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PRIMARY AGRICULTURE

... AND ...

PRACTICAL ARITHMETIC

... FOR ...

Rural Schools

BY

J. A. HASELWOOD, Superintendent Jefferson County Schools

AND

K. L. HATCH, Principal, Waterloo, Wisconsin, Public Schools

Class S495

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FOR USE IN THE

County Schools

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Waterloo, Wisconsin.

Love for farm life and for household duties should be nourished, but can only be through knowledge of its importance, its pleasures, its blessings and its profits taught in schools instituted for the purpose.

Acknowledgment.

The tables used in this book are taken from the published reports of the United States Department of Agriculture and adapted to the needs of this publication. Only averages and approximate values are given. Conditions vary so widely that accuracy is impossible. The value of the tables lies in their *use* rather than in the numerical results obtained from their use.

Grateful acknowledgement is also given to the friends who have given valuable assistance and suggestions.

H. & H.

Introduction.

As the population of our country increases, it is fast becoming evident that two things must be done: poorer soil must be cultivated and what is already under cultivation must be made to produce more. In either case more thoughtful methods in agriculture are absolutely essential. The farmer of the to-morrow, who is to-day the farmer's boy, must know how to farm better than his father does. In order for him to do this, he must acquire a more or less complete knowledge of the sciences on which agriculture is based.

The farmer of the future must be able to read farm papers understandingly, or better still, he should be trained for his life's work in some agricultural school, as doctors, lawyers and teachers are now trained. It is the purpose of this book to give to the farmer's child who studies it a start towards such necessary knowledge. The language used is plain and simple and may be readily understood by any bright boy or girl of twelve or fifteen years of age. All scientific terms are defined in a simple way whenever it has been necessary to introduce them.

Each chapter is followed by a set of practical farm problems to be used as exercises for the arithmetic class. These problems have a definite relation to the subject matter which they follow, as well as a close relation to farm life. It is believed that their solution will enable the farmer's children to solve ordinary practical problems arising on the farm, as well as the more complex ones of experimental agriculture.

It is hoped that the careful study of this book will

lead to a deeper interest in farm life and a more careful and systematic study of the soils, crops, feeds, fertilizers and the like by the children in the rural schools and perhaps, incidentally, by the farmers themselves.

The State Legislature of 1905 revised Section 447, Chapter 27, of the school laws to read as follows:

"Orthography, reading, writing, grammar, geography, arithmetic, ELEMENTS OF AGRICULTURE, history of the United States, the constitution of the United States and the constitution of this State, and such other branches as the board may determine, shall be taught in every district school."

It is hoped that this little book, by combining the subjects of arithmetic and agriculture, will be of material assistance to the teachers in their compliance with the law.

1. Why Plants Grow.

If you were to be asked, "What makes a pig grow?" you would reply, "Milk, grass, corn, etc.," but if you were asked, "What makes a plant grow?" would you answer so readily, "The food which it consumes?" But this is precisely what you should reply. Plants, like animals, must have food and drink, and like animals, they will perish without them. At some later time, we will tell you what these foods are, in such a way that you will readily recognize them at sight. For the present, however, we will only observe the way in which plants grow and find out, if possible, the source from which the little plant gets its first food.

The little pig, or lamb, or calf lives and grows upon the milk of its mother until it is large enough to hunt for its own food. It then begins to use the same food as the larger animals of its kind. Now from what source does the little plant get its first food.

If you will carefully remove the skin from a bean that has been soaked over night and then separate it into two parts, you will discover two tiny leaves near one end, between the two halves of the bean. Extending in the opposite direction is a tiny stem and root. This little plant is called the germ or embryo and it is this germ which later develops into a full grown

plant. The two halves of the bean serve as a storehouse for food and are called cotyledons. If a kernel of corn is taken instead, and examined in the same way, the same kind of a little plant will be found. Instead of two leaves pointing upward as in the bean, but one will be found in the corn. The peanut will be found to resemble the bean in this respect; wheat and rye resemble the corn.

In the spring, as soon as the seeds begin to come up, go out into the garden and field and notice how many leaves are first seen from the seed. In one list write the names of all plants showing but a single leaf or sprout, and entitle that list monocotyledons. In another list write the names of all plants showing a pair of first leaves and call these plants dicotyledons and you will have begun your first systematic study of botany. But, if you are interested, you will not wait for spring, but will want to begin now, which you may do by planting all kinds of seeds grown on the farm, in sawdust in an old pan and setting it in a warm place. You can then examine these seeds from day to day and watch their growth.

If you keep these seeds wet they will grow well for a few days and then they will wither and die. Now, why is this? Because the little plantlet lives on the food contained in the seed until this food is all used up and it has attained sufficient size and strength to get its food from the soil. But it cannot get sufficient food from the sawdust and of course it starves to death just as a little pig would starve if it were not given sufficient food.

When asked why plants store up so much food matter in seeds we usually answer, "To furnish food for animals and men." Nothing could be further

from the truth. Nature intended this food matter, not for man, but for the little plantlets, found in the seeds, to use for their own growth until they were large enough to get it for themselves directly from the soil. Try this experiment: From soaked beans or kernels of corn cut away about two-thirds of this food matter, being very careful not to injure the embryos, and watch the sprouting of what remains. These sprouts will wither and die much sooner than those from perfect seeds, because not enough nourishment is left to supply them with food until they are large enough to get it from the soil. This should teach us that we cannot be too careful in the selection of large, well developed seeds if we wish strong, healthy plants and, consequently, good crops.

Every farmer's child must have noticed how potatoes shrivel up when they sprout in the cellar. This is due to the fact that the young sprout uses up a part of the potato as food for its own growth.

But there are other things necessary for the growth of plants. Grain rarely grows in the bin or stack, and if it does you will say that it is because the grain is too wet. Moisture then is another requisite for plant growth. But even wet grain fails to grow in the winter time because heat is necessary. Neither will crops grow in ground covered with water because all growing plants must have air and much water keeps the air out of the soil. There is still another requisite to plant growth, and that is light. No plant grows well in the shade, and it always has a yellow and sickly look.

Summing up: Good seeds and proper conditions of soil, moisture, air, heat and light are essential to plant growth and the study of agriculture consists in

determining just how to control these conditions. "What?" you ask, "Can the farmer control the amount of heat, air and moisture in the soil?" He can, and it is the purpose of this little book to teach the farmer's children how it may be done.

Table showing legal weight per bushel of farm products in Wisconsin:

Wheat	60 lbs.
Potatoes	60 lbs.
Peas	60 lbs.
Beans	60 lbs.
Root crops (average)	60 lbs.
Onions	57 lbs.
Corn (shelled)	56 lbs.
Rye	56 lbs.
Barley	48 lbs.
Buckwheat	48 lbs.
Oats	32 lbs.

Handy Values to Use.

A bushel requires about $1\frac{1}{4}$ cubic feet of space.

A bushel of corn in the ear requires about 2 cubic feet of space.

A barrel of water requires about 4 cubic feet of space.

A ton of hay fills about 512 cubic feet of space or 8x8x8.

A cubic foot of water weighs $62\frac{1}{2}$ pounds.

NOTE I. All the above should be memorized.

NOTE II. Pupils should also memorize tables, of avoirdupois weight, dry measure, liquid measure, long measure, square measure, and cubic measure with all the necessary abbreviations.

Problems.

1. How many pounds of wheat are grown on an acre yielding 25 bushels?

2. How many pounds are grown on eight acres at the same rate? How many tons?

3. How many square rods in an acre? How many pounds would that be per square rod?

4. What is the value of the above crop per acre at \$0.80 per bushel?

5. At the same rate what is the value of all the wheat grown on a piece of land containing 240 square rods?

6. At \$0.90 per bushel what is the value of the wheat grown on an acre if the yield is 20 bushels?

7. Which is the more valuable, the crop in problem 4 or that in problem 6?

8. If 20 bushels of \$0.90 wheat can be grown on an acre, how many pounds is that? What is the price per pound? How many pounds are grown on a square rod? What is the value of the wheat grown on a square rod?

9. At the same rate and price, what is the value of the wheat grown on a piece of ground 14 rods wide and 20 rods long?

10. How many acres in a field 40 rods long and 24 rods wide?

11. If a man can plow 2 acres per day, how long will it take him to plow the above field? What will it cost for plowing at \$2 per day?

12. What will be the cost of plowing a 40 acre field at the same rate?

13. If a man and team can seed 4 acres per day how long will it take to seed a 40 acre field? What

will it cost at \$2 per day?

14. If it costs \$.50 per acre to get this crop cut with a binder what will be the cost of cutting the field?

15. It will cost about \$.25 per acre to stack the grain. Find the cost of stacking.

16. What is the threshing bill at 2 cents per bushel? Find the entire cost of the crop.

17. If the yield has been 20 bushels per acre, worth 90 cents per bushel, how much has the farmer made over and above the entire cost of labor?

18. How much has he made if the crop has yielded 25 bushels per acre, worth \$.80 per bushel?

19. Have any items of the cost of producing this wheat been omitted? If so, what? Should we allow for them? Let us do it and find the result.

20. With a crop of 50 bushels of shelled corn per acre worth \$.40 per bushel work the same series of problems, omitting such as do not apply to corn raising.

TO THE TEACHER: The above list of problems is intended to suggest others. Ask the pupils to find out the current prices of corn, oats, barley, hay, etc. Ask them what is considered a good crop per acre of each of these. Ask them the cost of labor. Have them furnish all the necessary data. This they can get from home. Make up a list of problems similar to the above from data furnished by the pupils. Let one pupil furnish data for one set of problems, another pupil furnish data for another set, and so on. Pass the honors around. You should have both parents and pupils interested before you have progressed far with this work. Observe this policy throughout the course of instruction in this branch.

2. The Plant and the Water.

We have already seen that the seed furnishes the food for the little plantlet until it is large enough to get it from the soil, in much the same way that the mother cow furnishes milk for her calf until the calf is large enough to hunt for its own food. If asked, "What are the foods which a cow eats?" you would probably answer, "Hay, straw, fodder, oats, bran, etc." Not many of us could answer so readily if asked to give a list of plant foods. There are but a dozen of them and half of these are nearly as familiar to you. Here they are: Water, lime, iron-rust, soda, ammonia, and sand. The other six are magnesia, potash and four acids, viz: Carbonic, phosphoric, hydrochloric and sulphuric. Now let us examine these foods.

Every one knows that plants cannot live without water, but few people stop to think of the enormous amount of water consumed daily by an acre of growing vegetation. You may try this experiment: Put exactly the same amount of water in each of two vessels—tumblers, glass fruit-jars or even old tin cans will answer. Pull up a thrifty bunch of clover and put its roots into one of these vessels of water. Stand both on a table or shelf side by side. In a few days you will notice that the water in the vessel containing the clover is disappearing much more rapidly than that in the other vessel. As soon as the clover begins to wilt take it out of the water and compare what remains in the two vessels by measuring. Of course, both have lost by evaporation—that is, both have "dried up," as we say,—but, if the vessels are of the same size, one should have "dried up" as fast as the

other. Why, then, should not the remainders be equal? Because the clover plant has been using up water. The difference between what remains in the two cans represents the amount used by the clover plant.

Plants make use of water in two ways. In the first place they use it as food just the same as animals do. In the second place a plant cannot eat solid food. It has neither mouth nor teeth and it must suck in its food through its roots in liquid form. The solid foods, mentioned above, dissolve in water—just as sugar dissolves in coffee—and in this dissolved condition they are easily taken in by the roots of the plant. Substances like salt, which dissolve in water, are said to be soluble and, when found in the plant in this dissolved form, the liquid is called sap. The solid food and a portion of the water is taken from the sap to be used in plant growth and the remaining water is passed off to the air through little holes in the leaves. These, then, are the reasons why plants need so much water. Grain uses up thousands of tons of water per acre during the growing season.

But you ask: "Can the farmer regulate the amount of moisture in the soil?" "Does not that depend wholly upon rainfall?" No, it does not depend upon rainfall. If the ground is too wet, the farmer can drain it by ditching or tiling and by careful cultivation he can keep the moisture in the soil in times of drought. Just how this is done is left for later discussion.

Table showing proportions of water in farm crops:

One bushel of root crops contains about 55 pounds of water.

One bushel of potatoes contains about 45 pounds of water.

One bushel of corn (dry shelled) contains about 5 pounds of water.

One bushel of wheat contains about 6 pounds of water.

One bushel of oats contains about 3 pounds of water.

One ton of dry hay contains about 300 pounds of water.

One ton of green feed contains from 1,500 to 1,800 pounds of water.

NOTE: This represents only the water left in the plants and seeds as a part of them. By far the greater amount used by the plant passes off to the air through the pores in the leaves.

TO THE TEACHER: By the aid of data furnished by the pupils, the above table will enable you to devise other problems similar to the ones given at the end of the chapter.

Problems.

1. If rain falls an inch deep on the level, how many cubic inches is that per square foot? Per square yard? Per square rod? How many cubic feet per square rod? Per square acre?

2. About how many barrels of water fall on an acre with 1 inch rainfall?

3. How many tons will this water weigh?

4. The total rainfall during the year in Wisconsin is about four feet. What does the water that falls on a square yard of ground, during the year, weigh? On a square rod? How many tons to the acre?

5. Suppose the plants use one-eighth of this. What is the weight of the water used by a square yard

of vegetation? A square rod? An acre?

6. From 10 to 90 per cent. of all crops is water. Suppose potatoes contain three-fourths of their weight of water. How many pounds of water in a bushel of potatoes?

7. If 150 bushels of potatoes is a good yield, how many pounds of water in the potatoes grown on an acre?

3. Plant Foods.

Every child knows what lime is. He knows, too, that it will dissolve readily in water. It thus becomes available for plant food. Large quantities of lime are found in the soil. Of course, it comes from the lime rock.

Soda, or saleratus, as it is sometimes called, is also easily dissolved in water. Soda is made from common salt and the plants get it from the soil.

Iron-rust gives the red or yellow color to rocks and soils. It dissolves easily in water, especially after a little acid is added.

But what is an acid? The commonest kind of one, without which no farmer's wife could well get along, is vinegar. Acids are usually sour in taste and their presence in the soil assists water in dissolving rock. A copper penny can be made bright or an old brass ring to look like gold by rubbing it with a little vinegar. This is because the acid dissolves off the tarnish and leaves the clean surface exposed. Some of the plant foods dissolve much more readily in water to which a little acid has been added. Soda is a good example. Put a teaspoonful of it in a cup about one-fourth full of water without stirring. Add a little

vinegar and notice what takes place. The soda disappears because the acid acts on it. Gas is given off very rapidly, causing it to bubble and "foam." This gas is carbonic acid, one of the four acids named in the last chapter. These acids help the water to dissolve the plant foods in the soil and are themselves taken in as plant foods.

Sand needs no discussion. It is the food that gives stiffness to the stalks of barley, oats and other grains. Small grains, grown on rich bottom land, usually "lodge" partly because they are unable to get sufficient sand from the soil.

One who has smelled ammonia knows what it is. It is used for cleaning clothing and windows. If you go into the barn on a warm morning you will get a strong odor of ammonia from the horse manure, if the barn has been closed during the night. Ammonia is always given off to the air when animal matter decays. It contains the element, nitrogen, so essential to plant growth.

Carbonic acid gas is a plant food and it is also found in the air. You will remember it as the gas that came off when you put vinegar on soda. This gas is always given off to the air when vegetable matter burns or decays. You are throwing it off from your lungs with every breath that you breathe. So, too, are all animals. Here is a simple test for it that any child can easily try: Put a piece of fresh lime in some water, shake well and let it stand until it settles and the water is perfectly clear. Pour off this clear liquid into another bottle. This clear liquid is lime water. Some of the lime has been dissolved. Taste it to satisfy yourself. Now, pour some of the lime water into a tumbler and blow bubbles through it

with a straw. It gets milky because of the carbonic acid in your lungs. Now mix up some more "soda water" and add vinegar. Carefully tip the tumbler so that the gas can run into the lime water. It is heavier than air and will run over the edge of the tumbler like water. Shake the lime water. It is milky again. This shows that the gas given off by the soda water when vinegar is added is the same as the gas given off by your lungs. Try one more experiment:

Place a little lime water in a saucer and set this on the floor in your sleeping room over night. In the morning it, too, will be found to be milky. This shows the presence of carbonic acid in the air.

Most of us are acquainted with magnesia. It is the white powder used by barbers and ladies to whiten the skin and prevent soreness from the wind.

Potash is found in wood ashes and gives to lye, made therefrom, its soapy feel.

The water, soil and air are the sources of plant food. The air contains two—ammonia and carbonic acid—the soil the other nine. All of these foods except carbonic acid dissolve in water and enter the plant by its roots. Carbonic acid is taken in directly from the air by the plant through the little holes in the leaves.

Now, if these foods are not found in sufficient abundance in the soil the plant grows slowly and finally dies. Again, the soil may contain plenty of plant food, but it may not be in a form readily soluble by the water and the plant suffers from a lack of food, just as one may starve within ten feet of plenty of food which is securely locked up so that he can not get at it. So that one problem which the farmer is called

upon to solve is how to make the soil of his farm more easily soluble.

Plants may be killed by too much food. Who has not seen spots of grass killed out where the cattle have been salted or have dropped manure? This is because the plants have taken in too much solid food. Plants can live on so small an amount as one part of solid food dissolved in a million parts of water and more than one part in a thousand kills them. One way to kill out noxious weeds is to cover them with salt, lime, ashes, etc., so that they will take in more than one part of this food in every thousand parts of water that they use.

From what we have learned it is clear that if the farmer raises grain on his farm to sell and never returns manure to the soil he will rob it of its plant food and it will soon begin to show evidence of being "worn out." Plant foods are being continually used up by the growing plants and removed with them and none are returned to take their place. The heavier the crop the faster will be the loss. Tobacco and root crops being so much heavier, wear out the soil faster than small grains.

But worn out soil does not mean soil in which all the different kinds of plant foods are used up. In fact, soil usually contains all plant foods in inexhaustible quantities with but three exceptions, namely: Potash, phosphoric acid and the nitrogen found in ammonia. To restore the fertility of the soil means only to restore these three substances. The general rules for fertilizing soils will be taken up later.

Table showing proportion of fertilizing substances in farm crops:

OUNCES PER BUSHEL.

OTHER TABLES LIKE THIS ARE NOT marked

Crop.	Phosphoric		
	Nitrogen.	Acid.	Potash.
Wheat	20 oz.	8 oz.	5 oz.
Rye	17 oz.	9 oz.	5 oz.
Corn, shelled	14 oz.	5 oz.	3 oz.
Barley	12 oz.	6 oz.	4 oz.
Buckwheat	12 oz.	4 oz.	2 oz.
Oats	10 oz.	3 oz.	2 oz.
Potatoes	3 oz.	1 oz.	4 oz.
Root crops, average.	3 oz.	1 oz.	2 oz.

POUNDS PER TON.

Crop.	Phosphoric		
	Nitrogen.	Acid.	Potash.
Timothy or red top hay..	20 lbs.	9 lbs.	30 lbs.
Clover hay	40 lbs.	10 lbs.	40 lbs.
Tobacco (leaves)	60 lbs.	13 lbs.	80 lbs.
Straw (average)	10 lbs.	4 lbs.	20 lbs.
Sugar beets	3 lbs.	1-5 lb.	4 lbs.

Problems.

1. How many pounds of each of the three important fertilizers in a crop of wheat that goes 20 bu. per acre? 25 bu. per acre?
2. A corn crop of 50 bu. per acre? 60 bu.? 75 bu.?
3. An oat crop of 40 bu. per acre? 50 bu.? 60 bu.?
4. A barley crop of 40 bu.? 45 bu.? 50 bu.?
5. A potato crop of 110 bu. per acre? 120 bu.? 150 bu.?
6. A clover hay crop of $3\frac{1}{2}$ tons per acre? 4 tons? 5 tons?

7. A meadow hay crop of 2 tons per acre? $2\frac{1}{2}$ tons? 3 tons?
8. A tobacco crop of 1,500 lbs. per acre? 1,800 lbs.?
9. Compare the results and notice which crop is hardest on the soil.

TO THE TEACHER: Pupils may furnish data for similar problems. Have them tell how many acres of corn, wheat, hay, etc., were raised on the farm at home, the number of bushels or tons per acre, and find the amount of the three essential fertilizers taken off with the crop.

4. Soils.

A good deal has been said about soils and it may interest you to discuss how soils are made. The soil in Wisconsin and most of the northern states contains much hard gravel mixed with fine soil. This "drift," as it is called, varies in depth from a few inches to hundreds of feet. Underneath this drift is solid rock. Any "well-driller" will tell you this. He can also tell you how far he has had to go down into the earth before striking rock, in the different wells that he has drilled. He will also tell you that this rock does not resemble the stone or gravel above it. Where, then, did this drift come from?

Many years ago, before man first made his appearance on the earth, a great mass of ice and snow, called a glacier, swept down from the polar regions, scraping up the loose earth, rocks, and stones as it moved slowly along, crushing and grinding them together, knocking off hill tops and filling up valleys and leaving, as it passed, the gravelly soil in which the farmer now

sows his seed. The reason why the stones that may now be picked up are so hard is that only the hard ones could stand the grinding. The softer ones were easily ground up and formed soil. In the western part of the state of Wisconsin is a tract, known as the "driftless area," over which the glacier did not pass. Here the soil may be seen in the actual process of formation. The rock on top gradually "rots" and breaks up. The water washes the lighter portions down and spreads them out at lower levels. The rain and snow work their way into the cracks of the rocks, and, freezing there, break them up into smaller pieces. Even the wind breaks off small pieces and carries them away. Great drifts of sand, like snow, may sometimes be seen piled up by the action of the wind. Plants and trees drop their leaves, die and decay, and thus help build up the soil. Roots of trees sometimes work their way into crevices of the rock and, growing there, split off great pieces. Roots also secrete a kind of acid that helps to dissolve the rock. The gases in the air help in breaking up the rock, thus forming soil. Animals, too, like the gopher and woodchuck, burrow into the earth and help to tear up and break down the rock. When they die their bodies decay and become a part of the soil. Earthworms, or "angle worms," as they are called, feed on the soil and break up the particles into still finer ones.

These are the agencies, then, that assist each other in the formation of soil: Glaciers, wind, water, frost, plants, animals, and gases in the air.

What kinds of soils are formed by all these agencies? It must be remembered that all soil originally came from the rock and the kind of soil must therefore depend on the kind of rock from which it was

made. That is, we have sandy soil in sandstone regions and in limestone regions clay is usually found. The black soil, found on low, flat land, is made up principally from decayed leaves and plants. This soil is called humus. Humus mixed with clay and sand is called loam. If there is more sand than clay in the mixture it is called sandy loam and if there is more clay than sand in the mixture it is called clayey loam. Of course, these soils are found mixed in every possible proportion. This fact leads to a great variety of soils and it is the farmer's business to learn the nature of the soil on his farm and how best to handle it. Loamy soils are the best farm lands because of the ease with which they may be cultivated. They are warm soils and hold moisture well. A sticky clay soil may be improved in texture and warmed up at the same time by a plentiful addition of barn yard manure, containing much straw. This adds humus and makes the clay into a clayey loam. The same treatment is also good for sand, as it increases the capacity of sand for holding moisture and makes a sandy loam. If it were possible and less expensive, many barren, sandy places might be made fertile by adding to them plentiful quantities of swamp muck. This treatment would convert them into a loam of good quality. Plowing under full grown crops of rye or clover has much the same effect. Either method adds humus to the soil and tends to make it more loamy. Rye grows well on sandy soil and clover is a good crop to raise on clay for plowing under.

A good loam contains all the foods needed by growing plants. As has been said before, but three of these foods ever become exhausted (with the possible exception of lime). You will remember that

these three are nitrogen, potash and phosphoric acid. It is the purpose of the next chapter to tell you how you may judge from the character of the soil and the growing crop which one of these plant foods is most needed.

Table showing fertilizing substances in average soils:

POUNDS PER TON.

One ton of	Phosphoric		
	Nitrogen.	Acid.	Potash.
Loam	7 lbs.	3 lbs.	8 lbs.
Clay	3 lbs.	3 lbs.	15 lbs.
Drift	3 lbs.	$\frac{1}{2}$ lb.	6 lbs.
Sand	1 lb.	2 lbs.	5 lbs.

(Adapted from Stockbridge.)

Problems.

By a comparison of the two tables showing fertilizing substances in soils and crops answer the following questions:

1. What crops are hardest to grow on sandy soils? Clay? Loam? Drift? Why?

2. What crops can best be grown on sand? Clay? Loam? Drift? Why?

3. Suppose soil is cultivated to the depth of 4 in. How many cu. ft. of cultivated soil per sq. ft. of area? Per sq. yd.? Per sq. rod? Per acre?

4. If a cu. ft. of soil weight 75 lbs., how many lbs. of cultivated soil per sq. yard? Per sq. rod? Per acre?

5. Find number of pounds of nitrogen, potash and phosphoric acid in the cultivated soil per acre for each of the four kinds of soil.

6. If the soil is cultivated to the depth of eight

inches how many pounds of each of the three fertilizing substances per acre in each of the soils given in the table?

7. How many pounds of nitrogen, potash and phosphoric acid are used, annually, per acre, by a crop of 20 bu. of wheat? In how many years will one-half of all the nitrogen in clay be used up by this crop feeding to the depth of four inches?

8. How will this affect future crops?

9. Work the same problem for the other soils.

10. Use a 50 bushel corn crop per acre and work problem 7. Also a 60 bu. oat crop. A 120 bu. potato crop.

TO THE TEACHER: Have pupils furnish data for similar problems.

5. The Soil and the Crop.

As was stated in the last chapter, the crop will usually tell the farmer by its appearance the kind of food it most needs. Good, fertile, well-drained soil, properly cultivated, usually produces healthy, dark green plants with strong, good-sized stalks and numerous well-filled seeds.

Now the growth of the stalk and the foliage of the plant is largely due to the nitrogen in the soil, provided, of course, that the drainage is good and other conditions of heat, light, air and moisture are favorable. If the plant has a yellow and sickly look and refuses to grow with proper cultivation, it is likely starving for want of nitrogen. What should the farmer do?

Barn yard manure is an almost perfect fertilizer; that is, it has the right amounts of nitrogen, phosphoric

acid and potash in it in a form readily obtainable by the plant. A plentiful application of barn yard manure will improve the next crop and is the best remedy for yellow and sickly plants.

In the next place, clover, alfalfa, peas and like plants which bear their seeds in pods will grow readily on this kind of soil, because they have the power of using the nitrogen of the air in a way that will be explained later. These plants store up the nitrogen that they take from the air, and if they be plowed under when full grown they will add this store of nitrogen to the soil, besides forming an excellent soil mulch. Clover stands next to manure for the restoration of nitrogen and is sometimes easier of application.

Another method consists of applying commercial fertilizers, containing nitrogen, directly to the soil. These may be bought in the market, but as yet they are little used by the farmers, because manure and clover are ordinarily cheaper, more convenient, and easier to apply. Guano, saltpeter, fish, and animal refuse from slaughter houses are the principal commercial fertilizers which contain large amounts of this much-needed plant food.

A shortage of phosphoric acid in the soil is usually shown by small, undeveloped and shrunken seeds. The grain does not "fill well," as the farmer says. The ground has been carefully prepared, tilled and drained. What is he to do? Nothing simpler. Apply phosphoric acid fertilizers to the soil. Here again, barnyard manure, because it is a perfect fertilizer, is the best and easiest one to be had. Ground bones, burned bones, marls and rock phosphates are the fertilizers of commerce, but as yet they are not extensively used.

Potash is especially essential to the production of

fruits, potatoes and root crops. In most cases, when other conditions are perfect, under-sized, shriveled and imperfect fruits and roots are due to a lack of potash. Here again barnyard manure is the universal remedy. Wood ashes are especially valuable because of the potash which they contain. They should never be wasted, but saved and put on the land. Potash salts may be bought on the market, but, like other commercial fertilizers, they have not yet come into general use.

To sum up what has already been said: Barnyard manure is called a perfect fertilizer because it contains all the elements that become exhausted from the soil, namely: nitrogen, phosphoric acid and potash. It is the easiest fertilizer to get and for that reason is always the best to use. Clover, plowed under, will restore nitrogen to the soil because it has power to take nitrogen from the air, a power which few other plants have. Wood ashes are rich in potash and should never be wasted, but sown on the soil. Commercial fertilizers, containing what the soil especially needs, may be bought and applied.

There is still another use to which commercial fertilizers, like lime and land plaster, are put. They are used not so much because they are themselves plant foods, but because of the chemical effect which they have upon the soil. Your attention has already been called to the fact that plants sometimes starve with an abundance of food near at hand, but in a form in which they can not use it for food—locked up, as it were, like pies in a pantry. If a boy was starving because his food was “locked up” he would want the key. No boy will die of starvation with a well-filled cupboard, unlocked, in the house. Neither will plants.

Now lime and land plaster are the keys that unlock other plant foods in the soil and change them into a form in which the plants can get at them. It is, principally, for this reason that they are used.

The subject of fertilizers and fertilization is a big one and a very important one to the farmer. It needs much thought and careful study and is only touched upon here in the briefest possible manner. The problems which follow will help to emphasize the points made in this chapter.

Table showing average amounts of nitrogen, phosphoric acid and potash in fertilizers:

POUNDS PER TON.

Substance.	Phosphoric		
	Nitrogen.	Acid.	Potash.
Clover hay	40	11	36
Straw	10	2	10
Barnyard manure	10	6	9
Wood ashes	..	60	160
Burned bones	..	500	..
Ground bones	..	400	..

Problems.

1. Suppose a load of barnyard manure weighs a ton. How many pounds of nitrogen in it? Of phosphoric acid? Of potash?

2. How much of each of the above in 15 loads? 20 loads? 50 loads?

3. How many loads of manure did you haul onto the land last year? How much of each fertilizing substance did you apply?

4. If you put 15 loads on an acre how much of each fertilizing substance did you apply per acre?

5. Suppose you harvested 50 bu. of corn per acre. How much of each fertilizing substance did you take off with the crop?

6. Was your soil richer or poorer after the corn was harvested? Did you take off more than you put on? How much of each kind?

7. How much of each of these fertilizing substances will be taken off with a 25 bu. crop per acre of wheat? A 40 bu. crop of barley?

9. How many loads of manure per acre will be necessary to restore the fertility lost when a 25 bu. per acre wheat crop is harvested?

TO THE TEACHER: Ask pupils to furnish data for similar problems.

6. Wearing Out the Soil.

From what we learned in the last chapter it is easily seen that the farmer who raises grain and tobacco to sell and who returns nothing to the land in the form of fertilizers is literally "selling his farm." He sells soil in small quantities, it is true, but he sells it nevertheless. There can be put one result from this kind of farming. No matter how rich the soil, sooner or later it will wear out. The poorer the land the sooner will its fertility become exhausted.

In the early history of Wisconsin much wheat was grown, the land in many cases yielding as high as forty bushels per acre. But the yield rapidly decreased until no more than ten or fifteen bushels could be grown. The farmers gave up selling wheat and the wheat belt moved on to the west. Now why was this? Simply because wheat, a heavy feeder as shown by the tables, wore out the soil. No fertilizers were returned to take the place of the soil matter taken off

with the wheat, and in a few years the wheat crop starved out. What is true of wheat is equally true of every other crop, in the proportion in which it uses up nitrogen, phosphoric acid and potash in its growth.

Wisconsin farmers have learned that grain farming does not pay and they have gone into dairying and prospered. Why is dairy farming so much better? Because the grain and hay raised on the farm are fed there and returned again to the soil in the form of barnyard manure. Very little soil matter is sold from the farm. The proportion of nitrogen, phosphoric acid and potash in butter, cheese, beef and pork is very small for the amount of feed consumed, as the table following this chapter will show. It will take a long time to lessen the amount of these substances in the soil by dairy farming.

Again, the dairy farmer raises much clover, and clover, as you have already seen, really enriches the soil by adding to it nitrogen from the air.

The wise farmer wastes nothing. If he raises peas and corn for the canning factory he hauls the vines and stalks back to his farm. If he grows beets for the sugar factory he has the pulp returned to his land. He sells neither hay nor grain, but feeds it on his farm. He saves all manure and carefully returns it again to the soil.

Table showing fertilizing substances in dairy products:

OUNCES PER 100 POUNDS.

	Phosphoric		
	Nitrogen.	Acid.	Potash.
Cheese	63 oz.	10 oz.	2 oz.
Milk	8 oz.	3 oz.	3 oz.
Butter	2 oz.	3-5 oz.	1½ oz.

Table showing fertilizing substances in farm animals:

OUNCES PER 100 POUNDS.

	Phosphoric		
	Nitrogen.	Acid.	Potash.
Cattle	40 oz.	29 oz.	3 oz.
Sheep	35 oz.	19 oz.	3 oz.
Hogs	32 oz.	130 oz.	2½ oz.

PROBLEMS.

1. How much nitrogen is sold from the farm with every ton of butter? How much phosphoric acid? How much potash?

2. How many pounds of these three substances are sold with every ton of cheese?

3. How many pounds of each are sold with 100 lbs. of butter? With 100 lbs. of cheese? Which is harder on the soil?

4. How much of each of these fertilizing substances in a 300 lb. pig?

5. How much of each of these fertilizing substances in a 1,200 lb. steer?

6. A farmer sells 20 hogs, each weighing 225 lbs. How many pounds of each kind of fertilizing substance does he sell?

7. Suppose he sells 6 head of cattle weighing 1,050 lbs. each. How much of each of these three substances does he sell?

8. How much butter did you (each family represented in the class) sell last year? How much of each of these three fertilizing substances did you sell with the butter? Did it wear out the farm much? About how many loads of manure will it take to replace them? (Suppose a load of manure weighs a ton).

9. How many hogs did you sell last year? About how much did they weigh? How much phosphoric acid went with them? How much nitrogen? How much potash?

10. Did you sell any wheat? Any other grain? If so, how much? How much of your farm went with it?

TO THE TEACHER: Require pupils to furnish data for other similar problems.

7. Legumes.

From a study of the table on fertilizing substances in different soils and a comparison of this table with the one on fertilizing substances in farm crops, it will be seen that nitrogen is the element which, from ordinary soils and under ordinary conditions of farming, is likely to be the soonest exhausted. Ordinarily, then, the farmer's attention should be turned to methods of restoring nitrogen. If a sufficient quantity of manure were produced on the farm, of course the best method of fertilizing would be to apply barnyard manure to the soil, as it not only contains nitrogen, but also phosphoric acid and potash, the other needed elements. But it is not always possible to do this. There is a class of plants, however, called legumes, that have the power to add nitrogen to the soil. Peas, beans, clover and alfalfa belong to this class. It is the purpose of this chapter to explain the manner in which these plants add nitrogen to the soil.

The air that we breathe is composed largely of two gases—oxygen and nitrogen. Both are colorless, odorless, and invisible. About one-fifth of the air is oxygen and the other four-fifths nitrogen. It is the oxy-

gen that causes iron to rust, coal to burn, or wood to decay. Oxygen is a very active element, combining readily with other substances. If the air were pure oxygen, any fire once started could never be put out, and even our bodies would take fire and burn up.

On the other hand, nitrogen is a very inactive element and does not combine readily with other substances. Its presence in the air dilutes the oxygen and makes it less active. It is well known that tea can be made so strong that no person can drink it. It may be readily diluted and its strength greatly lessened, however, by the addition of water. It is much the same way with oxygen. It is so active that it must be mixed with nitrogen before it can be used by man and animals. It is so mixed in the air, there being, as has been said, about four times as much nitrogen as oxygen in it. Farm crops can not use this "free" nitrogen in the air.

There are, however, little germs which live in the soil that *can* and *do* feed upon this free nitrogen in the air. These germs are a kind of parasite and are usually found associated with the legumes, i. e., with peas, beans, clover and the like. They fasten themselves to the roots of these plants and build their homes there. Their little "nests" look like tiny potatoes and are called tubercles. They are about as large as pin-heads and are to be found adhering to the roots of clover, beans, and peas. Pull up a bunch of thrifty clover and examine its roots for these tubercles. A peculiar thing about these germs is that they do not seem to thrive without the legumes and the legumes do not thrive without the germs. Sometimes clover refuses to grow on certain soils. The reason is that there are no germs in the soil. Such soils should be

"inoculated," i. e., the germs should be planted there and then the clover will grow. These germs are sent out in little cakes, like yeast cakes, by the United States Department of Agriculture and may be dissolved in water and sprayed on the land.

In order to restore nitrogen to worn out soil it is only necessary to seed with clover. The germs found in the tubercles on the roots of the clover will feed upon the nitrogen of the air, which the plants themselves cannot use, and store it up. If this crop is plowed under, nitrogen is added to the soil. It is consequently enriched and at the same time improved in texture, especially if it be a clayey soil. This is the secret of clover growing on the farm. It is the common practice among farmers to cut the first crop of clover for hay and plow under the second crop. Thus the clover is made to serve a double purpose—first furnishing food for stock, and next a supply of nitrogen for the soil.

Problems.

1. How does clover compare with other hay in the amount of nitrogen it contains? Phosphoric acid? Potash?

2. If two tons of hay per acre is an average yield, how much of each fertilizer is removed from 8 acres of ground yearly?

3. Which kind of hay makes the richest manure? Why?

4. How much more of nitrogen in a crop of 25 acres of clover hay yielding 3 tons per acre than in the same number of acres of mixed hay yielding 2 tons per acre? Where does this extra nitrogen come from?

5. How many tons of each kind of hay did you raise on the farm last year?

6. How many tons of hay did you sell last year? How many pounds of each of the three important kinds of "soil fertility" did you sell? How many pounds altogether?

TO THE TEACHER: Ask pupils to furnish data for similar problems.

8. Tilling the Soil.

Tillage stands next in importance to fertilization and with many soils it is even more important. Tillage is here meant to include both the preparation of the soil before planting, and, with crops that admit, the cultivation of the crop after it is planted.

As we have learned, the plant is fed by its roots that penetrate the soil in every direction. These feeding roots are very small and work their way between the soil particles, gathering up the dissolved food and passing it into the plant. If the soil is coarse and lumpy these little rootlets cannot get at the food locked up in the lumps, but can only feed upon their surface. Proper preparation of the soil will break up these lumps, pulverize them, and allow the roots of the plants to get at the food matter which they contain. Again, water cannot dissolve plant foods in lumpy ground so readily. Stirring the soil will hasten the solution of this food matter. These facts may be easily shown by experiment.

Throw a handful of fine salt into a tumbler of water. Into another tumbler put a lump of salt or a piece of rock salt about the same size. Which dissolves the sooner? Stir both and note the effect of

stirring. Does stirring hasten solution? Now put the same amount of fine salt in each of two glasses. Stir one, but do not disturb the other.

You have noticed in the above experiments that lumpy salt dissolves much more slowly than fine salt and that stirring always hastens solution. It is just so with plant foods contained in the soil. Plant foods contained in lumpy soils dissolve very slowly and cultivation has the same effect upon them that stirring has upon the salt in the water. It causes them to dissolve. The plant cannot use these foods until they are dissolved, so that excellent preparation of the soil before planting and constant cultivation of it after planting both tend to increase the supply of plant food and hasten the growth of plants.

The depth to which soils should be cultivated depends in a large degree upon the depth to which the plants' roots will penetrate. The grains are shallow rooted and do not need so deep cultivation as do corn and root crops. The farmer is not likely to plow too deep for any crop, however. Deep plowing brings to the surface plant foods that have never been reached by shallow cultivation, and it pulverizes the soil so that the roots can penetrate it to a greater depth and have more soil to feed upon.

For root crops the ground must be plowed deep and very carefully pulverized. There are two reasons for this. In the first place, poorly pulverized soil spoils the shape of roots like beets and parsnips. They cannot grow equally in all directions and become crooked, split, and misshapen because of the hindrance of lumps to their growth. In the second place, if they cannot penetrate the soil easily, they will be raised out of the ground as they increase in length, when they

strike the hard soil below. All that has been said about cultivation of plants applies with special force to root crops.

Another important reason for cultivation is to be found in the fact that cultivated soils do not dry out so rapidly during a drought. This seems strange at first, but it is nevertheless true, and the reason is easily seen. There are two kinds of water in the ground—capillary water and “free” underground water. Underground water flows along underneath the surface and sometimes comes out again in the form of springs. It is this water that supplies our wells. But it is the capillary water and *not* the “free” water that is used by the plants. A simple illustration will make clear what capillary water is. You have, no doubt, observed how oil rises in the lamp wick. The oil in the wick is moving upward and may be called “capillary” oil, while that in the lamp is “free.” The oil in the wick corresponds to the capillary water in the soil, while that in the lamp corresponds to the underground water. Another illustration: At the breakfast table take a spoonful of sugar and just touch the tip of the spoon to the surface of the coffee in your cup and notice how the coffee creeps up into the sugar. It is in exactly the same way that the underground water creeps upward in the soil and becomes capillary water. Still another illustration: Fill a pan half full of water; set it on a table and throw a rag over the edge so that one end will dip into the water and the other end will lie on the table. In a little while the water will be running from the pan out upon the table. In other words, it runs “up-hill,” over the edge of the pan, through the cloth and “down-hill” through the cloth to the table. The water that runs uphill is capillary

water while that in the pan is free water. The capillary water is being continually supplied from the free water in the pan below. Let us remember that it is the capillary water that the plant uses and which is also evaporating from the soil.

We know that if we cover up a kettle it keeps the water from evaporating, "boiling away," as we say. In the same way a blanket, spread over the soil, will prevent the evaporation of this capillary water. The simplest way to get this blanket, spread over the soil, is to cultivate it. The layer of cultivated soil dries out very rapidly, but it prevents the air from getting at the moist soil underneath and thus keeps it from drying out. It acts as a sort of dry blanket to prevent the evaporation of moisture.

To conclude: There are three chief reasons for tilling the soil. 1. To pulverize it, making it easy for the plants' roots to penetrate it in every direction and get at the store of food it contains. 2. To stir it and thus hasten the solution of plant food as well as to destroy weeds that rob the plants of their food. 3. To form a soil mulch, a sort of "dry blanket" as it were, which will prevent rapid evaporation of the capillary water from the soil.

Problems.

1. How many sq. ft. in one sq. yard? In one acre?

2. If soil is cultivated to the depth of 4 in. how many cubic feet of cultivated soil per acre? How many if cultivated to the depth of 6 in.? If cultivated to the depth of 8 in.?

3. How much more plant food is made available

with cultivation to the depth of 8 in. than with a 4 in. deep cultivation?

5. How many times as much available plant food in soil cultivated to the depth of 6 in. as in soil cultivated only 4 in. deep?

5. If a man and team can plow $1\frac{1}{2}$ acres 6 in. deep or 2 acres 4 in. deep in a day, how much more does it cost per acre to plow land 6 in. deep than to plow it only 4 in. deep? Labor worth \$2.40 per day.

6. If a man and team can till 3 acres thoroughly in a day or 5 acres in a careless manner, how much more per acre does a good job cost if labor is worth \$2.40 per day?

7. How much more per acre does it cost both to plow and till well? How many additional bushels of oats worth \$.36 per bu. will it take to pay for the additional labor?

8. How much will be the gain if but 40 bu. of oats can be raised with shallow plowing and careless seeding, and 57 bu. with the extra work? How much will these oats be worth at 24 cents per bu.? At \$.30 per bu.? At the present price of oats?

9. A certain piece of land yields 35 bu. of corn per acre. By careful cultivation the farmer is able to increase this yield to 60 bu. With corn worth \$.40 per bu. how many additional days' labor at \$1 per day will the extra yield pay for?

10. If he spends but 20 days' extra time on his 12 acre field of corn to produce the increase in crop shown in problem 9, how much does he get per day for his extra time?

11. Suppose a farmer is able to double the average yield of 160 bu. of potatoes from an acre of land by putting 15 days' extra time on it. What wages

does he get with potatoes at \$.24 per bu.?

TO THE TEACHERS From answers to the following questions furnished by the pupils, make other problems similar to the above. What does labor cost per day? How many acres can a man plow per day? How many acres can he seed in a day? How many acres of corn can he cultivate? Will extra labor increase the yield of corn? etc., etc.

9. Draining the Soil.

As was stated in the last chapter, the plant makes use of the capillary water in the soil and this capillary water is being continually supplied from the free water in the ground below. There is a level to this underground water just the same as there is a level to the water in a pond. On low, flat land this level is very near the surface. It is at or above the surface on swampy ground and many feet below the surface in high places. High ground needs little attention so far as drainage is concerned, as the water which falls upon it either soaks in or runs rapidly off as surface water.

Low ground, however, does need attention. Plants cannot grow without air, and much water in the soil keeps out the air. The level of the underground water must therefore be below the depth to which the roots of the crop ordinarily penetrate the soil. In other words, a crop will not do well on a field where the ground water level is too near the surface. You have all seen crops "drowned out," as the farmer says. If you dig a post hole in this soil it will soon fill with water to within a foot or so from the top. The level of the water in this hole will be the ground water level

and if it comes very near the surface no crop can be expected to do well on this soil.

Again, wet soils are cold soils. It takes so much heat to dry up the water in them that there is little left to warm up the soil. Many times these soils are sour soils and will not become sweet until the water is drained off and the heat and air let in. Sometimes it is even necessary to sow lime on these soils in order to sweeten them after the water has been drained off.

What is the farmer to do with low, wet ground? Evidently there is but one thing to do—drain off the water. There are two ways of draining this water off, the open ditch and the tile drain. To begin with, the land may be so low and flat that no kind of drainage is possible. This, of course, may be determined by noting the level of the water in the nearest stream. If it is within a foot or two from the surface of the land and overflows with every heavy rain, easy drainage is impossible. But if the surface of the soil is a few feet above the level of the stream, the land can be easily drained. It is conceded that the tile system of drainage is better than the open ditch, though it costs more to begin with and is harder to put in. The tiles should be placed about three feet below the surface, so that the ground water level will be lowered to this point and the ground cultivated without interfering with the tiles. The size of the tile to be used and the distance apart which they should be placed depend upon the slope and the character of the soil. An experienced drainage engineer should have charge of the work.

Open ditches may prove quite as effectual in draining the land if they be deep enough and not too far apart. Of course, they must be kept cleaned out. The greatest objection to open ditches is that they cut up

the land too much and thus interfere with cultivation. They can best be used in draining out sloughs and narrow, swampy places. Many acres of low land now uncultivated might be made very productive if properly drained.

NOTE: Farmers who are interested in this subject should write to the U. S. Department of Agriculture for Farmer's Bulletin, No. 40, on Farm Drainage, which may be had for the asking.

Table showing average cost of drainage tile in large quantities:

3 in. tile cost about 3c each
4 in. tile cost about 4c each
5 in. tile cost about 5c each
6 in. tile cost about 6c each

All sizes are 12 inches in length.

Problems.

1. If a farmer owns a plat of low ground 80 rods long and 50 rods wide how many acres in this plat?

2. A creek runs lengthwise through this land. The level of the water in the creek is 4 feet below the level of the land. Can it be drained?

3. Will the creek answer as a channel to carry off the water from the tiles?

4. Suppose he puts the tiles crosswise of the field, 4 rods apart, so that they open into the creek. How many rods of tiling will it take? How many feet? How many 4 in. tiles?

5. What will be the cost of these tiles according to the above table?

6. What will it cost to dig the ditch and lay the tiles at 20 cents per rod?

7. What will be the entire cost if 4 in. tile are used? 3 in.? 6 in.?

8. What will be the cost per acre for each kind of tile?

9. Suppose the open ditches in which the tiles are laid will answer. How much more will the tile system cost than the open ditches?

10. If the farmer is able to grow only $1\frac{1}{2}$ tons of marsh hay worth \$4 per ton on this land before draining and can grow 60 bu. of corn worth \$.35 per bu. after draining, what is the increase in the value of the crop due to drainage?

11. In how many years will this increase alone pay for the open ditch? For the 4 in. tile system? For the 6 in. tile system?

12. Suppose the open ditch costs 5 cents per rod annually for repairs. In how many years will the open ditch cost as much as the tile drain?

13. If the above is a true example of the cost and value of drainage, does it pay?

14. What would it cost to dig an open ditch on each side of a slough 10 rods wide and 100 rods long at \$.25 per rod?

15. Is there a place on your farm that needs draining? Measure it. Draw a plan for ditches and estimate the cost of both systems.

TO THE TEACHER: Ask pupils to furnish data similar to that called for in the last problem for similar ones.

10. The Crop.

Every farmer desires to be prosperous. He tries to raise that crop which will give him the largest returns in money, but often in his anxiety to do this he

takes too little heed for the future. He reasons thus: "If tobacco is a high price and my soil will raise good tobacco, then tobacco is the crop for me to raise." So, year after year, he plants tobacco, until he finds that his soil will no longer raise a good crop of tobacco or anything else. Plainly, he has made a great mistake. What is the matter?

The trouble is not hard to find. Tobacco is very hard on the soil as you will readily see by consulting the table showing the amount of fertilizing substances in farm crops. Besides, tobacco requires the same kind of food, year after year, and unless the farmer has made a careful study of this crop and the fertilizers needed for its proper growth, his soil soon becomes exhausted of some of its fertilizing substances. The same is true of wheat, or corn, or any other crop, grown year after year on the same piece of ground. So the farmer needs to consider both the immediate returns, that is, the amount of money he will get from his crop this year, and the effect that the crop will have upon the soil.

Good farmers have devised a plan, known as "crop rotation," whereby the farmer is able to secure the greatest possible returns from his farm with the least possible loss to the soil. This plan consists of growing one kind of crop on a certain piece of ground this year, another kind of crop requiring different food materials next year, still another the year following, and so on.

Now, what should form the basis of a good crop rotation? Let us see. Suppose tobacco is to be grown this year. It is a heavy feeder and therefore hard on the soil. A large amount of soil matter will be removed with the crop. This should be restored.

But how? With barnyard manure. Instead of planting tobacco next year on this piece of land better try some light feeder. If the soil is not too rich, oats will be a good crop to follow the tobacco. Clover can be sown with the oats and add more nitrogen to the soil. A crop of clover hay can be taken off the third year and the second crop plowed under. The soil is now in good shape again, and wheat or corn can be grown. Corn will afford an excellent opportunity for a thorough cultivation of the soil. A crop of peas may follow the corn. As you will remember, peas belong to the legume family and restore nitrogen to the soil in the same way that clover does. If the peas are sold to the canning factory, the vines should be brought back onto the land and plowed under to enrich the soil. It is now in good shape for the second crop of tobacco.

Now let us see what has been done: A five year's rotation has been planned, consisting of tobacco, oats, clover, corn, and peas, returning to tobacco again the sixth year. During that five years it has been necessary to manure this piece of land but once. During two years legumes have been grown and plowed under to enrich the soil. This manure and these legumes have doubtless kept up the fertility of the soil. The farmer has had an opportunity for four years to manure other pieces of land. At the same time he has been following some plan of rotation on the rest of his farm. Each year he has grown tobacco and realized a handsome profit from its sale, he has raised corn and sold his hogs, he has made hay for his cattle, and he has sold peas to the canning factory. He has been taking in money all the time, but he has not greatly exhausted his soil.

There is still another feature of crop rotation worthy

of note here. It is the different depths to which the roots of various crops penetrate. In the first place, tobacco is a long-rooted crop and feeds deep down in the soil. Oats, which follow, are shallow and feed near the surface. Then comes clover, whose roots penetrate for several feet, bringing food matter to the surface from deep down in the soil. When this crop is plowed under it furnishes a food supply for the corn which follows it. Now, if oats had been grown on this soil year after year, their short roots would soon have exhausted the food supply near the surface. This difficulty has been avoided by the rotation of crops. Again, crop rotation affords an opportunity for cultivation which destroys weeds and increases the power of the soil to produce.

The rotation given in this chapter is only a "sample" rotation, not an "ideal" one, and is introduced here only from the purpose of illustration. The farmer should devise rotations of his own, suited to his own special needs and those of his farm.

Problems.

1. If corn is planted in rows four feet apart each way, how many hills to the acre? With three good ears to the hill, how many ears to the acre?

2. If it takes 100 ears to make a bushel, how many bushels to the acre?

3. Which is the best crop? Five stalks to the hill that bear ears requiring 200 to make a bushel or 3 stalks to the hill that bear ears requiring 100 to make a bushel?

4. How many bushels per acre is one crop better than the other?

5. Suppose a ten acre field produces 60 bushels of corn per acre the first year, but falls off 5 bushels per acre yearly when corn is continually grown on it. What will be the yield the fourth year?

6. What will be the total loss in the four years? With corn worth \$.30 per bushel what is the money loss?

7. Suppose this loss can be avoided by rotation of crops. What is saved yearly, per acre, on this basis from rotation of crops?

8. What is the value of one acre of tobacco, 1,500 lbs., at \$.08 per lb.?

9. What is the value of one acre of oats, 60 bu., at \$.30 per bu.?

10. What is the value of one acre of clover, 3 tons, at \$6 per ton?

11. What is the value of one acre of corn, 50 bu., at \$.40 per bu.?

12. What is the value of one acre of peas, 20 bu., at \$1.50 per bu.?

13. You will observe that the above problems are based on the crop rotation of the last chapter. What is the entire value of the five years' crop?

14. What is the average yearly value of the crop?

TO THE TEACHER: Ask pupils to furnish data for similar problems. Number of acres of different crops raised on the farm at home, yield per acre, price per bushel, ton, etc.

11. Insects and Diseases That Injure the Crops.

The farmer may prepare the soil ever so well, he may fertilize with the greatest of care, he may cultivate thoroughly, the weather conditions may be favorable and yet he may lose all or a portion of his crop

through the attacks of insects or the ravages of plant diseases.

Every child has seen potato bugs at work and knows full well the damage they will do in a short space of time. If they are not destroyed the crop of potatoes will be. However, the farmer has learned how to fight this pest successfully. But there are many other insects that are injurious to the crop which the average farmer has not yet learned how to fight, and he has paid but little attention to plant diseases. It is not within the province of this book to deal with these subjects in detail, but there are a few general principles which may be laid down here and which will prove of value in the war that the farmer must continually wage against plant diseases and insect pests.

It is necessary for us to know something of the life history of the insects which we fight—when they lay their eggs, where they lay them, when the eggs hatch, and the like.

Insects are so called because they are “in sections.” They have a head provided with a pair of feelers and a pair of strong jaws, a body to which are attached three pairs of legs, and usually two pairs of wings and an abdomen. The abdomen is the back portion of the body made up of several ring-like sections and capable of holding a large amount of food. They breathe through little holes in the sides of their bodies. There are ordinarily four stages of insect growth—the egg stage, the “grub” or caterpillar stage, the resting stage and the full grown insect. The egg is laid by a full grown insect in the ground, on the leaves of plants and weeds, in rotten wood, on the bark of trees, or even in the blossoms of plants or the fruit of trees.

This egg hatches into what we usually call a grub or worm. It is the grub that does most of the damage. The grub is a great eater and grows very rapidly as those of you who have watched the red potato bugs grow can testify. It then hides itself somewhere and goes into the resting state, from which it emerges a full grown insect, ready to lay eggs and repeat this cycle. Some insects, as the potato bug, have legs in the "grub" stage, and others, like the grasshopper, do not go into a resting state at all, but grow their wings as they hop about in search of food.

For our convenience, we will divide insects into two classes—one class that eats the leaves and another class the members of which are too small to eat leaves, but large enough to suck the sap of plants.

Now, what can the farmer do if his crop is attacked by insects? If he can find out where these insects lay their eggs, he can destroy the eggs. If they lay them on weeds and rubbish, he can destroy them by keeping fence rows clean and fields free from weeds. If they lay them in the ground in the fall he can plow the ground and freeze them out. If they are leaf-eating insects he can spray the crop with water containing paris green and poison their food. If they are sap-sucking insects, like plant lice, he can spray the trees or plants on which they live with a mixture of kerosene and soap suds, which will fill up the little breathing holes in the sides of their bodies and kill them. At the close of this chapter will be found formulæ for spraying mixtures for both these kinds of insects. Some farmers plant a "trap" crop, that is, a crop earlier than the regular one, upon which the insects light to deposit their eggs. As soon as the eggs are laid the crop is destroyed, or else it is poisoned to destroy both

the old insects and the young ones when they hatch.

A word of caution in the use of poisons is necessary here. Cases are on record where people have been poisoned with paris green intended for insects. Of course, it should never be applied to cabbage or celery or any vegetable that is used for food. Currants have sometimes been poisoned in an effort to kill the currant worm. In no case should deadly poison be used on fruit trees after the fruit has begun to form.

It is often convenient for the farmer to fight other enemies of his crop, known as plant diseases, while carrying on his fight against insects, as one spraying may be made to do for both.

Rust, blight, smut, rot, and the like are diseases which afflict the plant. They are caused by little, dust-like particles, called spores, that float around in the air and settle on healthy plants. Here they grow and multiply in numbers very rapidly. They injure the plant by living upon its sap—in much the same way that lice and ticks suck the blood of cattle and sheep. They must be destroyed or they will destroy the plant on which they feed.

As soon as they make their appearance in the field or orchard the farmer should begin his fight. If it is blight the affected part should be immediately cut off and burned. If this is not done the wind will carry the spores to the other trees and soon the whole orchard will be affected. The other trees should be sprayed with Bordeaux mixture to prevent the spread of the disease.

For some years past oat smut has been destroying a large portion of the crop all over the United States, but this disease is now under control, as a way to kill

the spores has been discovered. The treatment consists in soaking the seed in a solution of formaldehyde for a few minutes and then spreading it out on the floor to dry before sowing. The recipe is given at the close of this chapter.

So it is with all plant diseases—destroy the spores and the disease is destroyed. The best medicine for this purpose is formaldehyde, a substance which can be obtained at any drug store. It will destroy the spores of more plant diseases than any other remedy yet discovered. It is usual to soak the seed in the solution before planting.

Care must be taken in applying mixtures for both insects and plant diseases not to get too much poison on the plants, as the crop itself may be injured thereby. Paris green may be sprinkled on potato vines with an old pepper box if care is taken not to use too much. It should be dusted over while walking rapidly along the row. Two pounds of poison is ample for an acre of potatoes.

When the crop is troubled by both insects and plant diseases, the remedies may be mixed and applied at a single spraying. A good spraying pump costs from \$2 up. The average cost of the mixtures is given below.

FOR PLANT DISEASES.

(Bordeaux Mixture.)

4 lbs. unslacked lime.....	\$.04
6 lbs. copper sulphate at 5c.....	.30

Total \$.34

Dissolve each thoroughly in 25 gallons of water. When both are thoroughly dissolved, mix. Use only wooden vessels.

FOR LEAF-EATING INSECTS.

$\frac{1}{2}$ lb. Paris green to 50 gallons water. Spray.
Cost 15c

FOR SAP-SUCKING INSECTS.

2 gallons kerosene \$.25
1 lb. hard soap (1 qt. soft soap)10
One gallon water

Total cost \$.35

The above are the best remedies in general use. The first two may be combined, or rather the poison may be added to the first mixture.

FORMALDEHYDE SOLUTION.

(For oat and wheat smut and potato scab.)
1 pint (40 per cent.) formaldehyde . . \$.50
36 gallons of water

Total \$.50

Use wooden vessels. Put seed in "gunny sack." soak in this solution for ten minutes, and spread out to dry. The above solution is sufficient for 40 bushels of seed.

Problems.

1. Suppose it takes 200 gals. Bordeaux mixture to spray an acre of potatoes. What is the cost of the mixture?

2. Suppose it takes two applications to cure the blight and each application requires a day's time, worth \$1. What is the cost of the cure?

3. How many bushels of potatoes worth \$.25 will it take to pay the cost of this cure?

4. Suppose two fields of potatoes of an acre each owned by different farmers. One farmer sprays to cure the blight and gets 188 bushels of potatoes worth \$.25 per bu. The other neglects his field and gets but 75 bu. What is the difference in the value of the two crops?

6. What did it cost the first farmer to apply the spray? What is his actual gain over the other farmer? Did it pay to spray?

7. Suppose it takes two applications of two lbs. of paris green each, and two days' time at \$1 per day to destroy the bugs on an acre of potatoes. How many bushels of potatoes, worth \$.20 each, will it take to pay for the fight?

8. Suppose the yield is increased from 50 bu. to 200 bu. thereby. With potatoes at \$.20 per bu. what does the farmer gain?

9. If both bugs and blight attack the crop, what is to be done? What will be the cost of both remedies? What will be saved by mixing the cures?

10. How much does the formalin solution cost per bushel for seed oats?

11. If 3 bu. are sown to the acre what does this solution cost per acre?

12. Suppose it takes a day's work worth \$1 to treat the seed for 12 acres. What is the total cost of the treatment?

13. How many bushels of oats worth \$.30 each will it take to pay the cost of the treatment?

14. Suppose the treatment increases the yield 20 bu. per acre. How much does the farmer gain on his crop?

15. How much is gained per acre by the use of the treatment?

16. What is the cost per acre of the treatment? The cost of the treatment for a 40 acre field? For a 24 acre field?

QUERY: Does it pay? .

TO THE TEACHER: Ask pupils to furnish data for similar problems.

12. The Fight Against Weeds.

The Bible condemns man to "eat bread in the sweat of his face." This is especially true of the farmer's life. His is a continual battle against the enemies of his crops. He must work hard, early and late, to combat the ravages of insect pests and plant diseases, but harder still to eradicate the weeds.

Any plant where the farmer does not want it to be is a weed. Why are weeds objectionable? In the first place, they rob other plants of their food? Suppose you went out every morning to feed the chickens, and as soon as you threw down the grain for them a great flock of pigeons from a neighboring farm should swoop down and pick up half of it before the chickens could get it! Would you not say to that neighbor: "If you don't take care of those pigeons, I will"?

Weeds rob the other plants of their food just as truly and just as effectually as the pigeons rob the chickens in the illustration given above. If weeds are allowed to grow in a field, the crop is starved out. They rob the plants of moisture as well as food. In the second place, they serve as a breeding ground for insects as many insects seem to prefer to lay their eggs on weeds. In the third place, they shade small plants and rob them of much needed sunlight. These are the principal reasons why weeds should be destroyed.

In order to fight weeds to the best advantage we must know something of their life's history. They may be divided into three classes—annuals, biennials, and perennials. Annuals are those that go to seed every year and then die, coming up from the seed each year. Pigweed, wild mustard, sweet slover and ragweed belong to this class. It is only necessary to prevent them from going to seed to destroy them. This class of weeds is the easiest one to fight.

Biennials are plants that live for two years. They grow up from the seed one year and grow a heavy root but do not go to seed that year. The next year they come up from the root, go to seed, and then die. If we pull them up by the roots the first year, or keep them from going to seed the second year, we can easily destroy them. Cutting them off and not allowing them to go to seed for two years in succession will have the same effect. Mullein, wild parsnip, burdock and bull thistle belong to this class.

Perennials may go to seed every year, but their roots live on from year to year and the only way to eradicate them is to destroy them root and branch—not an easy thing to do. Perennials give most trouble to the farmer. To this class belongs the large number of “noxious” weeds, Canada thistle, ox-eye daisy, couch grass, sorrel and common dock. As soon as any of the above make their appearance on the farm, the farmer should dig them up and burn them. If they are allowed to spread they will soon have possession of the farm. The writer has seen whole plantations, thousands of acres, in the South, surrendered to ox-eye daisies. When once weeds have driven the farmer off, the land is rendered valueless, as it is next to im-

possible to subdue them if they once have gained control.

Problems.

1. If a clean field produces 60 bu. of corn per acre and a weedy one only 35 bu. per acre, what is the damage caused by weeds, with corn at \$.35 per bu.?

2. What would be the damage to a 20 acre field at the same rate?

3. How many days' labor at \$1 per day will an amount of money equal to this damage pay for?

4. Suppose it required only four days' work to keep an acre free from weeds. What would be the gain per acre?

5. What would be the gain on a 24 acre field?

6. Is the quality of the corn from a weedy field ever so good? Why?

7. Suppose clean oats produce 65 bu. per acre and weedy oats produce only 48 bu. per acre. With oats at \$.30 per bu. what is the loss from weeds? What is the loss on a 16 acre field?

8. Are weedy oats as good in quality as clean oats? Why?

9. Give several reasons for weedy oats. Can weeds in oats be easily destroyed after the oats are sown?

10. Will crop rotation prevent weeds in oats? What is a good crop for oats to follow? Why?

11. A yield of 300 bu. of potatoes per acre would be an excellent crop. The land would need to be well cultivated and kept free from weeds to produce this. Suppose but 140 bu. are grown instead. What is the loss from lack of labor? At \$.25 per bu. what is the money value of this loss?

12. How many days' labor at \$1.25 per day will an amount of money equal to this loss pay for?

13. Suppose only twelve days' extra labor were required to give the larger yield. How much would be gained?

14. If the farmer did these extra 12 days' work himself, what would he get per day for his time?

To the TEACHER: Ask pupils to furnish data from their own experience and from home for similar problems.

13. The Stock on the Farm.

The successful farmer avoids "scrub" stock. He has learned two important facts: First, that it pays to take good care of his stock, and next, that it costs no more in care and feed to raise a good animal than it does to raise a poor one. Now, let us analyze these two propositions and see how a thorough understanding of this truth affects the farmer's success.

As will be more fully discussed in the next chapter, animals must be fed for several reasons. In the first place, they must grow and the food that they eat furnishes the material for this growth. In the second place, they must be kept warm and the fuel for this animal heat comes from their feed. Again, if some special product, like milk, is to be produced, this, too, must come from the feed. Now, why does it pay to take good care of stock?

Care is here meant to include feed, shelter and general attention. If the animal is to grow rapidly it must be well fed, since the feed furnishes the material for this increase in weight. Not only this, but it must be fed regularly. If not its digestive organs become

deranged; that is, it gets dyspeptic, and its food passes off without being properly digested and is wasted.

Stock should be provided with shelter at all seasons of the year, to protect them from the storms of summer and the blasts of winter. If their stables are cold, then the additional heat required to keep them warm must be furnished by additional feed. Animals, like people, are very sensitive to sudden changes of temperature, to sleet and snow, and cold and wind. They "catch cold," get sick and lose flesh in consequence. How necessary, then, for the farmer to provide a shed for the cattle to run under during storms, a tight board fence on the north and west sides of the barnyard to break the wind, and warm stables for all his stock.

General attention covers that watchful care so necessary to successful stock raising. Barns and barnyards must be kept clean, stalls bedded, pure water provided, stock kept free from ticks and lice, horses curried, their feet attended to, the health of all animals carefully watched, diseased ones removed and shut up by themselves; these, all these, and a thousand and one other little things constitute the general attention which the successful farmer gives to his stock.

We can best prove that it *pays* by imagining the result of a lack of such care. With neglect more feed is required to make the animals grow and more feed needed to keep them warm. Neglected animals grow slowly, are "stunted" in growth, finally stop growing altogether, and, sometimes sicken and die. Dirty animals are unhealthy and get "scabby" and "lousy." Unless carefully attended to, horses get the thrush or contracted feet, are "foundered" and ruined. Cows exposed to wet and cold or chased by dogs, shrink in

milk. All these cause great loss to the farmer. No one can doubt that it pays to take good care of the stock.

Now for the other proposition: "It costs no more in feed and care to raise a good animal than it does to raise a poor one." A scrub cow takes as much stable room, eats as much hay, requires as much pasture, takes as much time to milk, needs as much general attention and in the end returns about half as much product to the farmer. A "scrub" colt requires all that a blooded colt requires and is worth about half as much on the market. A "scrub" sheep is no better than a "scrub" cow. She produces about half as much wool and raises a "scrub" lamb that sells for about half what a good one brings. There is nothing bad enough to say of a "scrub" hog. It certainly requires as much care as a genuine "porker" and is a thousand times meaner. What does it bring on the market! Not half what a well bred pig of the same age will bring!

If more facts are needed to convince you of the truth of the two propositions stated at the beginning of this chapter, they will be found in the list of practical problems which follow.

One thing must not be lost sight of, however. Hay and grain fed to stock is not entirely wasted. In a ton of hay, worth \$6, there is at least \$3 worth of manure, if it is carefully saved and returned again to the land. But \$3 in value has actually disappeared when the hay has been fed. Ten dollars' worth of oats, or corn, or barley, fed to stock will give in return \$3.50 worth of manure. Below is given a table showing the actual cash value of the manure produced by different farm animals, during the year, when they are kept in stalls and the manure carefully saved. On the aver-

age farm at least two-thirds of this value is wasted. Pupils should use the second table for ordinary problems. To the increase in the value of the animal produced by feeding a certain amount of feed must be added the value of the manure produced by the animal from the feed that is fed.

Table showing value of manure, per head, produced annually by farm animals:

Horse	\$27.00
Cow	19.00
Hog	12.00
Sheep	2.00

Table showing value of manure, per animal, saved annually from animals by the average farmer:

Horse	\$10.00
Cow	6.00
Hog	4.00
Sheep	.75

Problems.

1. A cow requires about 4 ft. by 9 ft. floor space for a stall, with 4 ft. by 3 ft. additional for a manger. How much floor space will be required for 20 cows?

2. Will it be best to stand the cattle in one long row or in two rows of 10 each?

3. If in two rows, would you have them face each other with the manger between or face the wall? Why?

4. What will be the dimensions of a barn for 20 cows in two rows of 10 each, using the floor space given in the first problem?

5. Draw a plan of this barn with cows facing each other. With the cows facing the wall. What are the advantages and disadvantages of each plan?

6. How many feet of two inch plank will it take to lay the floor in this barn? Find cost of same at \$25 per thousand.

7. What will be the cost of a cement floor for same at 10c per sq. ft.?

8. Will "scrub" cattle require the same room?

NOTE: Do not forget to add the value of the manure to the value of the product in the following examples:

9. If a cow eats 3 tons of hay worth \$6 per ton, 1,000 lbs. of ground feed worth \$.80 per cwt., and pasture amounting to \$5 in a year, what does it cost a farmer to keep a cow? Will a "scrub" cow cost as much?

10. A "scrub" will give 15 lbs. of milk daily for 300 days in the year, worth \$.80 per cwt., and raise a calf worth \$3. What is the farmer's profit on her?

11. A Durham cow will give 25 lbs. of milk daily for the same time and raise a calf worth \$5. What is the farmer's profit on her?

12. How much more does he make on the Durham than on the "scrub"?

13. If it costs 2 tons of hay, 40 bu. of oats and \$6 worth of pasture annually to raise a colt, what does it cost to raise a horse 4 years old with hay at \$5 per ton and oats at \$.30 per bu.?

14. A "scrub" colt will bring about \$80. Has the farmer lost or gained, and how much?

15. A coach horse will bring \$150 instead. What has the farmer gained or lost on this colt? Which is the more profitable animal?

16. If it takes 3 tons of hay worth \$6 per ton, 50 bu. of oats worth \$.25 per bu., and \$10 worth of pas-

ture to keep 10 sheep for a year, how much is that per head?

17. If "scrub" sheep each will shear about 4 lbs. of wool worth \$.20 per lb. and raise a lamb that will weigh about 50 lbs. and bring about \$3.50 per cwt., what will the entire flock return to the farmer? What will each sheep return? Will he gain or lose, and how much?

18. If of a good breed, each will shear about 8 lbs. of wool and raise a lamb weighing about 70 lbs., worth \$5 per cwt. What will this flock return? What will each sheep return?

19. How much per head will be the farmer's gain on a well bred flock?

20. If it takes 12 bu. of corn worth \$.35 per bu. and \$3 worth of other feed to raise a pig until it is six months old, what is the cost of the pig to the farmer?

21. If a "scrub" it will weigh about 125 lbs. at six months and bring \$4 per cwt. Will the farmer gain or lose?

22. If a Poland China it will weigh about 400 lbs. and be worth \$4.75 per cwt. What is the pig worth? Will the farmer gain or lose and how much?

23. How much more will the blooded pig bring on the market than the scrub?

TO THE TEACHER: Ask pupils to furnish data on the weight of animals sold, the number pounds of milk, wool, etc., produced, the price of feed and products for similar problems.

14. Feeding the Stock.

We all know that farm animals should be fed, well fed, but we do not all know exactly *why* they need

feeding. Some of the reasons were mentioned in the last chapter. Let us name them all now:

1. To repair the waste.
2. To build up the body.
3. To keep the body warm.
4. To furnish energy for the body.
5. To make special products—milk, eggs, wool and the like.

As the horse works and the sheep or cow walks about in search of food or even in the ordinary functions of life the animal body is continually wearing away. What child has not noticed the horses grow poor during "spring's work" or observed that he himself has lost weight after great exertion! This loss in weight is the *waste* that must be repaired and for this repair food is necessary. Farmers always feed their horses more when they work them hard for this very reason.

Young animals must not only keep this waste repaired, but they must also increase in weight. For this reason they need more feed in proportion to their size. First, waste must be repaired before the animal can grow; then, whatever is left over, goes toward building up the body.

Work horses must feel strong; that is, they must be full of energy. But what is energy? Simply this: power to do work. A healthy man has more energy than a healthy boy. He has stronger muscles. He has greater power to do work and can do more of it. So the horse, to do work, must have muscular energy. His muscles are formed from the feed that he eats.

The milk cow must have more feed than the one that gives no milk. She must have food to build up her body, to repair the waste, to keep her warm, to furnish her with energy and, besides this, she must have

additional food out of which to make milk. Let her food supply decrease and she will at once show it in the amount of milk that she gives. You have all noticed this shrinkage when the pastures get "short" in summer. So, too, the sheep must have extra feed out of which to make wool and the hen requires special feed from which to make eggs.

If a man were to start a shoe factory, he would buy leather, pegs, nails and thread. These are the raw materials out of which he makes shoes. If he were to start a chair factory, he would buy lumber instead. That is, his selection of material would depend upon the kind of product he expected to manufacture. It is just the same in the feeding of farm animals. If milk is to be produced, then feeds that make milk must be fed. If eggs are wanted, then hens must be fed egg-producing foods. If work is to be done then feeds which supply energy must be fed. The horse is a machine to do work, the hen an egg-making machine, the cow a milk factory. Different feeds are the raw materials; eggs and milk, the manufactured products.

But, you say, "We know that lumber is needed to make chairs; leather, nails and thread necessary to the manufacture of shoes; but we don't know what will make milk and eggs." Well, you have grasped at the question that underlies the whole system of feeding and until the farmer determines for himself the best and most economical feed to be fed in order to produce the desired results, farming will not pay him its largest returns.

Feeds are conveniently divided into three classes—fats, protein, and carbohydrates. These are big words, but they are easily understood. Butter, lard, tallow, and all kinds of oils come under the head of fats. The

white of egg is almost pure protein; the sticky part of flour is protein; the scum on the top of boiled milk is protein; the principal part of cheese, the curd, is protein; lean meat is composed largely of protein; glue is protein; the hides, wool and feathers of animals are largely protein. You all know the odor of burned feathers; any kind of a substance that scorches and gives off that odor contains protein.

Starch, sugar and vegetable fibre are called carbohydrates. In a certain sense, fats, too, are carbohydrates, but they are usually put in a class by themselves. When carbohydrates are spoken of in this book fats are meant to be included.

Now, the great difference between protein foods and the carbohydrates is this: protein contains nitrogen and the carbohydrates do not. Nitrogen, as you will remember, is the substance taken from the air by the bacteria on the roots of the clover plant, and added to the soil. You will also remember it as one of the three plant foods that become exhausted from the soil.

By consulting the table at the end of this chapter you will readily learn the amount of protein and carbohydrates in the different feeding stuffs. A balanced ration is one in which there are about six times as much carbohydrates as protein. By a balanced ration, we mean the best ration to feed under ordinary conditions. For dry feeds, the combined weight of both the protein and the carbohydrates should be equal to at least one-half the total weight of the ration.

Feeds rich in protein are bone and muscle-formers. Those rich in carbohydrates are fat formers. Carbohydrates keep the body warm. If muscle is to be built up, then muscle-forming feeds should be fed. Farmers have learned that corn is a good feed for horses only

in the winter time. The reason is plain. Corn is rich in carbohydrates. These supply heat and produce fat. Oats are rich in protein, a muscle builder, and furnish energy. In spring time it is muscle and energy that is wanted, not heat and fat.

Sheep need feed rich in protein. Why? Wool is to be produced. Wool is composed principally of protein. Hens are expected to lay eggs. What should they be fed? Corn produces fat. A strictly corn diet should therefore be avoided. Eggs are composed largely of protein. Feed protein foods. The shells are composed of mineral matter. Lime, broken or ground bone, ashes and gravel should always be where the hens can get at them. In general: Nature has provided, in summer, proper foods for most farm animals and the nearer summer conditions can be duplicated the greater will be the farmers' success.

Pigs fed exclusively on a corn diet sometimes have weak bones. Why? Because there is not enough mineral matter in corn out of which to make strong bones. Growing pigs should be fed protein feeds with plenty of mineral matter in them to form bone and muscle. Later, when fattening time comes, fat-producing feeds, like corn, should be fed. In most foods there is an abundance of carbohydrates. The chief difficulty will be to provide sufficient protein to bring the ratio up to six to one, that is, so that there will not be more than six times as much carbohydrates as there is protein in the ration. In other words, for every six pounds of carbohydrates there should be at least one pound of protein. For young and growing animals it should be considerably more than that.

As has been stated, fat is usually put in a class by itself and not combined with the carbohydrates as it is

in this book. This is one reason: One pound of fat will produce about $2\frac{1}{4}$ times as much heat and energy as one pound of carbohydrates, so that one pound of fat is equal to $2\frac{1}{4}$ pounds of carbohydrates in feeding value. If we have 1 lb. of fat, $3\frac{3}{4}$ lbs. of carbohydrates and 1 lb. of protein in a given ration, we have a ratio of 6 to 1. In the following table the fat has already been added to the carbohydrates, so that, in order to find the value of a ration, it will only be necessary for you to use the following rule: RULE: Divide the total amount of carbohydrates in the ration by the total amount of protein.

If the result is greater than 6, more protein should be added. This ratio is generally considered the best for all animals except those that are fattening when a larger amount of cheaper carbohydrates can be fed with profit. Full grown animals can get along very well on a much smaller proportion of protein, while young, growing animals require a larger proportion than this because protein is a bone and muscle builder.

The great problem of economical feeding is to find those feeds that will produce the desired results with the least possible expense. It is not necessarily the cheapest feeds that will do this.

Table showing digestible nutrients in feeding stuffs:

POUNDS PER TON.		
Kind of Feed.	Protein.	Carbohydrates.
Clover hay	170	920
Red top hay	95	980
Mixed hay	88	880
Timothy hay	56	920
Corn fodder	50	710
Oat straw	24	920

Rye straw	12	830
Wheat straw	8	740

POUNDS PER HUNDREDWEIGHT.

Cotton seed meal	40	40
Linseed meal	32	42
Malt sprouts	18	46
Wheat bran	12	46
Wheat middlings	12	58

POUNDS PER BUSHEL.

Dry peas	10	32
Rye	5	30
Barley	4	32
Corn	3½	40
Oats	3	19

Table showing approximate amounts of protein and carbohydrates required daily by farm animals of average size:

Animal.	Protein.	Carbohydrates.
Dairy cow	2 lbs.	12 lbs.
Work horse	2 lbs.	12 lbs.
Calves under 1 yr... 1 lb.		6 lbs.
Pigs, growing ½ lb.		2½ lbs.
Lambs, growing ... 1-5 lb.		1 lb.

NOTE: This amount varies with the size and age of the animal. Fattening stock can be profitably fed a greater allowance of carbohydrates.

Problems.

1. How many pounds of protein in a bushel of oats? With oats at \$.30 per bu., what does this protein cost per lb.?

2. How many lbs. protein in bu. of barley? With barley at \$.44 per bu., what does protein in this form cost per lb.?

3. Which is the cheaper feed to feed at these prices? How much?

4. What is the cost per lb. of protein in rye at \$.60 per bu?

5. What is the cost per lb. of protein in corn at \$.35 per bu.?

6. At the above prices which is the cheapest feed to feed?

7. Which is probably the best feed to feed for fattening purposes? Why?

8. Suppose all kinds of hay sell at the uniform price of \$8.00 per ton. What is the price of protein per lb. in each of the four kinds of hay given above?

9. Which is the cheaper feed?

10. What is the best kind of straw to feed and why? How do we find the "nutritive ratio"? What is the nutritive ratio of clover hay? Is it a balanced ration?

11. Find the nutritive ratio of all the feeds given in the tables.

12. Which are nearest "perfect" feeds, i. e., which have a ratio of about 6 to 1?

13. Which are the poorest feeds, i. e., which have the lowest ratio of protein?

14. Which are the feeds having the largest proportion of protein?

15. Are any of the feeds given in the table so poor that, in themselves, they are practically worthless? If so, name them.

ILLUSTRATION.—One ton of mixed hay contains 88 lbs. protein and 880 lbs. carbohydrates. Its ration is 10 to 1. Let us mix it with some other feed to bring the ratio up to about 6 to 1. We will try peas. We

will feed 1 bu. of ground peas with every hundred lbs. hay.

100 lbs. hay contains 4.4 lbs protein, and 44 lbs. carbo.

60 lbs peas contains 10. lbs protein, and 32 lbs. carbo.

Mixed, 160 lbs. of the ration contains 14.4 lbs protein, and 76 lbs. carbo.

Dividing carbohydrates by protein (76 by 14.4) we get a little more than 5 to 1. We have more protein than we need. Let us try again, with $\frac{1}{2}$ bu. peas instead.

100 lbs. hay contains 4.4 lbs. protein, and 44 lbs. carbohydrates.

30 lbs. peas contains 5. lbs. protein, and 16 lbs. carbohydrates.

Mixed, 130 lbs. of the ration contains 9.4 lbs. protein, and 60 lbs. carbohydrates.

Again dividing (60 by 9.4) we get 6.3, about right, and a much cheaper feed. Now, how much of this ration shall we feed to a dairy cow? The table shows us that a cow needs about 2 lbs. protein daily, so this will be about enough for five days. One-fifth of each feed will give us as a result 20 lbs. of hay and 6 lbs. of peas for the daily ration.

16. With the ration given in the illustration, how long will a ton of hay last a cow?

17. How many bushels of ground peas will be required in the same time?

18. What will it cost to feed the cow for this time with hay at \$7.00 per ton and peas at \$1.00 per bu.?

19. Suppose she gives 25 lbs. of milk daily on this ration. With milk at \$1.20 per cwt., what is gained?

20. Make a ration of clover hay and corn in the

same way and figure its cost.

21. Make a ration of oat straw, clover hay, and ground peas.

Experiment until you get about the right ratio, being careful not to use more grain than is necessary.

22. Figure its cost at these prices of feed.

23. How long will your ration feed a work horse? What is the cost of this feed for a horse for one day?

24. Make a ration of oats, hay and straw for work horses. Add a little cotton seed meal to supply protein. When you get the ration "balanced" figure its cost. You may have to try several times, but don't give up. Figure its daily cost per horse and compare with cost in last problem.

TO THE TEACHER: Ask pupils to tell price of feeds, kinds grown on farm at home, stock to be fed, etc., for data for other feeding problems.

15. The Three C's.—Cows, Corn and Clover.

All, who understand the conditions, are agreed that diversified farming will yield the largest returns with least waste to the fertility of the soil. But what is meant by diversified farming?

When a farmer grows wheat to sell and little else, that may be called wheat farming. If he depends upon tobacco alone, we call that tobacco farming. If he plants his entire farm to corn and sells the corn or feeds it to hogs for the market, we may properly call that kind of farming, corn and hog farming. Whenever he engages in two or more kinds of farming his work becomes "diversified." He is then a "diversified farmer." The greater the number of different things he raises the greater the diversification.

But, we have agreed that it is not a good thing to

lowing corn, offering an excellent opportunity for to raise grain or tobacco exclusively, for the market. We have learned that this kind of farming soon wears out the soil and does not pay in the long run. We have learned, too, that milk products contain little soil matter and are therefore easy on the soil. We have observed that the stock usually sold off the farm contain but small quantities of soil matter in proportion to the feed that they consume. We, now, know that clover feeds upon the free nitrogen of the air and thus increases the store of nitrogen in the soil. We have learned that nitrogen is the principal ingredient in protein, the feed most sought after by the progressive farmer. From an examination of the table, we find that clover hay is richer in protein than any other kind of hay. A little calculation shows us that it contains about twice as much protein as redtop, three times as much as timothy, eight times as much as oat straw, fifteen times as much as rye straw and thirty times as much as wheat straw. A larger amount of clover can be grown per acre on average land than of any other hay crop and since it adds nitrogen to the soil it is by far the best hay crop to raise.

Another examination of the table reveals the fact that corn is one of the richest of grains and since corn fodder is the richest of fodders in feeding value and yields heavily, corn is an excellent crop to raise.

Cows, corn and clover are a splendid combination for other reasons. Corn requires frequent cultivation and the soil is improved thereby. Weeds are exterminated, the ground is plowed deeper and the manure is thoroughly mixed with the soil. Besides being an excellent feeding stuff and adding nitrogen to the soil, clover is a splendid crop to sow with oats, fol-

tation of crops, the advantages of which have already been pointed out.

Cows are a constant source of income to the farmer and at the same time they supply him with the cheapest and best of fertilizers. You will remember that if the manure from a single cow were carefully saved during the year and applied to the soil its value would be nearly \$20, besides improving the texture of the soil to a marked degree.

With cows, corn and clover, sheep and hog raising are made possible and profitable. The cows and clover furnish milk and pasture for the growing animals, while corn is one of the best of fattening feeds. Tobacco raising can also be engaged in if the farmer is careful not to exhaust the fertility of his soil by too frequent cropping with tobacco. Sugar beets, too, are a source of income to the farmer, and if the factory is so located that the pulp may be had for feeding purposes or for manure, they also can be grown with little loss to the soil. Sugar is a carbohydrate and, like butter, it is formed from the food matter which the plants get from the air and the water, but it must be remembered that beets are heavy feeders and if the return of the pulp is impossible, they, like tobacco, will soon wear out the soil.

The reader must not make the mistake of thinking that the system of diversified farming outlined here is necessarily the best system. The greatest flexibility is allowable, depending upon the location of the farm, the character of the soil, nearness to factories and markets and various other conditions. But, it is easily seen, that in Wisconsin at least, cows, corn and clover should form the basis of any system of diversified farming.

Problems.

1. A ration for cows consists of one ton of clover hay with 10 bu. each of ground corn and oats. How long will this feed a cow feeding two lbs. of protein daily?

2. What will be the total and daily cost of this ration with hay at \$7.00, corn at \$.40 and oats at \$.30?

3. What will it cost to keep a herd of 12 cows for 200 days on this ration?

4. On another farm, timothy hay, oat straw, bran and oats are mixed in the following proportions: One ton each of hay and straw, 20 bu. of oats and 1,000 lbs. of bran. Is this a balanced ration?

5. How long will this ration keep a cow? A herd of 15 cows?

6. With hay worth \$7.00, oats \$.30, straw \$4.00, and bran \$.80 per cwt., what is the total cost of this ration? The cost per cow per day?

7. What will be the cost of feeding a herd of 12 cows for 200 days on this ration?

8. Compare the rations in problems 1 and 4. Which costs the more? Which is the nearest to balanced ration? Which is likely to produce the better results in feeding?

9. Suppose 20 lbs. of each ration to be the daily allowance for each cow. How long would each ration last a cow? What would be the daily cost?

10. Which is the cheapest ration under these conditions?

11. It must be remembered that in order to get the best results a cow should be fed about 2 lbs. of protein daily. How much does she get with each ration?

12. Disregarding the value of the carbohydrates, what is the cost of the protein in each ration?

13. A lack of protein means a smaller quantity of milk. Suppose cows fed on 20 lbs. of the clover-corn-oats ration gave 20 lbs. of milk daily, while those fed on the hay-straw-oats-bran ration gave but 15 lbs. of milk daily. With milk at \$.80 per cwt., what is the gain on each kind of feed?

15. It must also be remembered that the right kind of feed produces the richest milk. Suppose the milk from the cows fed on the first ration is worth \$.85 per cwt., while that from the cows fed on the second ration is worth but \$.65 per cwt. Find the value of the milk produced monthly (30 days) by a herd of 10 cows.

16. Find the cost of the feed for the same herd for the same time.

17. Now determine if the cheapest ration is the most economical.

18. Which is the best ration to feed under the above conditions?

19. Make rations for all kinds of feeds and figure the cost of the protein therein.

20. When you have finished, compare results and note that cows, corn and clover seem to go well together and give the best results.

TO THE TEACHERS Ask pupils to furnish data from home—number of cows milked, amount of milk produced, amount and cost of feed fed, price of milk, etc.—for similar problems.

16. Home and School Gardening.

Home and School Gardening has been encouraged to a considerable extent in the country during the past

two years through circulars furnishing information and the free distribution of flower and vegetable seeds. The results observed warrant continuance of attention to the work of gardening. While all schools have not given particular attention to gardens on school grounds there has been a deeper interest shown in home gardening in almost every district in the county. Conditions have been such in many districts that it was wise for the teachers and pupils not to undertake the running of a garden on school grounds. However, there certainly has been no good reason for not encouraging home gardening through the schools. The coming school-year we wish every teacher to undertake the work early and encourage it during the entire year.

Every family in this country should be interested in a garden because of the comfort and satisfaction afforded by having one in or about the home. If the home lot is too small for a garden you might use the porches and windows. In most cases we find rich, fertile land, hardly being used at all, about the homes of citizens of this great agricultural county. It is a fact that cannot be successfully contradicted, that no land of equal size pays one-twentieth part as well financially, as that land allotted to gardening. It is not so much the money value afforded to a family by a garden as it is the pleasure and joy a well kept flower or vegetable garden offers. Our mad rush for money often blinds our eyes to the beautiful plants, flowers, shrubs and trees about our homes. We need to cultivate a love for our environment.

Interest in gardening furnishes one of the best ways of stimulating a love for the good, the beautiful and the inspiring things of life. It is difficult to live in harmony with nature's laws without having an ap-

preciation of the good—the pleasing things—which the plant and animal world provide for us. The man who does not love flowers, trees, birds, the running brook, the quiet glen, and beautiful fields of corn and grain, is to be pitied. One of the purposes of the work in gardening is to cultivate a love for nature and nature's teachings.

The treatment of the subject "gardening" in one chapter must of necessity be very general. Gardening includes a large part of agriculture, horticulture and floriculture. We must deal primarily with flower and vegetable gardening. We have been gardening too extensively, generally speaking, in this country, and not intensively enough to make the work of gardening as scientific and enjoyable, and as profitable as it might be. On account of this extensiveness we have made the work of gardening rather burdensome to all. It is advisable to have just a reasonable size plot for a lawn, or for a flower garden, or for a vegetable garden. The flower garden should be placed on one side of the house—never right in front of the house. A flower bed right in the middle of a lawn has a bad effect on the general appearance of the lawn. It is a good plan to have the flower beds and shrubbery separate the lawn from the vegetable garden. As a rule we have been trying to overdo the matter of having flowers, shrubs and trees on our lawn. The massive appearance of things spoil the general beauty of all. It takes time and study to plan a flower garden well; it requires time and study to arrange trees and shrubbery to look well about a home; it requires attention and careful thought to arrange a vegetable garden properly.

A beautiful lawn and good gardens add so much to

a home that if once undertaken they will be properly appreciated and never neglected. First, a garden or a beautiful lawn pays because it is restful to those about the home; second, a well kept lawn or garden pays because it is beautiful and pleases those who see it; third, a good garden or a nicely kept lawn pays because the value of the home or place is increased. The seasons and conditions vary so much in different years and different places that no hard and fast advice can be given for performing the work connected with gardening, yet a few brief hints or suggestions may prove of service to those interested.

1. During the winter season it is advisable to make a careful study of plans for gardening; test and study seed; give attention to bulbs and shrubs; consider vines, shade trees, rose bushes and all such things as are grown with success and satisfaction in this latitude.

2. A study of the soil should be made before beginning the garden work in the spring. There are certain plants well adapted to sandy soil, others grow better on clay or loamy soil. Determine what fertilizing should be done beforehand, so that when time for working in the garden begins, you will be able to go about it intelligently and scientifically. In the preparation of the soil the following points are to be taken into consideration:

- a. Do not stir the garden soil deeper than the top layer.

- b. If the garden is sodded, spade or plow, and turn under so that the grass and roots are well buried. In case it is difficult to cover the grass and roots well, shake all the dirt from the roots and pile the grass outside the garden.

c. Harrow or rake until the soil is fine, removing sticks, stones, etc.

d. The depth to which seed should be planted is determined by the kind of plants to be raised and the nature of the soil. Light sandy soil, which is apt to dry out rapidly, requires the seeds to be planted deeper than clay soil. Or soil that is sheltered from the wind need not have seeds planted so deeply in it, because wind dries out soil very rapidly.

3. Suggestions on the size, shape and position of beds:

a. If the beds intended for flowers or vegetables can be worked from both sides, make them about four feet wide; if they cannot be worked from both sides endeavor not to have them more than three feet wide. Two and one-half feet may be used effectively.

b. As a rule it is advisable to make the beds against some background, i. e., a fence, wall, shrubbery, etc.—not out in the middle of a plot. They may be so arranged that certain kinds of plants can be used as screens for objects it may be desired to hide.

c. Beds for vegetables should be planted in rows far enough apart to admit of passing between them in order to hoe the ground.

4. Suggestions on sowing and planting:

a. The seeds furnished by the government and those purchased from the best seed firms are put up in convenient packages and have printed on them directions as to the time and method of planting. Common sense and good judgment must be exercised by us in the planting and sowing of seeds, and, of course, we must be governed by the char-

acter of the season and soil. Onions, potatoes and sweet peas may be planted as soon as the ground can be worked.

b. Flower seeds should, as a rule, be sown or planted crosswise in the beds.

c. Cover all small seeds, such as phlox, lettuce, radish, etc., very lightly with fine earth, and pack by tapping the ground with the back of a hoe.

d. Seeds the size of parsnips, beets, carrots, etc., should be covered to the depth of an inch, and in rows two feet apart.

e. Plant sweet peas two or three inches deep. They should be planted in two rows close together—rows running north and south—six inches apart, and allowed to climb a wire netting or trellis placed between them. Nasturtiums may be planted two inches apart.

f. Plant bush beans three inches deep two feet apart. Plant sweet corn in hills three inches deep, three feet apart.

g. In transplanting cabbages, tomatoes, pansies, etc., make a hole deep enough to take the plant to its first leaves. If hot and dry, shield plant for a time with an old shingle. Be sure and water plants often. Transplant on a cloudy day or towards evening.

5. Cultivation of plants:

a. Use every precaution to preserve the moisture of the soil. Stir the surface lightly but often. Keep weeds and grass removed. Properly thin out plants. See that plants have plenty of water. Light sprinkling is almost as bad as no watering at all.

b. See to it that the plants have a sufficient amount of sunshine. Choose exposed or shaded

locations according to the habits of the plants. In every case the plants should be far enough apart to allow them to make full growth. Corn should be planted three kernels to the hill. Water melons, squashes and cucumbers should be planted in raised hills, eight or ten seeds in a hill. Such plants are likely to be troubled with insects. After they have made a good growth thin out plants to four or five well separated plants in a hill.

c. Keep a sharp lookout for insects. Better examine leaves frequently for insects' eggs. The old remedy of Paris Green mixed in water is about as good as any. Its application needs no explanation. Birds are usually as helpful as anything in the protection of our plants, therefore encourage them to live about your home. Someone has said, "Birds are worth more than insect powder and cheaper."

Landscape Gardening.

A few words on landscape gardening may aid in improving and beautifying home and school grounds. Plants and shrubs are beautiful if well grown. Florists' catalogs give valuable suggestions and directions for the cultivation of vines, plants and shrubs. We note, that in all landscape gardening, two principles must be observed. First, in order to produce the desired effect, care must be taken in locating plants, trees and shrubbery so as to hide objectionable features of the home or school grounds from the view of the passerby. Second, plants, trees and shrubs must be so arranged as to bring out in bold relief those features of the grounds and buildings that are in themselves attractive.

In order to observe the two principles we need to make a study of the grounds, the hardiness of the plants, trees and shrubs, their adaptability for growth under stated conditions, their shape, color of foliage and of blossom, etc. There are probably not more than a score of shrubs desirable for planting under conditions such as we find in Wisconsin. The following list of trees and shrubs have been planted upon the school grounds at Jefferson and are doing very well:

1. Arbor Vitae.
2. Colorado Blue Spruce.
3. Douglas Spruce.
4. Hemlock.
5. Norway Spruce.
6. Scotch Pine.
7. Cut-leaf Birch.
8. Tartanan Maple.
9. Common Barberry.
10. Purple Barberry.
11. Thumberg's Barberry.
12. Common Dogwood.
13. Golden Elder.
14. Papan Lilac.
15. Persian Lilac.
16. Syringia or Mock Orange.
17. Rosa Rugosa.
18. Russian Olive.
19. Tartarian Honey-suckle.
20. Spirea Van Houtei.
21. Red Dogwood.
22. Snow Ball.

23. Virginia Creeper
(vine).

All the above plants, shrubs and trees have been carefully tested at the Agricultural Experiment Station at Madison and found to be adaptable to the conditions in Wisconsin. The plants, shrubs and trees in the above list may be obtained from or through the Experiment Station.

List of Plants That May Prove Suggestive.

1. VEGETABLES.—Potatoes, onions, sweet corn, pop corn, cabbages, tomatoes, bush beans, lettuce, cucumbers, radishes, turnips, parsnips, beets, parsley, etc. etc.

2. FOLIAGE PLANTS.—Castor bean, canna (roots), calladium (bulbs), sunflower.

3. VINES.—Scarlet runner, morning glory, wild cucumber, moonvine, Madeira vine, Japanese hop vine, gourds of all kinds, ivy, sweet peas, cinnamon vine (bulb).

4. FLOWERS FOR BEDDING.—Alyssum, asters, bachelors' buttons, calendula, calliaopsis, candytuft, coreopsis, cosmos, four o'clock, gladiolus, hollyhock, marigold, mignonette, nasturtiums, petunia, phlox, poppy, salvia, verbena and zinnia.

The above list is far from complete but it gives an idea of the plants commonly grown in Wisconsin. It is better to take a few and make a "hobby," so to speak, of those few. You are more liable to have better success than if you undertake the study and raising of many. Try and cultivate a love for gardening. Goethe writes the following lines, showing his love and appreciation for a garden:

“Spacious and fair is the world; yet oh! how I thank
the kind heavens
That I a garden possess, small though it be, yet mine
own,
One which enticeth me homeward; why should a gar-
dener wander?
Honor and pleasure he finds, when to his garden he
looks.”

17. Why We Need an Agricultural School.

AGRICULTURAL SCHOOLS.

Almost every foreign land has agricultural schools. European countries and Canada are leading this country in agricultural education. France has over 100,000 school gardens. Germany, Denmark, Sweden, and Finland have Agricultural schools for every 25,000 rural inhabitants. Canada, under the leadership of Commissioner Robertson, is placing an Agricultural training within the reach of every farmer's child.

Agricultural schools consider along with English literature and mathematics, work on soils, plant life, animal life, carpentry and other manual training, economics and domestic science. All work is related to farm life.

FARMERS IN NEED OF JUST AS GOOD IF NOT BETTER TRAINING THAN OTHER CLASSES.

The farmer who is to be successful in the future must not only be intelligent in his farm work, but he must be a business man as well. Means of transportation makes it possible for farm products grown at a great distance to be laid down in home markets. Yes, a farmer in order to be financially successful needs more of an education than any other class of men,

except it be the professional. A man working in one of our factories does about the same thing, hour after hour, day after day, yes, year in and year out, while a man on the farm in the course of a day or a week may have a thousand things to think about and do.

DOES EDUCATION PAY?

Not long ago very interesting statistics were compiled showing that a people's productive power compares with the amount of time and money expended in popular education. The States of Massachusetts and Tennessee were compared. Massachusetts spends about \$12,000,000 and Tennessee about \$2,000,000 for educational purposes each year. Massachusetts produces about \$1,300 per family of five each year, Tennessee produces but little over \$500 per family. These comparisons are carried out much farther to show that it pays to expend money for education. The use of faculties trained to the widest range of enjoyment is what makes for fullness of life. Education gives ability to think, to know, to do and to manage life and things. The right kind of training always pays. No one will claim that we are giving the young people in this county a fair chance to gain the ability to manage things on the farm. We have an opportunity to do so, if we but accept the tender made by the state to institute a school that will furnish the training.

IS THERE A DEMAND FOR AN AGRICULTURAL SCHOOL?

It has been only forty years since Congress passed an act to provide for the establishment of the first school where instruction could be given in Agricultural and in the Mechanic arts in each of the states of the

Union. To-day every state and territory have splendid schools of Agriculture. Some of the states have large central schools only, while others have provided a central and branch schools. Our state has a large central school at Madison which furnishes an inducement to young men between 18 and 25 years of age. The school is so popular that it is necessary to turn students away every year, the supply being far greater than the school can handle. The County Agriculture school furnishes inducements to the boys and girls from 14 years up; it cultivates a love for farm life. It is a school that is to the farmers what the high schools in cities are to the citizens in the cities. No one who has studied the results of the Agricultural school at Madison will dare to contradict the statement that the school has paid for its expenditure a thousand times to the farmers of the state. The County school is in no way a competitor to the institution at Madison. The County school takes the boys and girls fresh from the country schools and affords them at public expense the corresponding educational advantages afforded to the city children in the high school. We believe in equal educational advantages at public expense to all. Why should the boy on the farm be denied four or five years educational privileges that are granted the boy in the city? It is unfair; it is unjust and should be remedied. The school we propose to institute will extend to the farmers' children similar advantages now offered through the high school to the children residing in villages and cities. High schools are putting in the practical courses, business courses, stenographic courses and manual training. It behooves the farmers to recognize the need of a course of study that will cultivate a love for agricultural pursuits.

HOW ABOUT THE CITIZENS OF CITIES AND VILLAGES BE-
ING BENEFITED BY THE COUNTY SCHOOL?

The question is a proper one! It may be answered in a general statement: whatever benefits the community or country around or about a city or village benefits the city or village. This statement needs no discussion. Some of the farmers and many of the farmers' wives of the future are coming from the cities and villages. However, the domestic science department appeals equally to girls, young ladies and women in cities, villages and rural communities. It does seem strange, but this is true, the heartiest support for the movement now is coming from cities and villages. Farmers are honest and mighty conservative; they are slow to take up with modern conveniences, but when they do, nothing is left undone to make them effective and of value. To-day there are thousands of farmers in this county enthusiastic over the institution of the school. A farmer ought to be the last one to raise an objection to the establishment of a County Agricultural school.

We believe that whatever will improve farming surrounding a city or village will correspondingly influence for good the city or village; while on the other hand it is possible to build up cities and not have a corresponding effect on the country adjoining the cities. Take for example the deserted farms in Massachusetts, near the large manufacturing cities, or the undeveloped ranches about the mining cities in Colorado. Love for farm life and for household duties should be nourished, but can only be through knowledge of its importance, its pleasures, its blessings and its profits taught in schools instituted for the purpose.

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