICAL CONDITION FOR PLANT GROWTH?

Answer: They are not, and no soil in poor physical condition can produce the best crops. A fertile soil may be in poor physical condition and produce only poor crops, while an infertile soil in good physical condition will produce good and profitable crops with proper treatment and liberal fertilization. Some soils are naturally harsh, hard, tenacious and cloddy. Water does not circulate in them well, they do not pulverize well when



Poorly drained soils puddle in wet weather and crack open as their surfaces become dry. Either may cause the winter killing of small grain. Compacting the soil in early spring with roller will be very beneficial to the crop. The roots loosened by the winter's freezes will be pressed into the soil and evaporation of water from the soil will be checked.

plowed or cultivated, nor do they respond to commercial fertilizers. Roots of plants do not penetrate them well, and the plant-food in them is not in a readily available form. The defects of such soils may be corrected by drainage, fall plowing and subsequent freezing, the addition of organic matter, applications of lime, harrowing and rolling when they are neither too wet nor too dry. The physical properties of clay and clay loam soils are often seriously injured by being plowed when they are too wet. The addition of organic matter or lime, or both, and their being plowed rough late in the fall and exposed to the freezing effects of winter will add greatly to the physical and other good qualities of soils.



The modern method of plowing. The tractor today is a mighty factor in America's Agricultural Program, and the need of them is growing daily. If America is to feed the world her farmers must produce more per acre. V-C Fertilizers will make your Soil and Crops Pay More.

Question: WHEN SHOULD LAND BE PLOWED?

Answer: It is out of the question to attempt to give any iron-clad rules that might be followed in determining when land should be plowed. On the other hand, under special condition it is not difficult to know the best time for plowing land. Land

as a rule should be plowed long enough before the crop is planted so as to give an opportunity for its thorough discing, harrowing, and other means for pulverizing and crushing, and that it may settle through the influences of rain-water falling between the plowing and the time the seed are sown. If a considerable quantity of stable manure, pea-vines, clover or other green manuring crops are to be plowed down, or if stubble or other crop residue covers the surface, it is a decided advantage to plow such lands far enough in advance of the preparation of the seed bed to allow these materials plowed down to go through at least a partial decomposition.

Land should not be plowed when too wet. If plowed at such times, especially if it contains a considerable amount of clay, great injury will result. Neither should land be plowed when it is too dry since such soils will be broken with great difficulty, and the large clods that are left will seriously interfere with good crop production. Land plowed in the fall so that the newly brought up soil may be exposed to the freezing effects of winter will receive greater benefit from plowing than land plowed at any other time.

Question: HOW SHOULD LAND BE PLOWED?

Answer: This question is one susceptible to so many answers and subject to so many exceptions that it can only briefly be discussed here. In the first place the plow used should be one



Turning under the sod in the fall. The newly brought up soil will be exposed to the freezing effects of winter and the sod turned under will form organic matter, which every soil needs in abundance so that the plant-food in the soil will be available for the use of the crop grown.

that is especially adapted to doing the kind of work you wish done in the soil to be plowed. The object of plowing is to break, partly turn over, and pulverize a certain depth from the surface. In different soils, at different seasons of the year and for different crops the depths to which a soil should be plowed will vary. Again, the character of the soil, the amount of organic matter it may contain, and the depth to which it has been previously plowed will all have an important bearing upon the manner of plowing that should be done in each case.



Another view of plowing with a tractor. On the vast fields of America the tractor is gradually taking the place of the horse, and is daily doing work that was impossible with the horse.

Question: HOW DOES TURNING THE LAND HELP IT?

Answer: The surface of the soil is constantly exposed to drying influences, to the effects of the sun, and the changes of temperature; it is upon the surface of the soil that organic matter naturally accumulates, so it naturally follows that it is on the surface of soil where the most sudden, the most extreme, and the most important changes take place. It is the surface of the soil that suffers most from washing, and is benefited most by the action of air, temperature, and other natural soil-making agencies. It is also well understood that a uniform and homogeneous soil is best adapted to plant growth. If soils are not turned there will be a wide variation between the characters and conditions of the surface and the characters and conditions at a depth of a few inches. Further, there is a gradual sifting of the

small particles of the soil downwards, and it is at the bottom of the plowed area where these small particles stop and accumulate, stopping up the pores or capillary tubes which establish communication between soil and subsoil and permit air, water, and roots of plants to penetrate readily. When the land is turned there is an opportunity for the mixing of the lower and upper parts of the soil area turned.

The manner of plowing will vary as the quantity of organic matter to be plowed down increases or decreases, and with the depth to which the soil has been previously plowed, as well as with the character of the subsoil and the degree of differences or changes which take place as one goes down. If a considerable amount of organic matter of any character is to be plowed into the soil the organic matter should be pulverized and well mixed with the surface of the soil to a depth of two, three, or more inches before the plowing is done. This will give a better distribution of the material plowed down, help the soil very much in developing its ability to take up and hold water, and to distribute that water uniformly throughout the soil.

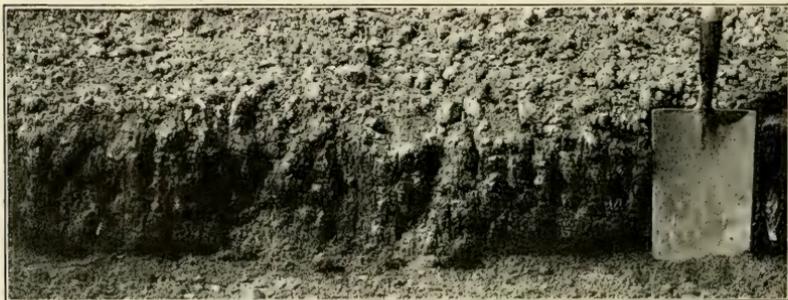
Depending upon several circumstances land may be turned completely over, or the plow slice may be turned on edge. The deeper the plowing the more necessary it is to leave the plow slice on edge. When land is plowed in this manner it gives a more thorough mixing of the bottom and top soils, thus making them better absorbers and holders of water and in other ways more congenial to plant growth.

Question: HOW DEEP SHOULD LAND BE PLOWED?

Answer: This question is susceptible to a great many answers. The depth to which a soil has been previously plowed, the character of the soil, and the amount of organic matter it contains, all these have a bearing upon the proper depth to which any given soil should be plowed. The aim, however, should be to gradually deepen all soils until a sufficient depth of good soil has been made for the full exercise of the functions of the plant for the attainment of its full growth. A soil that is 8 inches deep will hold twice as much plant-food and twice as much water as a soil 4 inches deep. A deep soil withstands extreme cold and extreme heat very much better than a shallow soil.

The best way to increase the depth of the soil is to plow a little deeper each time it is broken until the desired depth has been reached. Care should be taken, however, to increase the amount of organic matter added to the soil in proportion to the

increase in soil depth. Merely plowing deep and bringing to the surface the subsoil will not make soil of it. Soil is made through the combined action of heat, cold, and organic matter, all three of which act together in bringing about the changes in the character and composition of soils which best adapt them to an abundant plant growth. When a soil is made deeper it is a great advantage that the plowing which increases its depth be done in the fall or early winter. When done at this time opportunity is given for the breaking up and crumbling effects of freezes. If the deepening is done in late spring or summer the direct effect of the sun and wind often produces such a cloddy condition that a year or more will pass before it becomes thoroughly congenial to plant growth.



A soil in good physical condition for plant growth. The roots of a plant can easily penetrate a soil such as this, and obtain plant food. If V-C is the plant food applied the farmer can be assured of a bountiful crop.

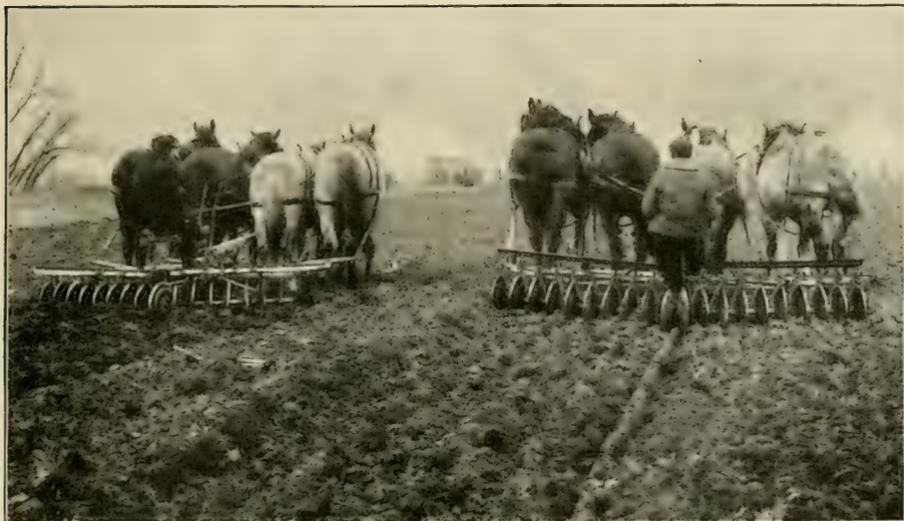
A deep soil suffers very much less from surface washing than a shallow soil, and in the deepening of the soil we find one of the best means for a conservation of plant-food. Fertilizers applied to a shallow soil are more apt to be leached from them and lost than when applied to a deep soil.

Question: HOW DOES HUMUS CONSERVE AND RESTORE FERTILITY?

Answer: Humus is the life of a soil and humus always maintained in good supply in a soil that is wisely and well tilled prepares the way for the development and perpetuation of a permanent fertility—the goal for which all who till the soil should strive. Humus is organic matter decaying in the soil and is supplied to the soil by plowing down crops grown for soil improvement, by the residues of crops and by the addition of manures.

Question: HOW SHOULD ORGANIC MATTER BE
PLOWED INTO THE SOIL?

Answer: When organic matter is added to the soil for the purpose of improving its condition, its effects will be much more marked if the material plowed into the soil is thoroughly incorporated with it. When stubble, clover, pea-vines, sod, stable manure and other such materials are to be plowed in, the land should be thoroughly disced to a depth of not less than 4 to 6 inches before these materials are plowed down with a turning plow. This not only mixes these materials well with the surface of the soil but enables one to plow to the bottom of the furrow, thoroughly pulverizes soil mixed with organic matter, thus



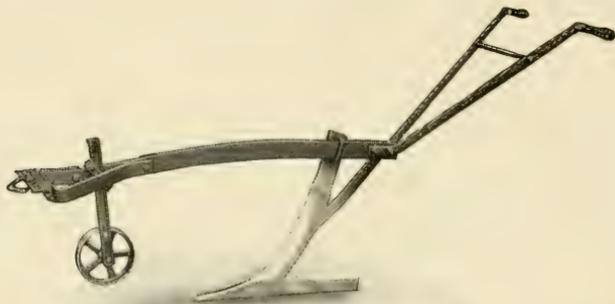
Discing is one of the most approved methods of plowing down organic matter which by discing is well mixed with surface of the soil. In many cases plowing will give better results if preceded by discing.

giving a distribution from surface to subsoil of the organic matter and insuring thorough pulverization of the soil throughout its area by surface treatment with disc and harrow after the organic material and pulverized surface has been plowed down. This is a very important consideration when the materials mentioned above are added to the soil, and will often more than double the good effect that should be expected of them. Should this ma-

terial be plowed down in mass and the plow slice inverted there would be a strata of plant residue between the soil and subsoil. This would very seriously intercept the rise of moisture from below, and often in practise will cause the dying of the crop should dry weather prevail.

Question: WHEN AND HOW SHOULD LAND BE
SUBSOILED?

Answer: The fall of the year is considered the most ideal time for subsoiling, though farther South there is more opportunity for midwinter plowing, and very often the work of the farm is better adjusted to subsoiling in late November, December and January than in the fall. Subsoiling should be done early enough, however, to allow the subsoiled land to be sub-



A popular type of subsoil plow. This subsoil plow follows in the furrow made by the turning plow, and reaches the soil the turning plow does not reach. New soil is thus incorporated with the old soil, giving greater soil depth.

jected to several hard freezes before spring. Subsoiling does not necessarily mean that the lower strata of soil is to be brought to the surface. More properly speaking the term applies to breaking the subsoil a few inches deeper than it is habitually broken by the use of the turning plow. The act of subsoiling is simple in performance. The subsoil plow is drawn by a team which follows in the furrow made by the turning plow. The foot of the subsoil plow penetrates and pulverizes the soil in and beneath the open furrow. It is usually considered safe, however, to bring that quantity of subsoil to the surface which is about equal to one-fourth the quantity of soil proper. The soil recently brought to the surface should be thoroughly mixed with the surface soil, both of which should be well pulverized.

Question: WHEN IS SUBSOILING BENEFICIAL?

Answer: If the soil proper has under it a hard, close, or tenacious subsoil the breaking of the sub strata will be of great benefit in permitting rain-water to descend and soil water to rise; in giving the roots of plants an opportunity to penetrate deep and secure their allotted supply of food and water. It will avoid extremes of temperature, extreme wet and extreme dry conditions.

Question: WHEN IS SUBSOILING HARMFUL?

Answer: If subsoiling is done when the ground is too wet it will cause a running together of the particles or "baking" and the locking up of plant-food. At the same time the power of the soil to hold water will be decreased. If too much of the subsoil is brought to the surface it will so dilute the productive surface soil that its evil effects may be shown for a year or more. If the subsoil is already loose and pulverized, and offers no resistance to the descent of water or the entrance of roots, it will be a useless operation, and may to some extent be harmful to subsoil it, though such soils may to advantage be plowed deeper.

Question: WHY ARE DEEP MELLOW SOILS BEST?

Answer: A brief answer to this question is that there is more soil if the soil is deep, and better soil if it is mellow. Deep and mellow soils will hold more plant-food and more water. They will give opportunity for the penetration of more roots, and thus with an abundance of food and drink and great numbers of roots, the plant has ample opportunity of supplying itself with

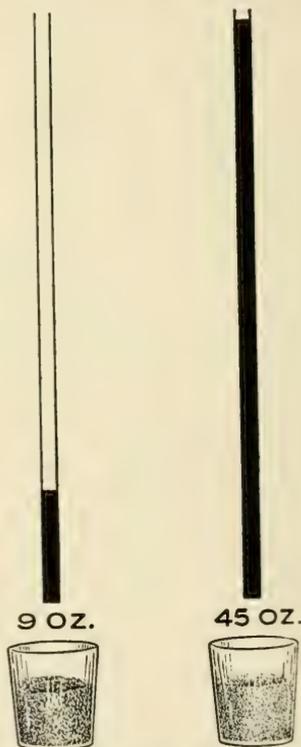


A deep mellow soil allows the roots to penetrate in every way in search of food with which to nourish the plant. If the necessary plant food elements are present the plant will be robust, healthy and strong.

all the nourishment necessary for the best growth and the most abundant growth. Fertilizers applied to deep and mellow soils will give from two to four times the beneficial results as would be given by the same fertilizers applied to shallow, harsh soils.

Question: WHY SHOULD SOIL BE PULVERIZED?

Answer: Soil should be pulverized so that the surface area of the soil may be increased, increased quantities of plant-food liberated, and the water-holding power increased. Pulverizing soil gives more soil and better soil. The importance of water in crop production is universally recognized, and a simple illustration will show how reducing the size of soil particles will increase the power of that soil to hold water. Remembering that the water is held in the soil by clinging to the surface of the soil particles we will find that should a cubic inch of stone be dipped in water the 6 sides of the stone when removed from the water would each hold a square inch of film water. Should this stone be cut in two 10 times in the direction of one of its dimensions, 20 more square inches of surface would be exposed. Should it be cut again 10 times in another of its dimensions, another 20 square inches of surface would be exposed. Should the cutting be repeated through the third dimensions, still another 20 square inches of surface would be exposed, giving 66 square inches of surface where there were only 6 before. In addition there would be the same increase in the exposure of the stone to the various agencies which act upon it, break it up and liberate its plant-food. A pulverized soil holds more water and holds it longer, holds more plant-food and holds it longer, liberates more plant-food from the particles which compose the soil, permits roots to grow wider, deeper and in increased numbers and gives greatly increased and more profitable returns from fertilizing materials added to the soil.



Amounts of water absorbed by equal quantities of course and fine soils. The smaller the soil particles the greater amount of water it will hold.

Question: HOW MAY SOILS BE TREATED TO TAKE UP AND HOLD MORE WATER?

Answer: The amount of water available for plant growth is one of the most commonly effective factors in crop production. It naturally follows that anything we may do to the soil which will enable it to take up and hold more water will be a direct and important step towards more profitable farming. There are a number of ways in which this desirable result may be obtained. Deepening the soil, pulverizing its particles, adding organic matter and frequent stirring of the surface are simple and easy means for increasing the power of the soil to hold water. The amount of water that a soil can hold is in direct proportion to the number and size of the particles that compose the soil. Every time a particle of soil is broken in two, two new surfaces are exposed, and when a particles of the soil is broken in two twice we have twice the area of surface for holding water, since the soil holds its water on the surface of its particles. Alternation in temperature and especially freezing are potent factors in crumbling the soil so that it may hold more water. The most effective treatment that soils may be given so that they may hold more water is found in pulverizing and adding organic matter.

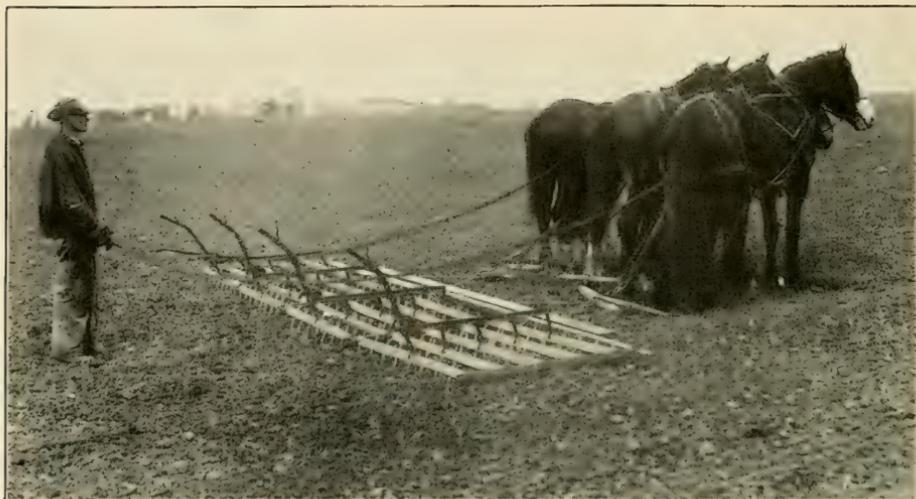
Question: HOW DOES HARROWING, DISCING, ROLLING, ETC., HELP THE LAND?

Answer: Implements are devised for the express purpose of crushing, pulverizing and stirring the soil surface so as to mix well all materials which compose the soil, thus making it uniform and homogeneous in texture. The crushing, pulverizing and stirring reduces clods, and leaves the soil in smaller particles, exposing more surface for holding of water and for the liberation of plant-food.

Question: HOW DOES THE CHEMICAL COMPOSITION OF SOILS AFFECT CROP GROWTH?

Answer: The materials that a soil contains are determined by chemical analysis, consequently the chemical composition of a soil is nothing more or less than the many elements and compounds found in a soil. It has been shown that certain elements and certain compounds are essential to crops—that crops cannot live or grow without them. If there is one essential element of plant growth wanting in a soil plants cannot grow on or in that soil. If one element is present in insufficient quantity for the full development of a plant or a crop the plant or crop may grow

as long as the supply lasts, but no longer, and, while growing will make but poor progress, since the supply is insufficient. The essential element that is present in the smallest quantity limits the growth of crops. Fertilizers are employed for correcting this serious defect, since fertilizers are for the purpose of supplying soil deficiencies.



Harrowing a field for corn. Harrowing levels the surface, pulverizes the clods, covers the seeds, and aids in destroying weeds. A harrow is especially desirable where fertilizers have been applied as it mixes the soil well.

Question: HOW DOES THE PHYSICAL CONDITION OF SOILS AFFECT PLANT GROWTH?

Answer: Physics is the science which deals with solids, liquids and gases—their properties, their actions and their relations to each other. Since crops live in and feed upon solids, liquids and gases, the laws which govern these three forms of matter must also govern plant growth. The physical properties of soils and plants involved in the relationship between the two are: porosity, tenacity, hardness, cohesion, adhesion, capillarity, solution, diffusion, osmose, and in an infinite number and variety of ways these physical principles make a soil a good one or a poor one for the support of plant life. If the physical properties of a soil are poor, crops will not grow profitably. It is very necessary that the physics of soils be understood if the farmer expects to make his soils and crops pay. Knowledge of soil

physics will enable him to correct poor physical conditions and make the soil a congenial one, one that will readily supply crops with food and drink. See that your soil is in good physical condition if you want the application of fertilizers to produce the best results.

Question: HOW DOES THE ORGANIC CONTENT OF SOILS PROMOTE PLANT GROWTH?

Answer: One of the many beneficial effects upon the soil is the addition of organic matter. If the soil is too porous or not porous enough, if it is too tenacious or not as tenacious as it should be, if it is too hard or too soft, if it is lacking in capillarity, if it does not promote solution and diffusion, the addition of organic matter will help it to better do these things or possess these properties. Organic matter makes humus, and has the additional good effects of enabling the soil to take up and hold more water, permit easier and more extended penetration of the roots of crops, warms the soil, enables it to be more easily cultivated, dissolves plant-food from soil particles, increases the profit from fertilizers by preventing them from leaching away, and organic matter supplies soil conditions that enable the crops to make better use of plant-food applied to and found in the soil.

Plant Food

Question: WHAT DOES THE PLANT DO IF IT DOES NOT GET ENOUGH FOOD?

Answer: If a pig or a steer is confined in a pen without enough food to sustain them neither will produce profitable growth. If plants do not get sufficient food their growth also will be poor and unprofitable. Feed the pig and the steer an abundance of an appropriate ration, and they will produce profitable pork or beef. Feed the plant an abundance of an appropriate ration, and a profitable crop will be harvested.

Question: HOW SHALL IT BE DETERMINED WHAT PLANT-FOOD TO USE?

Answer: First, by knowing in what element the soil is deficient; second, by knowing from experimental tests what each crop needs, and then correcting both defects. Commercial fertilizers are manufactured for each and every crop grown. The appropriate fertilizer can always be secured, and when applied properly an abundant yield follows and the fertility of the soil is

maintained. The prudent farmer will never buy or use anything but fertilizers made by reliable and trustworthy manufacturers. Buy your fertilizers as you buy your seed—nothing but the best.

Question: WHAT MUST THE FARMERS DO IF THERE IS NOT ENOUGH FOOD IN THE SOIL?

Answer: The quantity or amount of yield that any crop will produce on a given area of soil is controlled by the amounts of plant-foods present and available for supplying the needs of the particular crop grown. To produce 60 bushels of corn on an acre and the 5000 pounds of stalk, leaves, roots, etc., that goes with the 60 bushels of corn, requires 32 pounds of phosphoric acid, 84 pounds of nitrogen and 34 pounds of potash; to grow



A combination Fertilizer Distributor and Planter. This implement marks off the next row, opens up the furrow for the Fertilizer, applies it, and covers it up. The furrow is again opened up, and the seed is planted, covered up, and finally the soil is pressed firmly around seeds by means of a roller.

1600 pounds of tobacco with its 1400 pounds of stems requires 16 pounds of phosphoric acid, 76 pounds of nitrogen and 200 pounds of potash; and to produce 30 tons of cabbage per acre requires 70 pounds of phosphoric acid, 200 pounds of nitrogen and 270 pounds of potash. If these quantities of plant-foods are not present and available these yields will not be secured. If there is not enough plant-food in the soil to produce the yields desired, the thing to do is to add the necessary plant-food. Fertilizers are made and sold for just this purpose.

Question: WHAT IS COMMERCIAL FERTILIZER?

Answer: The elements that compose food products and the sources from which derived are just as well known as the multiplication tables. There is no more doubt about one than the other. That plants must be fed is an absolute and indisputable scientific fact; the manner of their feeding is determined by the Science of Chemistry, and the amount of their feeding by the Science of Mathematics. A soil that needs nitrogen must have nitrogen; a soil that needs phosphorus and potash must have both, and if it does not get them it remains a poor soil. All plants need these elements. The principal elements of plant-foods commonly deficient in the soil and without which no plant or crop can grow are phosphoric acid, nitrogen and potash, and a high grade *commercial fertilizer* contains these, the principal plant-food elements. A *commercial fertilizer* that fits the soil and fits the crop is the best, and no other is as good. The ideal fertilizer for soil and crops is that fertilizer which contains plant-food elements in appropriate proportions for and in forms that are available to the crop grown. Hence, a *commercial fertilizer* is a compound of plant-foods that crops must have if they are to grow. It is a soil builder which if properly applied will not only maintain soil fertility but increase it. Besides it will give the soil the power to be fruitful and multiply crop yields and give forth in increased quantity and in improved quality of the fruits of the earth.

Question: WHAT IS A "COMPLETE" FERTILIZER?

Answer: Of the ten or a dozen elements necessary to plant growth, three—phosphorus, nitrogen and potash—are very often found in the soil in quantities too small to supply the needs of crops. In some soils only one, in others two, but in a large majority of soils all three of these elements are so deficient crops can not produce full yields until their deficiencies are supplied by adding to them the missing elements of plant food. To meet the requirements of this majority of soils fertilizers containing nitrogen (ammonia), phosphoric acid and potash must be added. Such a fertilizer is a *complete fertilizer*, since it contains all of the needed elements of plant food and, so far as supplying the plant-food requirements of soils is concerned, completely supplies these requirements

Question: ARE "FILLERS" AND "CARRIERS" THE SAME?

Answer: No fertilizing material is all plant-food. It is im-

possible for this to be since nitrogen is a gas and in its pure form is not a plant-food, while phosphorus and potassium are minerals and are not found in nature in their pure forms. Neither phosphorus nor potash are plant-foods in their pure forms but must be chemically combined with other substances before the plant can use them. Materials used for making fertilizers and containing one or more of these three plant-food elements are called *carriers* of phosphorus, of nitrogen or of potash, as the case may be. These carriers may contain their plant foods in low or in high percentages according to the nature and the quality of the materials, and they must be combined or mixed in quantities that will give in the mixed fertilizer the analysis desired or guaranteed. Analyses are expressed in percent, and 2000 pounds or a ton is the commercial unit.

There is a common belief among many farmers that all mixed fertilizers contain a large amount of bulky material, without plant-food value, put in them to increase their weight. They believe that everything in a bag of fertilizer, besides the three actual plant-food elements, is what is commonly called "*filler*," and they believe that all of a fertilizer should be plant-food and all available. It is impossible for this to be since no fertilizing material is all plant-food. The plant-foods that fertilizers contain are nitrogen, phosphorus and potassium and the value of all fertilizers is based upon the amounts of these three elements the fertilizer contains in available forms.

These three essential elements of plant-food cannot be used by plants in their pure forms. Pure Nitrogen is a colorless, tasteless and odorless gas and composes about three-fourths of the air we breathe. Neither animals nor plants can use it in its pure forms. Pure Phosphorus and pure Potassium are minerals and are not found in nature in their pure forms. If pure phosphorus or pure potassium were applied to live plants they would kill the plants.

These essential elements are found in nature combined with many other substances and exist in a wide range of proportions in these various combinations. This is in accordance with nature's laws—laws ordained by the "Creator of all things visible and invisible." Nature has distributed the plant-foods throughout the world for man's use and they are found on or in the earth and are mined, they are taken from the sea and from the air, from plants and from animals and prepared and combined in the cheapest and best plant-food forms.

The materials with which these plant-foods are combined by

nature are not “*fillers*,” but “*carriers*” of plant-foods, and without these carriers there would be no fertilizers or manures that the farmer could use. If the elements of plant-foods were separated from their carriers they would not then be in forms that the plant or crop could use. This is in accordance with the laws of nature.

If a farmer wished to use fifteen pounds of nitrogen on a certain piece of land he could not apply it in a pure form since nitrogen is a gas. Besides there are many tons of nitrogen in the air resting over each acre of land, but it is not in a usable form. To overcome this, and to have the nitrogen in a form that will be available and suitable for plant-food, nature combines the nitrogen with other materials and thus gives us this valuable plant-food in a diluted and usable form, as in the case of nitrate of soda which contains 15 pounds of nitrogen in one hundred pounds of bulk—nature’s proportion or formula for nitrate of soda.

Nature does not confine the application of this law to plant-foods and fertilizer materials but to human and animal foods and feeds also. Very few of the animal feeds are composed of as much as half of available food. Only a small part of many of the dishes served thrice daily on our tables is really used or even usable as human food, yet we must use the whole bulk to get the nutriment in it. The greater part of our foods are *unavailable* and are conveyed by “*carriers*,” as the plant-foods in fertilizers. Fruits, potatoes, cabbage, beets, etc., are composed of more water than any other one substance. We do not complain of the “*carrier*” materials in our stable and barn-lot manures, yet the average ton of such manures contain rarely more than 30 pounds of plant-food, the remainder, 1970 pounds being “*carrier*” or accompanying bulk put there by nature.

Question: DO HIGH GRADE FERTILIZERS CONTAIN FILLER?

Answer: No. Filler increases the bulk of a fertilizer and is added for the purpose of balancing the analysis, insuring the fulfillment of the guarantee and conforming to the fertilizer inspection laws of the various states. The purchaser of a fertilizer should remember that he is paying for the *pounds of plant-food* the fertilizers contain. Some one has said and appropriately that filler in a fertilizer is ballast. Hence, it will be seen that low-grade fertilizers are, as a rule, more expensive than high grade fertilizers, since a pound of plant-food

in the latter costs less than a pound of plant-food in the former. *Three tons* of 8-2-2 fertilizer contains 720 pounds of plant-food and *two tons* of 12-3-3 fertilizer contain exactly the same number of pounds of plant-food. If the 8-2-2 goods retails at \$24.00 per ton, three tons will cost \$72.00. If the 12-3-3 goods retails at \$32.00 per ton the two tons will cost \$64.00, or \$8.00 less than the same amount of plant-food in the 8-2-2 goods. Thus he who purchases 720 pounds of plant-food in *three tons* of 8-2-2 fertilizer has an extra ton to pay freight on, to haul, to apply to the soil, and must pay \$8.00 more than he who purchases *two tons* of 12-3-3 fertilizer, yet each purchaser gets exactly the same amount of plant-food or 720 pounds. High grade fertilizer is cheaper and better.

Should the V-C Company add filler to its fertilizers what would it gain? The price of a fertilizer is determined by the number of units of plant-food it contains. However, worthless as filler might be as a plant-food it would cost a small fortune to purchase, ship, dry, grind, screen and mix thousands of tons of such materials annually. All of this would be an absolute loss to the company since its fertilizers are valued only for its plant food units, or the pounds of plant-food in a ton of fertilizer. In a high grade fertilizer there is no room for a filler.

Question: WHAT IS ROCK PHOSPHATE?

Answer: Many thousands of years ago enormous quantities of bones of animals became fossilized—turned to stone—and are now found in great deposits in South Carolina, Florida, Tennessee and other places. These rocks are mined and ground to a fine powder called “floats” or ground phosphate rock. This rock contains the equivalent of from 26 to 32 percent of phosphoric acid which in this form is but slightly soluble in water and consequently but little of it is available for the use of crops as plant-food.

Question: WHAT IS ACID PHOSPHATE?

Answer: Acid phosphate is the standard carrier of phosphoric acid and is made by treating ground phosphate rock with about an equal weight of sulphuric acid. The sulphuric acid changes the phosphorus in the rock phosphate to a soluble form. Thus 100 pounds of phosphate rock analyzing 32 percent of *insoluble phosphoric acid* becomes 200 pounds of *acid phosphate* analyzing 16 percent of soluble *phosphoric acid*. The phosphate rock after being treated with sulphuric acid becomes *acid phosphate* and the phosphorus it contains becomes *phosphoric acid*. Acid phos-

phate and phosphoric acid must not be confused—*acid phosphate* is the whole material while the *phosphoric acid* is the 16 percent and is actual plant-food. Thus a 200 pound sack of *acid phosphate* contains 32 pounds of *phosphoric acid*, or 16 percent.

Question: HOW DOES PHOSPHORIC ACID HELP THE PLANT?

Answer: If plants cannot get phosphoric acid they will die before reaching maturity. It is highly necessary to the development and maturity of the seeds of all plants, and increases their fruitfulness. Phosphoric acid also aids in making soluble and transferring to the seeds the nitrogen compounds so essential to the full development of the seeds.

Question: HOW DOES NITROGEN OR AMMONIA HELP THE PLANT?

Answer: Nitrogen or ammonia exercises a great influence in the development of the vegetative functions of plants. An excess of nitrogen retards fruitfulness, but with an abundance of phosphoric acid and potash present aids in producing a heavy yield of well balanced composition. Seeds and leaves are rich in nitrogen, consequently full seed and leaf development requires a full supply of nitrogen.

Question: HOW DOES POTASH HELP THE PLANT?

Answer: Potash helps to make the stalks, stems, branches and leaf-stems of plants. It is essential to the formation and transference of starch; it aids in the manufacture of starch in the leaves and in its transference to the fruits. Potash is essential to the growth and maturity of the stems or woody parts of plants and the fleshy parts of vegetables, grains and fruits.

Feeding Crops

Question: WHEN SHOULD FERTILIZER BE ADDED TO THE SOIL?

Answer: Fertilizers should be applied when the crop is not developing and producing as it should, when heavier yields of better quality and when greater profits are desired. There is a deficiency in the soil if crops do not grow well and fertilizers are made for the purpose of supplying deficient food materials for the use of the plant. The time to apply fertilizers is when the land is being prepared for the crop, while the crop is growing and whenever it needs to be fed so that it may do the duty expected of it.

Question: HOW SHOULD FERTILIZERS BE APPLIED TO THE SOIL?

Answer: Fertilizers are added or applied to the soil to make it richer. The richest soils have the plant-food elements which they contain evenly distributed through them. The best results come from fertilizers when they are well mixed with the soil. The soil receives the best benefits when fertilizers are applied broadcast, spread evenly and well mixed into the soil. Crops grown in rows more than two feet apart are fertilized in the



This is a type of Fertilizer Distributor commonly used for cotton, corn, and other crops cultivated in the row. The row is marked, opened and the Fertilizer put down, and then mixed with the soil by the solid wooden wheel which follows in the furrow.

drill, and later additional applications are made between the rows. In some cases only one application need be made, in others two applications, and others three applications. Implements are in common use for putting the fertilizer on or into the soil.

Question: IS THE MANNER OF APPLYING FERTILIZERS IMPORTANT?

Answer: How to apply fertilizers to growing crops is a matter of more consequence than might appear at first glance. In the first place the applied materials should be finely pulverized since lumps or clods are far more objectionable in fertilizers than lumps and clods in a field. This is particularly true regarding late applications of fertilizer. They should be well pulverized

and evenly distributed. The fertilizer may be distributed between the rows of growing crops more cheaply by the use of that valuable implement known as a combination cultivator and fertilizer distributor. When second or late applications are made to growing crops the roots of the crops have almost always spread far into the "middles" or the spaces between the rows. This wide spreading of the root system must be taken into consideration both as regards the depth of cultivation given the crop and as regards the place the fertilizer is put down. It is not at all necessary that it be near the point where the plant comes out of the ground. As a matter of fact, it is better that it be away from rather than near the base of the plant. When a crop has reached that stage of its development that calls for inter-cultural applications of fertilizer the feeding parts of its roots are not near the main stem of the plant, but spread far out in all directions. It is the tips of the roots and rootlets that take up the plant-food while those parts of the root system connecting the root tips with the plant are merely conveyors of plant-food—the pipe line system, so to speak—and do not take plant-food from the soil. The root tips with their root hairs alone perform the function of absorbing food from the earth. Consequently an even distribution of late applications of fertilizer over all the soil in which the roots are operating is necessary for the best use of the fertilizer applied by the crop.

Not only the distribution, but also the incorporation of the fertilizer with the soil is necessary. This incorporation or mixing of the fertilizer with the soil is often a very necessary act. When the combination fertilizer distributor is used in making the application it is of course mixed with the soil and for this reason the use of such an implement is urged. On the other hand, if the fertilizer is left on the surface of the soil it may remain there until rain falls and in the meantime be of no benefit to the crop. If rain does not fall for a week or two and no cultivation is given the crop its development may have passed that stage at which a late application would have been of benefit and the office of the fertilizer and increased yields it should have induced are lost. The farmers who have become prejudiced against late applications of fertilizer have developed their error in the *When* and the *How* of making the application. He who puts down his late applications of fertilizers at the right time in the right manner and uses the right fertilizer in the right condition for a crop in need of late fertilization will have his wisdom and industry rewarded by bountiful yields of high quality.

Question: MAY FERTILIZERS BE APPLIED PROFITABLY TO GROWING CROPS?

Answer: Second or intercultural applications of fertilizer are each year more commonly practiced and many of the best farmers are now making a third application. For cotton, tobacco, corn and many truck and other crops planted in rows the later application of fertilizer is an established practice and a profitable one. Many farmers apply half of the quantity decided upon for a crop before or at the time of planting and



A Fertilizer Distributor and Planter. The fertilizer is applied first and then the planter puts down the seed. Good seed and fertilizer will increase your yields per acre.

the remainder at some period of growth when experience teaches it is most beneficial. This will vary of course with different crops and on different soils. It may be assumed that the original or first application is for the purpose of developing the plant and the second (and third, if three applications are made) to develop the fruit, seed or the part of the plant to be used. The fruit of some crops, like wheat or corn all ripens practically at one time (if the strain of seed is a well bred one), while crops like cotton or tomatoes develop and ripen their fruits through sixty or more days. It naturally follows that the right time for making a late application of fertilizer for crops like wheat and corn is of brief duration while with crops like cotton and tomatoes the right time may be extended over a number of days or weeks.

The safest rule to follow in deciding when to make the second application is to apply just before or at the time the crop is beginning to fruit or when the crop demands the largest amount of available plant-food for its best development. With corn and wheat and other crops which ripen all their seed about the same time, the second application should be made when the plants show their first signs of tasseling or heading, or just before. With crops like cotton, tomatoes, etc., which continue to blossom and make fruit through many days the late application may be given when the first blossoms open or a little before. With this class of plants a third application may profitably be made between fifteen and thirty days after the second.

Intercultural applications of fertilizers are very profitably applied to crops grown for their leaves, such as tobacco, cabbage, lettuce and many others. Applications to be of greatest benefit to these crops must be made long before the blossoms begin to appear so that the fertilizer may supply the crop with plant food while the crop is beginning to make the final growth expected of it. A short time before a crop begins its heaviest growth—when it has the greatest demand for plant food—is the proper time for late applications of fertilizers. If the crop will for some time continue to make a heavy growth or through many days develop fruit a third application should be made, since the object of late or intercultural applications of fertilizer is to supply the demands of the crop and enable it to do its duty. The more appropriately this demand is met in time of application, character, quality, composition and quantity of plant-foods carried by the fertilizer the better will be the character, quality, composition and quantity of crop produced.

Question: IS THERE MORE THAN ONE WAY TO APPLY FERTILIZERS?

Answer: Fertilizers may be applied in five general ways: (1) Broadcast; (2) in the drill; (3) in hills; (4) interculturally (side applications); and (5) as top-dressing.

Question: HOW IS FERTILIZER APPLIED BROADCAST?

Answer: Broadcast application of fertilizer is obviously appropriate for crops that are seeded broadcast, like the small grains, grasses, clovers, etc. Broadcast applications are made with drills, planters, seeders, etc., that have attachments for distributing fertilizers, or with implements especially constructed for the purpose. Broadcasting of fertilizers under the above conditions is more effective when the distribution is uni-

form over all the surface of the land and when the fertilizer is thoroughly incorporated with the upper stratum of the soil from one to four inches deep.

Fertilizers should be used not only for supplying plant-food



The above view shows a method of Broadcasting Fertilizer which has met with the general approval of the farmers who are Making Their Soil and Crops Pay More.

to the current crop but also for the permanent enrichment of the soil. When they are applied with these two objects in view, broadcasting is more effective than any other mode of application and not only so for broadcast crops but for crops grown in rows also. Fertilizers should be of benefit not only to the crop for which they are directly applied, but also for future crops. The best farmers and truckers apply more fertilizer than the one crop needs, so that the surplus may act as a permanent enricher of the soil and the second crop be benefited by the residual effects of preceding applications. The cumulative effects of heavy broadcast applications are among the best means for preventing soils from losing their fertility and a sure means by which soils will become richer and richer each year.

Question: HOW IS FERTILIZER APPLIED IN THE DRILL?

Answer: Fertilizers are applied in the drill or row by the use of fertilizer distributors designed for this purpose. There is a

large variety of these distributors in use and they vary widely in merit and adaptation to different crops and different methods of culture. These distributors may be adjusted so as to regulate between their maximum and minimum capacities, the quantity of fertilizer put down per acre. While gauges or indices point to the quantity per acre with the distributor definitely adjusted, care must be taken to insure the application desired when the distance between rows varies. If the distributor is geared to apply 300 pounds per acre with rows three feet apart, more than 300 pounds will be applied if the rows are $2\frac{1}{2}$ feet wide, and less



A closer view from the rear of the combination Fertilizer Distributor and Planter as shown on page 96. Here is easily seen the roller which packs the soil over the seed, and the appliance which indicates the next row, and the fertilizer and seed containers.

if the rows are 4 feet wide. The reason for this is obvious. Assuming that an acre is 70 yards square there would be 3640 feet of rows to the acre if the rows were 4 feet apart, and 4900 feet of rows to the acre if the rows were 3 feet apart, and 5880 feet of rows if the rows were $2\frac{1}{2}$ feet apart. If the distributor's feed is not adjusted to the number of feet of rows in an acre there is no certainty that the desired quantity per acre is being applied.

Fertilizers applied in the row should not be placed too deep nor too near the surface of the soil; they should be uniformly distributed so that every foot of row will receive as near as

possible the same amount of fertilizer given every other foot; the fertilizer should be well mixed with the soil; and, no considerable quantity of fertilizer should be allowed to come in direct contact with the seed.

Question: HOW IS FERTILIZER APPLIED IN THE HILL?

Answer: Applications of fertilizers to crops grown in hills like melons, squash, cucumbers, etc., is more commonly made in the individual hills and this often is advisable, if it is properly done. In applying fertilizers in hills it is a mistaken idea that the fertilizer should be placed in a mass directly in or under the hill. It should be applied *in and around* the hill and *well mixed with the soil* over a space at least two feet square—the center of the square being the center of the hill.

The various kinds of fruit trees and vines especially when young may more economically and appropriately be fertilized individually rather than by the row or broadcast. This need not apply, however, when crops are grown in the young orchard or vineyard and these crops are well fertilized. In such cases the crops may be fertilized by broadcasting the whole area and thus feed both the orchard or vineyard and the crop at one application.

Question: WHEN SHOULD FERTILIZER BE APPLIED IN THE DRILL OR ROW?

Answer: This method of fertilizer application is practiced generally with such crops as are commonly grown in drills or rows, like corn, cotton, tobacco, potatoes, many truck crops, etc.; and, the time of application should be a comparatively short while before the seed are sown or at the time of sowing. The latter should be preferred since it is more economical, inasmuch as one implement may be used for both putting down the fertilizer and sowing the seed and both be done at one time. If, however, heavy applications are made in the drill they may sometimes be put down five or ten days before the seed are sown. The fertilizer should be well mixed with the soil so that no considerable quantity of it will be in contact with the seed.

Question: WHEN SHOULD FERTILIZER BE APPLIED BROADCAST?

Answer: Broadcast applications of fertilizer may be made (1) when the soil is being fitted for the seed, (2) when the seed are sown, (3) or after the seed are sown.

(1) Applications made after the land has been broken and

then worked well into the soil with disk and harrow will give a most ideal distribution of the fertilizer throughout the soil prepared and aid materially in developing a seed bed most congenial to the crop.

(2) If the application is made when the seed are sown and a combination fertilizer and seed drill is employed much time and labor is saved. This is the most common method employed for broadcast distribution of fertilizers and is the most economical for small or medium heavy applications. If heavy applications are made all, or a part at least, should be put down a few days before the seed are sown.

(3) Applications made after the seed are sown should be made with a broadcast distributor (or by hand) before the seed germinate and the land lightly harrowed or rolled. If rolled the harrow or weeder should at once follow the roller. Such applications are recommended only in cases of emergency and for small seeds that are covered very lightly.

Question: HOW IS FERTILIZER APPLIED INTERCULTURALLY?

Answer: Intercultural and side applications of fertilizers usually refer to the fertilization of crops cultivated in rows and the fertilizer applied after the crop has begun growth. Such applications may be made with the distributors used for fertilizing rowed crops before planting, but are best made with an implement known as a combination cultivator and fertilizer distributor. As the name implies, such an implement puts down the fertilizer for the growing crop while the crop is being cultivated and works it into the soil. It really does two very important and profitable things at one and the same time and may operate only on one side of a row at a time, on both sides; or, it may cultivate the crop and apply the fertilizer to two rows at a time—depending upon the construction of this valuable implement.

Intercultural or side applications of fertilizer has become an established custom very widely adopted in comparatively recent years, and on account of its profitableness is practiced more and more each year for increasing yields of practically all field, truck and orchard crops and for adding to their quality. While the application of the fertilizer may be and often is made by hand this method is slow and expensive and every farmer is urged to possess one or more of the implements made especially for this

purpose that he may not only make the application more economically but much better and reap through the efforts of one operation the benefits of needed plant-food (applied when the crop demands it) and needed cultivation.



A modern two row fertilizer distributor and cultivator. This method of cultivating destroys weeds, applies fertilizer and also keeps the soil in a good physical condition.

Question: HOW IS FERTILIZER APPLIED AS A TOP DRESSING?

Answer: Top dressing has the same object as inter-cultural or side applications of fertilizers and differs from it in no material way except in manner of application, and, that top dressings are most commonly made to broadcast-grown crops. However, some interpret "top dressing" to mean the application of fertilizers to growing crops and construe it to mean "side application," "late application," and "inter-cultural application." This interpretation is immaterial since the principle underlying all is the same and the only difference is the manner of application. Top dressing is the "finishing off" process in the production of good crops. It is the application of plant-food at the "psychological moment"—when fertilization gives best results. When all the fertilizer intended for a crop is applied before the seed are sown there is a *constantly decreasing* quantity of plant-food in the soil and *constantly increasing* size or volume

of crop to be supported. When the crop begins to develop its fruit or seeds a top dressing of appropriate composition is of greatest benefit and increases the yield and quality of the crop often to a remarkable extent.

Applications of top dresser to broadcast-grown crops may be made by hand or by broadcast fertilizer distributors to the crop while it is growing. If the condition of the soil and the habit of the crop will permit the application should be followed by a harrow, weeder, or some surface stirring implement. This will incorporate the fertilizer with the soil and it will become available to the crop as soon as the soil moisture dissolves it. If the soil surface is dry when the top dresser is applied it can not be dissolved or reach the roots of the crop before rain falls unless it is worked in with a harrow, weeder, or some similar implement and thus come in contact with moist soil.

Question: WHAT ADVANTAGE HAS TOP DRESSING TO CROPS?

Answer: A comparatively new practice in the use of fertilizers and one which is bringing heavier yields and greater profits is top dressing with commercial fertilizers. This practice embraces both conservation and preparedness since an application made just when the growing crop needs increased quantities of food, the food is taken up then and it is not washed or leached away as may be the case if all the fertilizer was applied at one time and before the crop even begins to grow. Top dressers applied, two, three or four times as cotton, corn, tobacco, truck crops, etc., are being cultivated and worked into the ground (or, sown broadcast, for broadcasted crops like small grain, meadows, etc.), is a practice by which needed plant-food is applied when most needed. A top dresser of composition appropriate to the crop to which it is applied and supplying the soil's deficiency in plant-food is a most logical practice since it is a means to an end and the end is attained.

Question: DO FERTILIZERS MAKE THE SOIL RICH?

Answer: A poor soil is one which does not contain enough plant-food to supply the needs of a big crop. Fertilizers are plant-food. If the right kind of high grade fertilizers and enough of them are applied, the soil is made rich. If it is to remain rich and fertile the food supply must be maintained.



Part of a 475 acre field of cotton on land which has been in cultivation for over 100 years, on plantation of Mr. F. W. Taylor, near Greenwood, La. Mr. Taylor is an enthusiastic user of V-C Fertilizers.

Question: DO FERTILIZERS SAVE LABOR?

Answer: The heaviest item of expense in growing crops is labor. With many crops the cost of labor for producing a low yield is almost as great as the cost of labor for producing a high yield. The labor cost of preparing the land, planting and cultivating an acre that produces 25 bushels of corn is practically the same as that required to produce 50 or even 100 bushels per acre. It costs practically the same (and often more) to cultivate a poor or infertile acre of land as it costs to cultivate a rich or fertile acre. Poor or infertile land is poor because it contains an inadequate supply of plant-food and the judicious use of commercial fertilizer is the chief means by which it may be made rich and yield, without additional labor, heavier crops of better quality and at a lower cost of production. When labor is difficult to get and when it is high in price crop production may not only be maintained but increased by the use of increased quantities of fertilizer. This is strongly illustrated in a bulletin written by Dr. B. W. Kilgore, Director of the North Carolina Experiment Station. Dr. Kilgore's report is based on a number of experiments the object of which was to ascertain the profits accruing from the use of varying amounts of fertilizer applied to cotton. The tabulated results given below are based upon the normal cost of both labor and fertilizers.

Fertilizers Save Labor

No. of Acre	Lbs. of Lint per Acre	Cost of Fertilizer Used per Acre	Cost of Labor per Acre	Total Cost per Acre	Value of Lint per Acre at 20c per pound	N't Pr'fit per Acre Not Incl. Value of Seed
1	105	No Fertilizer Used	\$35.00	\$35.00	\$ 21.00	-\$14.00
2	215	\$ 3.00	35.00	38.00	43.00	+ 5.00
3	430	7.00	35.00	42.00	86.00	+44.00
4	500	10.00	35.00	45.00	100.00	+55.00

The value of the lint from Acre No. 1 on which no fertilizer was used was \$14.00 less than the cost of production. Three dollars invested in fertilizer for Acre No. 2 resulted in a profit of \$5.00, a narrow margin of profit. On the other hand, when \$7.00 and \$10.00 worth of fertilizer, respectively, were used on plots Nos. 3 and 4 the profit above the cost of labor was \$44.00 and \$55.00. It would have required *eleven acres* receiving only \$3.00 worth of fertilizer to have made the profit *one acre* made when \$10.00 worth of fertilizer was used and *eleven times the labor* would have had to be employed. While this may be an exceptionally wide margin it has been duplicated and exceeded thousands of times with high priced crops such as tobacco, cotton, truck crops, etc. It is a striking example of how farmers may serve their country and themselves in trying times and when an abundance of cheaply produced crops becomes an economic and patriotic duty.

Question: DO FERTILIZERS IMPROVE THE QUALITY AND INCREASE THE MARKET VALUE OF CROPS?

Answer: In addition to the profits reaped from increased production and reduced cost of production which comes from the judicious and liberal use of fertilizer there are other important and often overlooked benefits derived from fertilizers. Since fertilizers are scientific and practical plant foods it is to be expected that crops which are liberally fed the foods they are in need of will develop higher qualities as well as produce higher yields. This is universally proven in practice and, in recognition of the better qualities, the market will and does pay a higher price for well fed, well developed, healthy and wholesome products. No one expects a half starved cow to give good milk, or a half fed hog to make rapid gains of high price pork, or a half fed horse to do a full day's work. Food produces quantity and quality of milk, pork and work in these three kinds of animals and food—plant-food—does the same thing for plants. It makes

more plants, better plants and plants worth more since there are more products to use or to sell and the products are more valuable and sell at a higher price. High qualities are always sought and always command a higher price. One cannot make a "silk purse out of a sow's ear" nor can one make higher priced truck, orchard and farm products from underfed plants and crops.

Soil Conditions

Question: WHAT SOIL CONDITIONS MUST BE PRESENT IF FERTILIZERS ARE TO BE EFFECTIVE?

Answer: That a crop may be able to make the best use of the plant-food already in the soil and the plant-food in fertilizers



Thorough cultivation is essential to good plant growth after the soil has been well supplied with Plant Food.

applied to the soil, the soil itself must be in such condition as will supply all the demands of the crop. The soil must be deep and fine. Depth of soil is obtained by deep plowing and sub-soiling, and a fine soil is secured from thoroughly plowing, followed by the best use of such implements as the disc, smoothing harrow and other harrows, and a roller if clods make the use of a roller necessary. Clods allowed to remain in or on a soil are not entered by the roots of crops. Clods seriously check the growth of plants by withdrawing plant-food from their reach, and reducing the water-holding power of the soil. The soil must be well drained to a depth not less than three feet if the full benefit is to come from fertilizers and from the plant-food found in the soil.

Humus enables the soil to hold more water and hold it longer, and loosens the soil by preventing it from baking or

running together into clods. Lime aids in pulverizing the soil and, if acid, makes it sweet. Deep, pulverized, well drained soils with a good supply of humus, if not acid, are congenial to crops, supplying their physical needs and enabling them to enjoy good health and make good and profitable use of fertilizers. Good soil conditions make healthy crops. Sick animals and sick plants cannot make good use of foods.

Question: HOW SHALL ACID SOILS BE CORRECTED?

Answer: Lime is a "digester" of plant-food. It corrects acid soils, making them sweet and habitable to plants. It aids in making potash a better food and enters into the structure of all plants. Lime is especially beneficial to legumes, such as clover, cowpeas, alfalfa, beans, peanuts, etc.



Method now extensively used in the application of lime.

Question: DOES THE COLOR OF SOIL AFFECT CROP GROWTH?

Answer: Soils may be brown, red, yellow, gray and black. While the kind and color of rocks from which soils are disintegrated partly control their color, it is controlled more by the amount of organic matter and by the form of the iron in the soil. The more organic matter a soil contains the blacker and more fertile it is. Red and yellow soils become brown and darker if organic matter is added. Black or dark soils absorb the sun's heat more than lighter soils, and if well drained will produce better crops earlier. Radiation of heat from the soil is also affected by color. Dark soils may be worked earlier in the spring and later in the fall, and on account of their higher tempera-

tures more plant-food becomes available, and the length of time plants may continue in best growth is extended. However, any soil may wear out, no matter what its color may be. Even a very black soil may be an infertile one, such as shale soils which are at times actually barren.

Question: WHAT EFFECTS HAVE MANURES ON CROPS?

Answer: A ton of manure contains about five pounds of phosphoric acid, seven pounds of nitrogen and eight or nine pounds of potash, which is not so much plant-food as is contained in a 200-lb. sack of complete commercial fertilizer. It is evident that manures can only in a limited way compensate for the absence of commercial fertilizers. On the other hand, a liberal application of manures enables the farmer to get better and more profitable returns from commercial fertilizers, since manures in several ways act beneficially upon the soil, especially so in improving their physical condition and water holding power. Manures also increase the bacterial population of the soil, for beneficial bacteria are great promoters of fertility and plant growth. Manures affect beneficially the color of soils, aid in making unavailable plant-food available, make the soil warmer, looser, more easily worked, and check leaching and soil wash. Fertilizers may nearly always be more profitable applied to soils filled with humus than to soils deficient in humus. The greatest benefit to soils from manures comes from the increased quantities of humus that result from applications of manures. Care should always be exercised in the use of stable manure since it is liable to cause the spread of insects, fungus and bacterial diseases, and the introduction of weed seeds.

Question: IS IT IMPORTANT TO HAVE A GOOD SEED-BED?

Answer: A good beginning is very helpful to a good ending, and good preparation for many crops is more necessary than any other one thing the farmer can do. A good seed-bed is secured by thorough breaking to a depth appropriate for the particular soil under treatment and for the crop to be grown, a thorough pulverization of the soil, especially for small seeds, and a compacting of the soil to at least a moderate degree so that the seeds may come into intimate contact with the soil particles and promptly absorb moisture for quick and uniform germination. A well prepared seed-bed better controls the soil water, presents

conditions for the ready delivery of plant-food to the plant roots, and enables the young roots to spread and to penetrate further as they seek water and food. The seed-bed is the home of the young plant in which it not only lives but from which it gets its food and water, and the more nearly its home is a congenial one the more sturdy and rapid will be germination and growth of



Preparation of seed bed. The caterpillar tractor is here shown using the three types of harrows,—the disc, cutaway disc and spike tooth harrow.

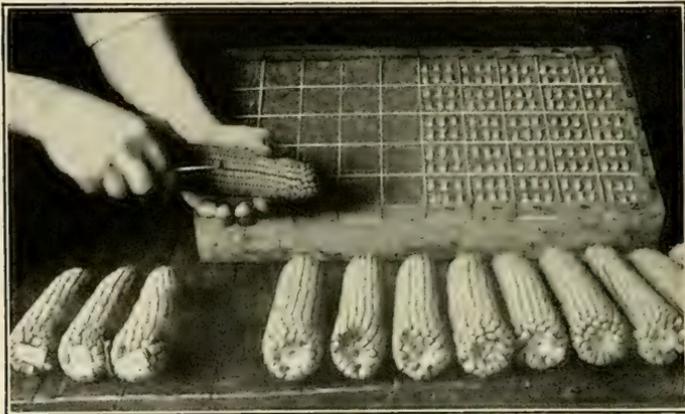
the plants, and the more profitable will the crop be. Good seeds and good seed-beds mean a good stand.

Good Seeds

Question: ARE GOOD SEEDS NECESSARY TO PRODUCE GOOD CROPS?

Answer: A farmer may have the best soil, the best climate, and the best fertilizers, yet without good seeds he cannot produce the best crops. The seed makes the plant and plants make the crop. Good seeds are true to name, sound, strong in vitality and free from weed seeds, adulterants and mixtures. Without good seed the farmer is not assured of a good stand, or a crop of good yield and high quality. Like begets like. If the

stand of corn on an acre is ten percent less than a perfect one there will be a loss of ten percent in the failure to utilize all the land, ten percent of the cultivation and of the fertilizers will be lost, and the yield will be ten percent short. Good seeds will often yield twice as much as poor seeds. By purchasing inferior,



Making a germination test of corn seeds. The seed samples that do not produce strong vigorous shoots should be noted, and the ears from which they were taken should be discarded.

cheap seeds the farmer is often subjected not only to the above losses but introduces many weeds that for years to come may annually increase his labors and reduce his crop yields.

Question: IS IT IMPORTANT TO PLANT ONLY GOOD VARIETIES?

Answer: The selection of good varieties is equally as important as the planting of good seeds. Varieties of a crop like different crops vary widely in their adaption to soil, climate and uses. A poor variety of apples may have no sale value, yet the trees occupy the same area that the trees of a good variety occupy. A poor variety of cotton may yield only a fourth of a bale of lint to the acre, while a good variety would yield a bale on the same land, though both be given the same care, treatment and fertilization. Certain varieties of the various crops are well adapted to some localities, and certain varieties poorly adapted, and large profits will come to the farmer who seeks, finds and grows the best variety for his farm. Likewise great loss will

result if a poor or even an average variety is grown in the place of one of the best. Each farmer should choose only the best varieties, improving these by careful selection from each kind every time the new crop is harvested.



Rack used for the storing of seed corn.

Question: HOW MAY CROPS BE IMPROVED BY SEED SELECTION?

Answer: Within recent years science has thrown a strong light upon the laws of heredity, and applied to seed selection in crops these laws have been the means of developing the art of selection so that the average farmer may practice it with great profit. Very profitable increases in yield, quality and other properties of plants may easily be secured by any one who will go to the trouble of becoming familiar with the simple practice of the art. Plants vary widely within families and varieties, and the selection from those which transmit the tendencies to vary in desirable directions will establish a strain of superior ability to give heavy yield, large size, better color, or superior quality of any kind. The same principle of selection has long been

practiced with domestic animals by many breeders. In any collection of plants will be found some that are poor, some that are very superior, and many that are between the two extremes. The selection of only the best for seed, and always the best each year, and those that came from the best the year before will soon develop a strain superior in yield and quality.

Question: DO FERTILIZERS IMPROVE THE QUALITY, VITALITY AND HIGH REPRODUCTIVE POWER OF SEEDS?

Answer: Every one knows and appreciates the value of good seeds and every one should know that no matter how carefully seeds may be grown, selected and kept they will not and cannot reproduce high qualities and abundant yields unless they are sown in well prepared, enriched soils and otherwise given that treatment necessary for their best development. A healthy, strong and fully developed plant will produce the best seeds and if not well fed it cannot do this. Like produces like in successive generations of plants when each generation is given full opportunity for the best development. Plant-food when utilized by the growing crop makes the crop through the transformation of the air and earth food materials into plant tissue. If the plant or crop is not adequately supplied with the food materials necessary for it to most perfectly perform its divine mission—the reproduction of its kind—it cannot do this. An undeveloped plant or one weakened and dwarfed by being underfed cannot fully perform its “divine mission,” nor reward the husbandman by bringing forth the “best of its kind.” The best seeds are produced by the best plants and the best plants are those which are fed best.

Question: HOW DO CROPS CROSS AND BECOME MIXED?

Answer: A very large proportion of our important crops are propagated from seeds, and seeds are produced from pollen, the male organ of plants, and the pistil, the female organ. The pollen which is found in the anther, which is the top of the filament, is carried by the wind, insects, etc., and coming in contact with the stigma, the enlarged top of the pistil, extends downward through the style and fertilizes the ovules, and these develop into the seed. Without pollen and pistils' plants cannot form seeds. The pollen from closely allied plants have the power of fertilizing or pollinating each other, and it is by this

cross-fertilization that hybrids or crosses are developed. If one kind of corn or one kind of cotton develops seeds from the pollen of other kinds of corn or of cotton the seeds that result will be crossed, and may partake of the character of either parent, or both, or may develop new characters, which may be or may not



Male and female flower of the Watermelon plant. The female or pistillate flower is to the right, and the staminate or male to the left.

be desirable. Some plants cross very readily, like corn, and some cross but slightly like wheat.

Plants that produce seed are of three classes, their classification being controlled by the relative positions of their male and female parts. Some plants have both male and female parts in one blossom, like tobacco, legumes, cotton, wheat, peaches, etc. Some have two kinds of flowers, one male and one female, like melons, corn, oaks, pines, etc., and some have all their female parts on one plant and all their male parts on another, like persimmon and juniper. The ease with which pollen may be blown by the wind and carried by bees and other insects is responsible for the crossing of many crops. Indiscriminate crossing is largely responsible for the "running out" or deterioration of some crops, and it is often necessary to plant only one variety of a crop in a field if the seed are to be kept pure. The precautions that must be taken in order to keep seed

pure and make them better vary with different crops, and the farmer should become familiar with the practices necessary for keeping his seed pure, and should know how to grow good seed and make them better by selecting the best from each crop; or better still, grow a seed patch and have it separated from other crops that would cause crossing. Some crops produce better from seeds fertilized with pollen from the same plant that produce the seeds, like tobacco and cotton, while corn should be fertilized with pollen from other plants than those from which the seed are saved, but the pollen should come from plants of the same variety of corn.

Planting and Cultivating

Question: WHAT DISTANCES SHOULD CROPS BE GIVEN IN THE ROW?

Answer: If crops habitually grown in rows are given too much distance between the rows and between the plants in the row the yield will be reduced, and the same undesirable result will follow if the rows or the plants in the rows are too close. The habit of growth and the manner of fruiting, the preparation of the soil, its natural fertility and the quantity of fertilizers applied and the season, all these affect the distance or the "stand" that crops should have. Only good judgment and experience are

safe guides. Examples of wide variation in the numbers of plants that will give the best returns on a given area are found in a comparison of the best distances to plant cotton and corn. Corn should be planted thickly on rich land, and further apart on poor land; cotton should be grown thinner on rich land so that each stalk may spread and produce more bolls, and thicker on poor land so that space will not be lost between the plants.



A cultivator in common use on shallow cultivated crops such as corn.

Question: DOES GOOD SOIL PREPARATION MAKE CULTIVATION MORE EFFECTIVE?

Answer: If the soil is not well prepared before the seeds are planted or the plants set out, as the case may be, the lack of preparation will not only affect the germination of the seed and the growing off of the crop by having an uncongenial home for the plants, but the subsequent cultivation of the crop cannot be as effective nor can it take the place of good preparation.



A poorly prepared field like this one will not grow good crops. Moisture cannot circulate well in the soil and the large number of clods prevents a goodly portion of the best of the soil from being used by the crop. Had these clods been crushed and the field then harrowed a good seed-bed would have been prepared and a good crop would result.

Good preparation pulverizes surface and undersurface soil, enables the soil to take up more water on account of its greater fineness and increased porosity. Preparation starts the soil off in a good condition. Poor preparation leaves the soil cloddy, harsh and often there is too much thrashy material on the surface, all of which interferes with cultivation and makes it less effective, more difficult and more expensive. Good preparation brings about conditions favorable to a greater supply and a well maintained supply of water, makes plant-food more available and enables the roots of the crops to penetrate further and have an extended feeding area, admits air and warmth, etc., while cultivation maintains these desirable conditions.

Question: WHAT BENEFITS ARE DERIVED FROM CULTIVATION?

Answer: If, after a field of cotton, corn, tobacco, cabbage or potatoes, has been planted, no further cultivation should be given these crops, the failure would be marked. The main

objects of cultivation are the keeping of the soil in good condition while the crop is growing, and the destruction of weeds. Cultivation pulverizes and loosens the surface, prevents the formation of a crust, checks the evaporation of water from the soil, prevents wide fluctuations in the moisture in the soil, modifies the extremes of temperature, kills weeds which would shade the ground and rob the soil of plant-food and water, and increases the effects of manures and commercial fertilizers by maintaining conditions in the soil which enable the crops to better utilize both the natural and applied food, and prevents the loss of plant-food and moisture that would be used by weeds if allowed to grow.



Dip one end of a lump of sugar in coffee and the coffee will rapidly rise through the lump. The grains of sugar which compose the lump are very small but have been closely pressed together and the coffee easily passes from one particle to another and the whole lump becomes wet with coffee. Soil-water will spread quickly through finely pulverized and compacted soil in the same way.

Question: WHEN AND HOW SHOULD A CROP BE CULTIVATED?

Answer: Since the object of cultivation is to keep the surface of the soil in good condition and to destroy and prevent weeds, it is evident that frequent cultivation at the right time with the right implements will prevent the surface from getting in a poor condition and prevent the growth of weeds. If the soil is not allowed to get in poor condition, and weeds are not allowed to grow, the soil is continuously in good condition, and weeds cannot do harm if not allowed to grow. If the field is not in the

best condition when a crop is planted cultivation should begin with a light harrow or weeder before the seeds are up. Light and thorough cultivation at this time hastens the germination by breaking the clods, admitting air and conserving water, and the plants come up promptly and strong. Cultivation should begin after each rain as soon as the soil is dry enough, and should be done with that implement which will most quickly, cheaply and thoroughly stir all the soil surface and pulverize it to the proper depth for the soil and crop.



Cover another lump of sugar with finely pulverized sugar and dip the lump in coffee. The coffee will rise rapidly through the lump of sugar but very slowly through the loose sugar on top of the lump. This illustrates the value of a pulverized and compacted soil upon which an earth mulch has been made. The mulch holds the moisture in the soil.

Question: WITH WHAT IMPLEMENTS SHOULD A CROP BE CULTIVATED?

Answer: Great ingenuity has been displayed by modern implement inventors in devising cultivators for every class of soil, every kind of crop and every variation in the methods employed for the preparation of the soil for different crops. Some crops are sown broadcast, some in continuous drills or rows, some at various intervals in drills or rows, and some in squares, triangles, etc. Implements are in use for the cultivation of all these. The best implement with which to cultivate a crop is one that will best work the spaces between the rows or between the plants in the rows or both. A cultivator should stir all the soil and stir it well, leave a fine earth mulch on the surface, prevent weed

growth before it begins, and destroy all weeds that have begun to grow. Weeders and harrows will cover a wide surface if employed as soon after a rain as the soil is dry enough and give the best soil condition, incidentally destroying weeds as they are germinating. Later on cultivators with fewer and larger working points must be used so that they may enter the soil which is harder, and cut the roots of weeds that have begun to grow.



Another type of two row cultivator in common use. Fertile, well prepared and well cultivated soil will produce abundant crops.

Question: WHY DO PLANTS HAVE ROOTS ?

Answer: Roots anchor or fix plants in the soil and supply them with food and water. The roots are the mouths of plants, and the active parts of them are covered with minute root hairs through which the food and water enter. The larger roots are the throats of the plants through which food and water are carried into the plants and then to the leaves which act as both stomachs and lungs for the growing plants. Crops cannot grow without roots, and the more roots each plant has the more food it is capable of taking. It is evident then that cutting or bruising of roots by cultivation is injurious. A very large proportion of the roots of crops is found in the prepared soil near the surface. If cultivation is deep the roots are broken and the plant suffers. If cultivation is frequent and shallow the roots are not only unmolested but the stirring of the soil above them holds water where the roots are, admits air and develops conditions favorable to root and plant growth and to the exercise of root and plant functions.

Question: WHY IS CULTIVATION SO IMPORTANT IN DRY SEASONS?

Answer: When rain falls upon the earth it soaks into the soil until the surface is full and any additional rain will run off. As soon as rain ceases to fall moisture begins to evaporate back into the air. Evaporation takes place at the surface of the soil, and the water evaporated comes from down in the soil through the little holes or capillary tubes it descended through. Cultivation in dry weather breaks up and covers over these tubes so that the water that rises is intercepted below the surface and is there held by the soil particles just where the greatest number of feeding roots are found. Thus it is seen that cultivation in dry weather not only prevents large quantities of water from evaporating but holds the decreasing supply where it is most accessible to the roots of the crop.

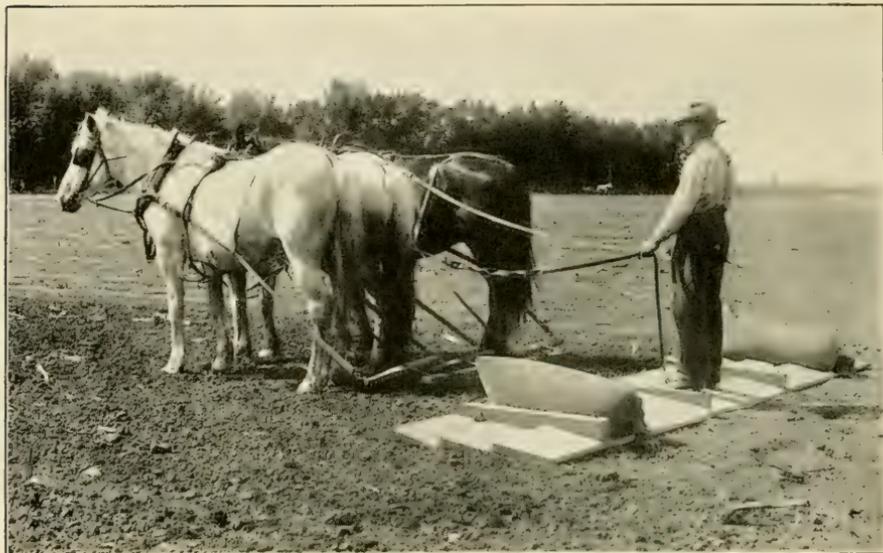


The soil in the bottom of this foot print is not only compacted but the clods are crushed. The darker appearance of the bottom of the foot print is due to the moisture that has risen to the surface of the soil. The roller and other surface compacting implements produce this effect. If the surface soil remains as it appears in the foot print or is left by the roller the moisture will rapidly evaporate into the air. A thorough stirring of the soil surface will form a loose earth mulch and trap or retard the passage of the water into the air thus maintaining a supply for the crop.

Question: HOW LATE SHOULD CULTIVATION BE CONTINUED?

Answer: Many farmers make the great mistake of having a certain date in a certain month for ceasing to cultivate their different crops. This is a mistake more often than otherwise, since it is a common practice to "lay by" or stop the cultivation of a crop at just the time when cultivation will do it great if not

the greatest good. Cultivation is for the purpose of making the soil a better place for the crop to live and grow in. It is more proper to say that the soil is cultivated, not the crop. From the time a crop is in full blossom on until the seeds or fruits are developed is when the crop uses the greatest quantity of plant-food and water, and uses them in the briefest time, consequently



Three horse common plank drag. An excellent tool for crushing clods and compacting the soil, which insures perfect capillarity, allowing the seed to come into direct contact with the moist soil.

shallow cultivation should be continued for the benefit of both soil and crop. Late cultivation not only benefits the growing crop but leaves the soil in better condition for the next crops, and destroys weeds that would injure the growing crop at its fruiting time, and that would mature seeds that would make other weeds and injure the next crop on that land.

Rotation of Crops

Question: WHAT IS ROTATION OF CROPS?

Answer: The amounts of plant-food removed by different crops varies widely. Grain crops remove phosphorus in excess; tobacco and root crops take large quantities of nitrogen. If one crop is grown on the same land for a period of years the ele-

ments of plant-food used by that crop in the largest amount will be unduly reduced, while elements not used largely will unduly increase. If another crop follows the first one, and this second crop has little demand for the element most in demand by the first, and a greater demand for the element the first crop consumed the least of, the growing of these two crops alternately would conserve the soil's fertility. While this could not be said to represent a system of rotation, yet it illustrates one of the most important effects of the rotation of crops.

Some crops feed heavily upon the subsoil, get their food deep down in the soil and raise it to the surface. Their deeply penetrating roots open the way for the descent and rise of water and for the better penetration of the roots of future crops. Air is more freely admitted and performs its invaluable functions. Other crops feed near the surface and rapidly consume the plant-food within their reach. The system of rotation which employs these kinds of crops will enable the farmer to make better and more profitable use of the plant-food in the soil, and will not exhaust it.

Some crops are sown broadcast like hay crops, small grain, etc., while some are sown in drills and cultivated. The treatment of these two classes varies widely. If crops sown in rows are grown continuously in the same field there will be a loss of humus and water holding power of the soil, washing will be more severe, the surface will become harsh and uncongenial and more difficult to work.

"Rotation of Crops" does not merely mean the change of crops grown on a given field nor is diversification synonymous with rotation. Rotation of crops means the establishment of a cropping system by which the several crops grown on a farm may systematically rotate from field to field in such order as to balance and distribute the draft upon the resources of the farm, economize in the utilization of fertilizers and at the same time make them more profitable, avoid the toxic effects of some crops, destroy weeds, lessen the injurious attacks of diseases and insects, regulate, control and conserve the water supply, increase the humus supply in the soil, facilitate diversification, distribute and economize labor and at the same time supply the home need and produce money crops for the financial needs of the farm.

Question: WHAT ARE THE BENEFITS OF ROTATION?

Answer: Rotation aids in rapidly freeing the land of noxious weeds; drives away or starves out injurious insects; gets rid of

fungus and bacterial diseases; admits of the introduction of a variety of crops and promotes diversified farming; enables the farmer to use cover crops and catch crops to greater advantage; distributes the labor required for preparation, cultivating, harvesting and marketing through the year; avoids an undue rush of work at one season and idleness at another; and enables the farmer to use fertilizers more wisely and to get greater profits from them, thereby making his soil and crops pay more.

Suggested Rotations:

1.

First Year.

Corn with Cowpeas.

Second Year.

Wheat, oats or rye followed
by Soy Beans.

Third Year.

Crimson or Bur Clover.

Cotton.

3.

First Year.

Cotton followed by a
Legume or Small Grain.

Second Year.

Small Grain followed by
Cowpeas or Soy Beans.

Third Year.

Crimson Clover plowed
down for Corn with Cow-
peas in the Corn.

2.

First Year.

Wheat and Red Clover.

Second Year.

Red Clover.

Third Year.

Corn and Cowpeas.

4.

First Year.

Tobacco followed by Clover
and Grass Mixture.

Second Year.

Clover and Grass.

Third Year.

Clover and Grass.

Fourth Year.

Corn and Peas.

Fifth Year.

Wheat or Oats cut for Hay
and followed by Tobacco.



RED CLOVER



CRIMSON CLOVER



SOY BEAN

Question: HOW DOES ROTATION BENEFIT AND REST THE LAND AT THE SAME TIME?

Answer: While rotation rests the land, at the same time it also produces a crop, conserves plant-food and moisture, adds organic matter to the soil, enables the soil to resist drouth, avoids the robbery of plant-food by noxious weeds, deepens the soil, enables the soil to more judiciously and profitably respond to applications of fertilizers, gives surer crops and heavier yields, distributes labor through the year, enables the farmer to get the most out of his land with the least soil exhaustion, to diversify and make greater profits with less expense and thus keeps the soil so fresh, well fed, healthy and vigorous that the growing of one crop leaves the land strong and ready for the next.

Question: HOW DOES ROTATION BENEFIT THE CROP?

Answer: Rotation balances the plant-food supply in the soil and a greater variety of crops may be grown; it supplies the different crops with greater quantities of the kinds of food that each crop needs most; it protects the crop from drouth, insects, diseases and weeds; makes the home of the crop more congenial; gives better opportunity to prepare the soil best for each crop; gives each crop the best chance; and, larger, better and more profitable crops are produced at a minimum cost, with the least injury to the land, and there is less danger of crop failures.



MELILOTUS (SWEET CLOVER)



HAIRY VETCH



VELVET BEAN

Question: HOW DOES ROTATION CONSERVE AND RESTORE FERTILITY?

Answer: Rotation aids in maintaining good soil conditions and conserves fertility in addition to aiding in checking the damage done by weeds, insects and diseases. Growing the same crop on

an area of land continuously unfits the land for the crop grown or for crops of similar character or habits and requiring the same cultural treatment. If a legume crop is grown continuously for several years on the same land and the crop harvested there will be an accumulation of nitrogen in the soil and diminished supply of phosphorus, potash and lime. If clean culture crops like cotton and tobacco are grown continuously the nitrogen supply in the soil will be seriously decreased. Clean culture crops tend to decrease the humus supply of the soil and the soil becomes poor on account of the loss of humus and the consequent deterioration in the physical properties. It is obvious that a system of rotation planned for the purpose of (1) checking weeds, insects and diseases and cleansing the land; (2) of resting and restoring the land by leaving it in sod or growing legumes; and (3) growing a money crop will not only check the loss of fertility but actually make the land more and more fertile and at the same time use the plant-food in the soil rationally.

Question: WHAT CROPS SHOULD BE GROWN IN DIFFERENT SECTIONS AND ON DIFFERENT FARMS ?

Answer: Successful farming in any section of any country and on individual farms is primarily controlled by the selection of such crops for each farm as are best adapted to the climate of that section, adapted to the soil and to the seasonal distribution



Kentucky tobacco field of Mr. D. W. Myers, Horse Cave, Ky. Mr. Myers is an enthusiastic user of V-C Fertilizer and says, "V-C has given me perfect satisfaction from start to finish."

of rainfall. A Wisconsin farmer would not attempt to grow cotton, nor would a New England farmer attempt to grow

oranges. There is quite a number of distinct crop sections scattered throughout the United States, and it is a business problem to grow most extensively only the crops that succeed best in the various sections. Sugar cane in Louisiana, cotton in South Carolina, alfalfa in Colorado, rice in Texas, wheat in Kansas, tobacco in Kentucky, corn in Illinois, red clover in Indiana, timothy in New York are examples of special adaption of crops. A number of crops are usually adapted to any one section, and the owner of one individual farm should not only choose crops adapted to his soil and climate but also those for which there is the greatest demand, those that he knows enough about to successfully grow and market, and those that give the highest net profit.

Question: WHY ARE SOME SOILS ADAPTED TO SOME CROPS AND NOT TO OTHERS?

Answer: While temperature and rainfall are controlling influences affecting the profitable culture of all crops, yet with both these present there are special soil conditions and compositions necessary to the profitable cultivation of many soils. Corn probably is the most widely adapted important crop grown in the United States, and tobacco the most specifically exacting crop. The quality of corn only to a slight extent is affected by soil types, while the quality of tobacco is controlled by soil types. The size of the particles which make a soil, the compositions of a soil, a soil's ability to permit water to be freely distributed in it, and the forms and proportions of the elements of plant-food found in a soil may make it suited or unsuited to a crop or several crops. While the unsuitableness of some soils may to some extent be overcome by soil treatment that will alter soil conditions, and soil feeding that will improve its composition, the highest degree of success will come from the selection of the crops in each locality which are best adapted to existing soil conditions.

Crop Enemies

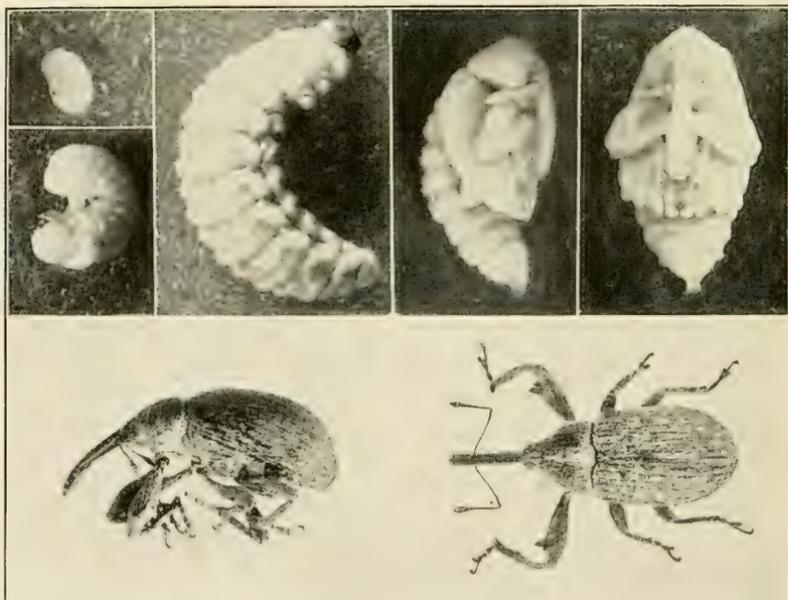
Question: ARE PLANTS ATTACKED, INJURED AND KILLED BY DISEASES?

Answer: Every plant grown is subject to disease. The diseases which affect them are nearly all fungi, such as rust and smut, or bacteria, like wilt and blight. Fungi and bacteria live as parasites within the tissues of plants, and always injure and often destroy whole fields. Their destruction of crops

amounts to millions of dollars in losses each year, a large proportion of which could be avoided if the proper precautions were taken to avoid, prevent or destroy the diseases. Losses from diseases may be checked by rotation of crops, by growing resistant varieties, and by combating them by the use of sprays. Vegetables, and especially fruits, are often sprayed with great success, and the investment of a dollar in spraying often gives a profit of ten or more dollars, and may save a crop from total destruction. Knowledge of the life history of plant diseases and of the remedial methods best adapted for combating them is necessary to the profitable growing of many crops, and the farmer who is not prepared to successfully fight them runs the risk of losing a part or all of his crops.

Question: ARE INSECTS INJURIOUS TO CROPS?

Answer: Insects are not all injurious for many are of great benefit to crops and to man. Many plants depend largely upon insects for pollination, and many other insects do no harm. There are also many insects which live upon and destroy those



This illustration shows the life history of the Boll Weevil, from the egg to the mature insect. This insect annually destroys over \$20,000,000.00 worth of cotton in our Southern states.

that are harmful. More than \$200,000,000 worth of silk is annually produced by the silk worm, and in the United States alone the honey bee produces nearly \$25,000,000 worth of honey annually.

Insects may attack every part of every plant. Large areas of forests are annually destroyed by insects, and millions of dollars of damage is done to standing timber. It is safe to place the loss to our various crops from the ravages of insects at ten percent per annum. It is estimated that the loss from the codling moth alone amounts to an annual sum of \$12,000,000. The boll weevil annually destroys \$20,000,000 worth of cotton, and the chinch bug destroys \$40,000,000 worth of grain each year. This is a \$72,000,000 loss annually from three insects alone and it is probable that there are half a million different kinds of insects, many of which are destructive to crops. A knowledge of the means effective in the control of insect pests should be possessed by every farmer, orchardist, trucker and live stock man. Control of insects often doubles the income from a crop, while uncontrolled they may destroy whole crops and always do them great damage.



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