ELEMENTARY AGRICULTURE

HATCH AND HASELWOOD

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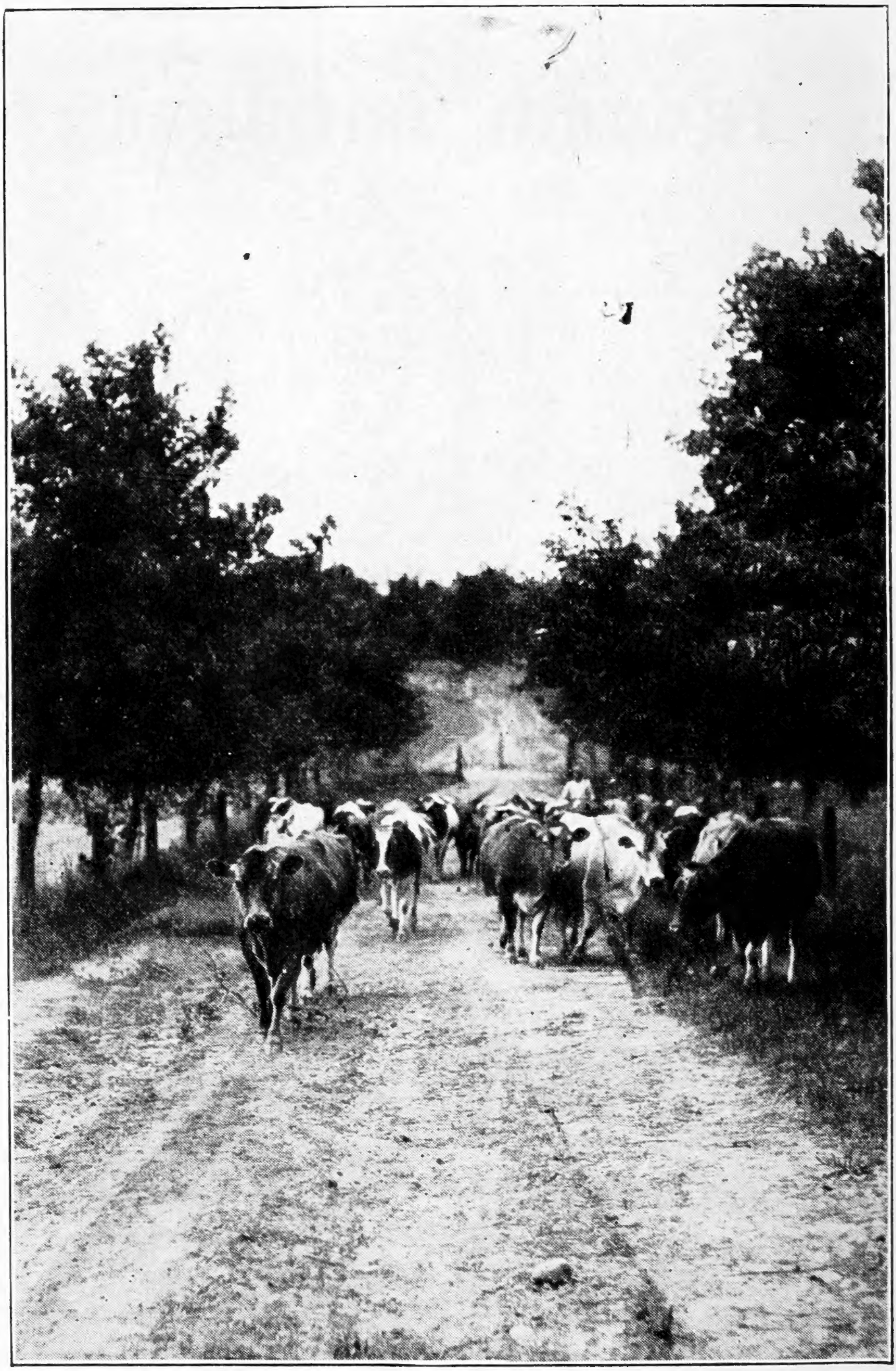

ELEMENTARY AGRICULTURE

WITH

PRACTICAL ARITHMETIC

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PRINCIPAL, SCHOOL OF AGRICULTURE AND DOMESTIC ECONOMY, WINNECONNE, WISCONSIN

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CHICAGO

ROW, PETERSON & COMPANY

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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 familiarity with their *use* rather than in the numerical results obtained from them. We extend our thanks to L. Lewellin & Sons, Percheron Breeders, Waterloo, and J. W. Martin, Red Polled Breeder, Richland Center, Wis. Grateful acknowledgment is also made to the University of Wisconsin for material used in illustration, and to the friends who have given us valuable assistance and suggestions. H. & H.

CONTENTS.

PREFACE

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 to-morrow, who is to-day the farmer's boy, must know how to farm better than his father does. In order 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 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 in such necessary knowledge. The language used is plain and simple, and may be readily understood by any bright boy or girl of twelve 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. Wherever appropriate at the close of a chapter some experimental studies are added. It is believed that the working out of these exercises will enable the farmer's children to solve ordinary practical problems arising on the farm, and prepare for 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 to 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.

It is a wholesome indication of the trend of educational thought, that the legislatures of several states have made compulsory the study of agriculture in the district schools.

We trust that this little book, by combining the subjects of arithmetic and agriculture, will be of material assistance to teachers in their efforts to do effective work in both branches.

H. & H.

ELEMENTARY AGRICULTURE

CHAPTER I

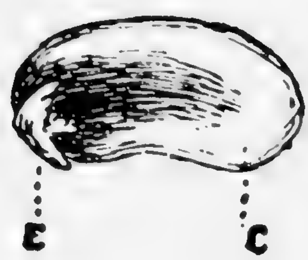
THE GROWTH OF PLANTS

What Makes Plants Grow.—If you were 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 perish without them. At some later time, we shall tell you what these foods are, in such a way that you will readily recognize them at sight. For the present, however, we shall observe the way in which plants grow and find out, if possible, the source from which they get their first food.

The little pig, or lamb, or calf lives and grows upon the milk of its mother until it is large enough to search 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?

How Plants Store 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

A BEAN PLANT.
A DICOTYLEDON.



A SPLIT BEAN.
E—Embryo.
C—Cotyledon.

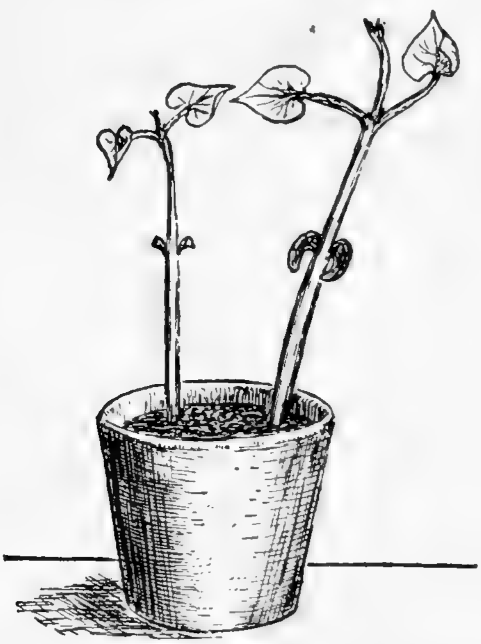
A CORN PLANT.
A MONOCOTYLEDON

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 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.

Classification of Plants.—In the spring, as soon as the young plants 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 name 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 the systematic study of botany. 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 kept in a light, warm place. You can then examine these seeds from day to day and watch their growth.

Germination.—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 the plant 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.

Why Plants Store Up 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 are large enough to get it for themselves directly from the soil. Make 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.



Drawing from life, showing effect of cutting away a portion of the cotyledons on the growth of the plant. The same results will be obtained by using small and large seeds. Try it.

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.

Necessity of Moisture, Heat, Air, and Light.—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 dense shade, and without sunlight plants always have a yellow and sickly appearance.

Summary.—Good seeds and proper conditions of soil, moisture, air, heat and light are essential to plant growth, and a part of 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.

A good bulletin on the subject treated in this chapter may be had *free* on application to the Secretary of Agriculture, Washington, D. C., or to your Senator or Representative in Congress.

Write for Farmers' Bulletin, No. 111.—The Farmer's Interest in Good Seed.

Experimental Study of Seeds.

1. Place a folded newspaper in the bottom of a cigar box, a crayon box, or on a plate; moisten with water, and place another folded newspaper over the first one. Between the papers place one hundred of the seeds to be tested, and set aside in a warm place for a few days. Keep the paper moist but not wet. At the end of a week the number of sprouted seeds represents the percentage of good seeds.

2. Select ten very small seeds and an equal number of very large seeds of the same kind, and plant

them at equal distances in parallel rows in the same box. Note which make the most rapid and vigorous growth during the first week; the second week; the third week.

3. Select seeds from a supply that has been previously tested and found to be good. Place a dozen of these seeds on paper in each of three dishes. Cover the seeds in the first dish with water and keep them completely covered. In the second dish keep the seeds half covered with water. In the third dish keep the paper on which the seeds are placed always moist, but do not allow water to stand around the seeds. Which seeds germinate most rapidly? Why? What finally happens to the seeds immersed in water? Explain.

4. Plant some seeds in moist soil and others in the same kind of soil kept very wet. Note the difference in germination and growth. Explain.

5. Start some beans growing well in each of two boxes side by side on the window sill; then cover one lot with another box or a paper cone. At the end of a week remove the cover and note the effect that absence of light has had on the growth and appearance of the plants.

6. Provide for the growth of seedlings against glass. This may be done by planting seeds in a glass jar, a tumbler, or even in an old crayon box set on end, the other end removed, and a piece of glass put in the place of the cover. By pressing the seeds close against the glass their germination and growth can be easily observed from day to day.

Table I.

Table showing legal weight per bushel of farm products in the majority of states:

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.

A bushel requires about 1¼ 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 cubic feet.

A cubic foot of water weighs 62½ 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 per acre of the above at 80c 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 90c 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 90c wheat can be grown on an acre, how many pounds is that per acre? 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 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 8 acres per day how long will it take to seed a 40 acre field? What will it cost at $2 per day?

14. At 50c per acre what will be the cost of cutting this crop?

15. It will cost about $0.25 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 $0.80 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 so and find the result.

20. With a crop of 50 bushels of shelled corn per acre, worth $0.40 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 the current prices of corn, oats, barley, hay, etc. What is considered a good crop per acre of each of these? Then estimate 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. It will be observed that there is a logical order in arrangement of the problems; in many cases the conditions necessary for the solution of a problem are found in one preceding it.

CHAPTER II

THE PLANT AND WATER

Kinds of Plant Foods.—We have already seen that the seed furnishes the food for the little plantlet until it is large enough to get food from the soil, in much the same way that the mother cow furnishes milk for her calf until the calf is large enough to find its own food. If asked, "What are the foods which a cow eats?" you would probably answer, "Grass, hay, straw, 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 well known to you as cattle foods. The most familiar are: water, lime, iron-rust, soda, ammonia and sand. The other six are: magnesia, potash and four acids, viz.: carbonic, phosphoric, hydrochloric and sulphuric.

Plants and Water.—Now let us consider these plant foods. Every one knows that plants cannot live without water, but few persons stop to think of the enormous amount of water consumed daily by an acre of growing vegetation. You may make this experiment: Put exactly the same amount of water in each of two similar 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 by

Relative amounts of water at the beginning of the experiment.

Relative amounts of water at the end of the experiment.

measuring compare what remains in the two vessels. 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, there should be equal evaporation. 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.

How Plants Use Water.—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 in liquid form through its roots. 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 such as salt, that dissolve in water, are said to be soluable, and the plant fluid containing these dissolved substances is called sap. The solid food, with 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. This is the reason why plants need so much water. Grain uses up thousands of tons of water per acre during the growing season.

Moisture Can Be Regulated.—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.

Experimental Study of Water in Plants.

1. Place a clean, dry glass vessel over a growing plant. A fruit-jar or a tumbler will do. In a few hours what appears on the inner surface of the glass? Where does this moisture come from? How can you show that it does not come from the soil?

2. Place a thrifty clover plant in a clean, dry glass jar and seal it tight. In a few hours what appears on

the inner surface of the bottle? Explain what you observe.

3. Place some cut flowers that have begun to wither in a vessel containing cold water, immersing all except the blossoms. Set in a cool place for several hours. What change occurred? Explain.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 46.—Irrigation in Humid Climates
No. 116.—Irrigation in Fruit Growing.
No. 138.—Irrigation in Field and Garden.
No. 158.—How to Build Small Irrigation Ditches.

Table II.

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.

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 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 weigh that falls during the year on a square yard of ground? 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. Suppose potatoes contain three-fourths of their weight of water. How many pounds of water in a bushel of potatoes?

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

8. By the aid of data furnished by the members of the class make and solve at least ten other similar problems.

CHAPTER III

PLANT FOODS

Lime.—Lime is known to every child. It is known, too, that lime will dissolve readily in water, and thus become available for plant food. Large quantities of lime are found in the soil. Of course, it comes from the lime rock.

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

The Use of Acids.—But what is an acid? The commonest kind of acid, 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 tea-spoonful 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.—Sand needs no discussion. By some it is believed to be the food that gives stiffness to the stalks of barley, oats and other grains, which, when grown on rich bottom land, usually "lodge" partly because they are unable to get sufficient sand from the soil.

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

Carbonic Acid.—Carbonic acid 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 make. 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 with a straw blow bubbles through it. 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. Make 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.

Magnesia.—Magnesia is known to most of us. It is the white powder used to whiten the skin and prevent soreness from the wind.

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

Sources of Plant Foods.—The water, soil and air are the sources of plant foods. The air contains two —ammonia and carbonic acid—soil and water 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.

Plant Starvation.—Now, if these foods are not found in sufficient quantity 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 that is securely locked up so that he can not get at it. One problem which the farmer is called upon to solve is, how to make the soil of his farm more easily soluble.

Effect of Too Much Food.—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 noxious weeds is to cover them with salt, lime, or ashes, so that they will get more than one part of this food in every thousand parts of water that they use.

Soil Exhaustion.—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 greater will be the loss. Tobacco and root crops, being so much heavier, exhaust 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 rule for fertilizing soils will be taken up later.

Experimental Study of Plant Foods.

1. Make a collection of the following plant foods: Lime, iron-rust, soda, ammonia, magnesia, acid, sulphur, and sand. Place each specimen in a small bottle and label properly.

2. *Potash* may be easily prepared from wood ashes. Place about two quarts of wood ashes in a pan, cover with water, and let stand for a few hours, stirring frequently. Then allow the ashes to settle and pour off the clear liquid into another tin dish. Place this lye on the stove and evaporate all the water. The dry powder found on the bottom of the dish is potash. A little potash dissolved in water makes it feel soapy. This "soapy feel" is the test for potash. Put some of the potash in a small bottle, label, and add to the collection.

3. It is very difficult to obtain uncombined *phosphoric acid.* The easiest way to procure it is in combination with lime. Burn a bone to whiteness, crumble

it up, and put it into a bottle. This powder is a combination of lime and phosphoric acid. Now, if a little water is poured over this powder and a small quantity of sulphuric acid added, the lime will soon settle and the clear liquid will be phosphoric acid.

4. To prepare *nitrogen,* provide a glass bottle with a large neck, a piece of wire, a bit of cotton, a little alcohol, and a shallow dish containing lime water to the depth of two inches. Twist one end of the wire around a small piece of cotton, and then bend it nearly double about three inches from the end bearing the cotton. Dip the cotton in alcohol and light it. Resting the wire loop on the bottom of the dish with the torch standing upright, place the inverted empty bottle over the torch so that the bottle rests on the bottom of the dish and the bend in the wire. Soon the flame dies out because the fire uses up the oxygen in the bottle. The oxygen has united with the carbon of the alcohol, forming carbonic acid gas. Without taking the mouth of the bottle from the water, remove the torch, put one hand under the mouth of the bottle to close it tight, invert the bottle quickly, and shake. The lime water becomes milky, showing that the carbonic acid gas has been taken up by it. The colorless, odorless, invisible gas now remaining in the bottle is *nitrogen.*

Plunge a lighted taper or splinter into the gas and the flame is immediately extinguished, showing that the gas is not air.

Table III.

Table showing proportions of fertilizing substances in farm crops:

OUNCES PER BUSHEL.

Crop.	Nitrogen.	Phosphoric 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.	Nitrogen.	Phosphoric 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 yields 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 3½ tons per acre? 4 tons? 5 tons?

7. A meadow hay crop of 2 tons per acre? 2½ 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.

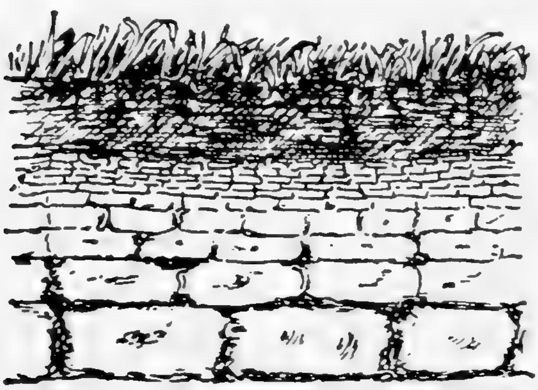
10. Pupils should furnish data for similar problems. Tell how many acres of corn, wheat, hay, etc., were raised on the farm at home, the number of bushels or tons per acre, and find the amount of the three essential fertilizers taken off with the crop.

CHAPTER IV

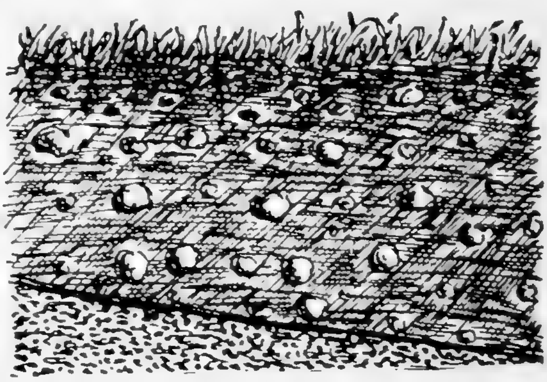
SOIL

How Soils Are Made.—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. Further he will tell you that this rock does not resemble the stone or gravel above it. Where, then, did this drift come from?

Glacial Drift and Rock Decay.—Many years ago, before man made his appearance on the earth, a great mass of ice and snow, called a glacier, moved down from the polar regions, scraping up the loose earth, rocks, and stones as it passed slowly along, crushing and grinding them together, wearing off hilltops, 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 withstand the grinding. The softer ones were easily ground up and formed soil. In the western part of the state of Wisconsin, in eastern Iowa, and in northern Illinois 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 grad-



Drawing, showing how rock gradually breaks up and decays from the top downward.



Drawing, showing glacial drift deposited on top of the solid rock.

ually "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 die and decay, and thus help to 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 "angleworms" as they are called, feed on the soil and break up the particles into still finer ones.

Agencies of Soil Formation.—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.

Kinds of Soils.—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, 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.

The Treatment of Soils.—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 barnyard manure containing much straw. This adds humus and makes clay more like clayey loam. The same treatment is also good for sand, as it increases the capacity of sand for holding moisture and makes it like 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.

Plant Foods that Become Exhausted.—As has been said before, only three of these foods, with the possible addition of lime, ever become exhausted. You will remember that these three are nitrogen, potash and phosphoric acid. It is the purpose of the next chapter to tell how you may judge from the character of the soil, and the growing crop, which one of these plant foods is most needed.

Experimental Study of Soils.

1. Rub a pinch of soil between the thumb and forefinger. Are its particles fine or coarse? Spread a little on the palm of the hand. Are the particles all of the

same size? Does there seem to be any decayed vegetable matter in the soil? What is the color of the particles? Are they all of the same color?

2. Small samples of soil may be spread out in a thin layer on white paper and further examined with a magnifying glass.

3. Thoroughly dry a sample of fine sand without lumps, and fill a water-tight tin can with it. Fill another can of exactly the same size with loam prepared in the same way. From a graduate[1] pour water on the sand, allowing time for it to soak in. Soon the sand will have absorbed all the water it can hold, and the level of the water will be even with the surface of the sand in the can. What has become of the water which you poured onto the soil? How much water have you used? Now do exactly the same thing with the loam soil and compare results. Which soil has more pore space?

4. Fill three soil tubes[2] respectively with fine dry sand, clay, and loam. Set the filled tubes in separate

[1] A graduate may be made by ruling lines one-eighth inch apart on a strip of paper and pasting the paper vertically on a glass tumbler.

[2] To prepare soil tubes: Take some tall glass bottles, wrap a cloth wrung out of cold water around each about half an inch from the bottom, and place the bottles on a hot stove. The sudden expansion of the bottom will usually break it off even. Smooth the edges with a file or on a grindstone. Plug the neck of each bottle with cotton, and turn it upside down. A rack for holding these tubes in an upright position can easily be made by nailing slats or stretching wire or strong cord across the top of a small box.

dishes, and pour into each from the top the same amount of water. When it soaks out of sight pour in more. Use your graduate for this, so that you will get exactly the same amount of water in each tube. Which soil holds water best? Which soil allows it to soak through most rapidly?

Free Bulletins, U. S. Dept. of Agriculture.

Bureau of Soils.

Circular No. 4.—Soils of Salt Lake Valley, Utah.
Circular No. 8.—Reclamation of Salt Marsh Lands.
Circular No. 13.—The Work of the Bureau of Soils.

Table IV.

Table showing fertilizing substances in average soils:

POUNDS PER TON.

Soil.	Nitrogen.	Phosphoric Acid.	Potash.
Loam	7 lbs.	3 lbs.	8 lbs.
Clay	3 lbs.	3 lbs.	15 lbs.
Drift	3 lbs.	½ lb.	6 lbs.
Sand	1 lb.	2 lbs.	5 lbs.

(Adapted from Stockbridge.)

Problems.

1. 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?

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

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

4. 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?

5. 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 eight inches?

6. How will this affect future crops?

7. Work the same problem for the other soils.

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

9. Pupils will furnish data for similar problems.

CHAPTER V

THE SOIL AND THE CROP

Lack of Plant Food in Soil.—As suggested in the last chapter, the crop will usually tell the farmer by its appearance the kind of food it most needs. However, the only way by which he can find this out for a certainty is by making careful experiments with the three essential fertilizers. Good, fertile, well-drained soil, properly cultivated, usually produces healthy, dark green plants with strong, good-sized stalks and numerous well-filled seeds.

Nitrogen.—Now, the growth of the stalk and 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 appearance and, with proper cultivation, refuses to grow, it is likely starving for want of nitrogen. What should the farmer do?

The Best Fertilizer.—Barnyard 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 barnyard manure will improve the next crop, and is the best remedy for yellow and sickly plants.

Plants as Fertilizers.—In the next place, clover, alfalfa, peas and like plants which bear their seeds in pods may grow well 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 are plowed under when full grown they add this store of nitrogen to the soil, besides forming an excellent soil mulch. While generally not so good as barnyard manure, clover is an excellent means of restoring nitrogen to the soil. In some cases it does more for the soil than barnyard manure can, and it is easier of application.

Commercial Fertilizers.—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 that contain large amounts of this much-needed plant food.

Phosphoric Acid.—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 is simpler. Apply phosphoric acid fertilizers to the soil.

Here, again, barnyard manure, because it is a nearly perfect fertilizer, is one of the best and most easily obtainable for the purpose. Ground bones, burned bones, marls and rock phosphates are the fertilizers of commerce and are being more and more extensively used.

THE EFFECT OF FERTILIZERS.

Fertilized with 560 lbs. of mixed Nitrate, Potash and Phosphate. 4,310 lbs. of hay per acre.

No fertilizers, 2,110 lbs. of hay per acre.

Fertilized with 720 lbs. of mixed Nitrate, Potash and Phosphate. 6,610 lbs. of hay per acre.

(Cornell University Bulletin.)

Source of Potash.—Potash is especially essential to the production of fruits, potatoes and root crops. In most cases, when other conditions are perfect, undersized, shriveled and imperfect fruits and roots are due to a lack of potash. Here again barnyard manure is the usual 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.

Chemical Effect of Commercial Fertilizers on Soil.—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 cannot use it for food—locked up, as it were, like bread and butter in a pantry. If a boy were 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 starve when suitable food is obtainable. 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 use them. It is, principally, for this reason that they are used.

Summary.—To sum up what has already been said:

THE BOY'S CHORES.

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 usually easy to get, and for these reasons is generally recommended. 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. When they are wisely selected the profit from their use is large. The subject of fertilizers and fertilization is a large and 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.

Free Bulletins, U. S. Dept. of Agriculture.

Extracts.

No. 169.—Soil Investigations in the United States.

Table V.

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

POUNDS PER TON.

Substance.	Nitrogen.	Phosphoric Acid.	Potash.
Clover hay	40 lbs.	10 lbs.	40 lbs.
Straw	10 lbs.	4 lbs.	20 lbs.
Barnyard manure	10 lbs.	6 lbs.	9 lbs.
Wood ashes	..	60 lbs.	160 lbs.
Burned bones	..	500 lbs.	..
Ground bones	..	400 lbs.	..

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 were hauled onto your land last year? How much of each fertilizing substance was supplied?

4. If you put 15 loads on an acre, how much of each fertilizing substance 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 is taken off with a 25 bu. crop per acre of wheat? A 40 bu. crop of barley?

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

9. Pupils will furnish data for similar problems.

CHAPTER VI

WEARING OUT THE SOIL

Soil Exhaustion.—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 but 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.

Over-Cropping Land.—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. 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 in its growth nitrogen, phosphoric acid and potash.

How Fertility May Be Retained.—Progressive farmers have learned that grain farming does not pay, and they have gone into dairying and have 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 to any great extent the amount of these substances in the soil by dairy farming.

Tubercles on the roots of soja beans in which nitrogen from the air is stored up.

Clover Enriches the Soil.—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.

Summary.—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 to the soil.

Experimental Study of Soil Treatment.

1. Fill one soil tube with dry sand. Take some very dry clover hay and pulverize it very fine with the hands, throwing out all coarse material. Mix this pulverized hay with about twice its volume of sand, and fill another soil tube with the mixture. Now pour water into the top of each tube and see which holds it the better. What are the effects upon a sandy soil of plowing under clover?

2. Make a "mud pie" of clay and set it in the sun to bake. Make another mixture of clay and pulverized clover hay, and set this beside the first one. When both pies are baked, see which can be more easily broken up. What are the effects upon a clay soil of plowing under clover?

3. Take two samples of clay—one very wet, the other only slightly moist—and place them in the sun to dry. Which makes the harder cake? In what condition, as to moisture, should clay soil be when plowed?

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 44.—Commercial Fertilizers: Composition and Use.
No. 77.—The Liming of Soils.
No. 192.—Barnyard Manure.

Table VI.

Table showing fertilizing substances in dairy products:

OUNCES PER 100 POUNDS.

	Nitrogen.	Phosphoric Acid.	Potash.
Cheese	63 oz.	10 oz.	2 oz.
Milk	8 oz.	3 oz.	3 oz.
Butter	2 oz.	3-5 oz.	½ oz.

Table VII.

Table showing fertilizing substances in farm animals:

OUNCES PER 100 POUNDS.

	Nitrogen.	Phosphoric 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?

11. Pupils will furnish data for other similar problems.

CHAPTER VII

LEGUMES

Restoring Nitrogen to the Soil.—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, alfalfa, cowpeas, and soja beans belong to this class. It is the purpose of this chapter to explain the manner in which these plants add nitrogen to the soil.

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

Nature of Nitrogen.—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 its 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 mixed in the air, there being, as has been said, about four times as much nitrogen as oxygen in it. Farm crops cannot use this "free" nitrogen in the air.

The Use of Bacteria.—There are, however, little plant-like germs, called bacteria, 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 pinheads

CLOVER AND ALFALFA ROOTS SHOWING TUBERCLES.

and are to be found adhering to the roots of clover, beans and peas. Pull up a bunch of thrifty clover, or any other legume, 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 by the United States Department of Agriculture in little cakes, somewhat resembling yeast cakes, which may be dissolved in water and sprayed on the land.

ALFALFA FIELD, ONE-HALF OF WHICH HAD BEEN INOCULATED.

Clover Restores Nitrogen to the Soil.—In order to restore nitrogen to worn-out soil it is only necessary to seed with clover or some other legume. The germs found in the tubercles on the roots of the legume will feed upon the nitrogen of the air and store it up in the legume. If this crop is plowed under, nitrogen is added to the soil, which 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.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 89.—Cowpeas.
No. 194.—Alfalfa Seed.
No. 214.—Beneficial Bacteria for Leguminous Crops.
No. 215.—Alfalfa Growing.

Problems.

1. How does clover compare with other kinds of 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 yearly with this crop from 8 acres of ground.

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?

7. Pupils will furnish data for similar problems.

CHAPTER VIII

TILLING THE SOIL

Tillage.—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 the crops that admit of it, the cultivation of the crop after it is planted.

Effect on Roots.—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 easily dissolve plant foods in lumpy ground. Stirring the soil will hasten the solution of this food matter. These facts may be easily shown by experiment.

How Solids Dissolve.—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.

The Effect of Stirring Soil.—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. Lumpy soil holds the plant foods so that the plant cannot get them, and cultivation has the same effect upon them that stirring has upon the salt in the water. It causes them to dissolve or in some way makes them accessible. The plant cannot use these foods until they are in the right condition, 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 as well as to hasten the growth of plants.

Deep Cultivation Best.—The depth to which soils should be cultivated depends in a large degree upon the depth to which the plant 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 great depth and have more soil to feed upon.

Deep Plowing for Root Crops.—For root crops the ground must be plowed deep and be very carefully pulverized. There are two reasons for this. In the first place, poorly pulverized soil spoils the shape of

THE RESULT OF CAREFUL CULTIVATION.
This tomato plant attained the height of eleven feet, six inches and bore one hundred one perfectly formed tomatoes.

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, when they strike the hard soil below, they will be raised out of the ground as they increase in length. All that has been said about cultivation of plants applies with special force to root crops.

How Water Rises in Soil.—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 beneath 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," through the cloth, over the edge of the pan, and "down-hill" through the cloth to the table. The water that runs up-hill 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

A WELL CULTIVATED CORN FIELD.

it is the capillary water which the plant uses and which is also evaporating from the soil.

Cultivation Retards Evaporation.—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.

Summary.—There are three chief reasons for tilling the soil: (1) To pulverize it, making it easy for the plant roots to penetrate it in every direction and to 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," which will prevent rapid evaporation of the capillary water from the soil.

Free Bulletins, U. S. Dept. of Agriculture.

No. 306.—Some Soil Problems for Practical Farmers.

Problems.

1. How many square feet in one square 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. depth of cultivation?

4. 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 1½ 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, labor being worth $2.40 per day?

7. How much more per acre does it cost to both plow and till well? How many additional bushels of oats worth $0.36 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 $0.30 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 $0.40 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 $0.25 per bu.?

12. From answers to the following questions 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.

CHAPTER IX

DRAINING THE SOIL

Underground Water.—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.

Water Level Must Be Below Surface of Soil.—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 free 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 such 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 free water level, and if it comes very near the surface no crop can be expected to do well there.

Wet Soils Are Cold Soils.—In wet soils a large

A PIECE OF MARSHY LAND BEFORE IT WAS DRAINED.

amount of heat is used in evaporating part of the water, and so much is required to raise the temperature of what remains that these soils never become warm. Often such soils are sour, and cannot 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, after the water has been drained off, in order to sweeten them.

Drainage.—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 methods of draining this water off, the open ditch and the tile drain. To begin

THE SAME FIELD AFTER BEING TILE DRAINED.

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 of 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.

Tiling.—It is conceded that the tile system of drainage is better than the open ditch, though it requires more labor and expense. 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 tiles to be used, and the distance apart which they should be placed, depends upon the slope and the character of the soil. An experienced drainage engineer should have charge of the work.

Open Ditches.—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 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.

Farmers' Bulletins.

No. 40.—Farm Drainage.
No. 187.—Drainage of Farm Lands.

Table VIII.

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. 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 ditches and lay the tiles at 20 cents per rod?

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

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

9. Suppose open ditches costing twenty cents per rod will answer. How much more will the tile system cost than the open ditches?

10. If the farmer is able to grow only 1½ tons of marsh hay worth $4 per ton on this land before draining and can grow 60 bu. of corn worth $0.35 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 $0.25 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.

CHAPTER X

THE CROP

Effect of Unwise Cropping.—Every farmer desires to be prosperous. He tries to raise those crops 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?

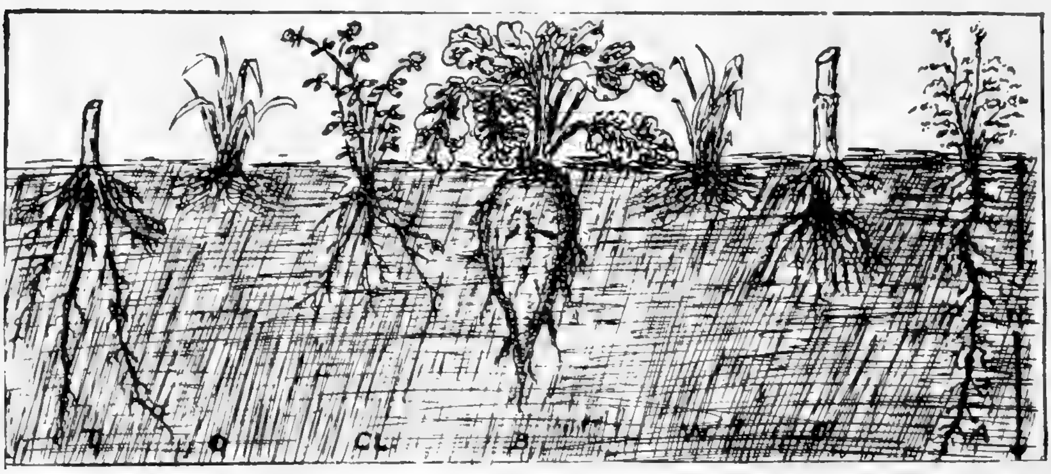
Tobacco Exhausts the Soil.—The explanation is not hard to find. Tobacco is very hard on the soil, as you will readily see by consulting the table showing the amount of fertilizing substances in farm crops. Besides, tobacco requires the same kind of food, year after year, and unless the farmer has made a careful study of this crop, and of 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 not only the immediate returns—that is, the amount of money he will get from his crop this year—but the effect that the crop will have upon the soil.

Crop Rotation.—Good farmers have devised a plan, known as "crop rotation," whereby they are able to secure the greatest possible returns from the farm with the least possible loss to the soil. This plan consists in 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.

One Plan of Crop Rotation.—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 in good condition 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 condition for a second crop of tobacco.

HARVEST TIME.

Results of Rotation.—Now let us see what has been done: A five years' 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, 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.



VARIOUS ROOT SYSTEMS.
T—Tobacco, O—Oats, Cl—Clover, B—Beets, W—Wheat, C—Corn, A—Alfalfa.

Crop Rotation and Length of Roots.—There is still another feature of crop rotation worthy of study 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 short-rooted and feed near the surface. Then comes clover, whose roots penetrate 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 desired crop.

Conditions Determine Kind of Rotation.—The rotation given in this chapter is only a "sample" rotation, not an "ideal" one, and is introduced here only for the purpose of illustration. The farmer should devise rotations of his own, suited to the special needs of his farm and to the market for his products.

Free Bulletins, U. S. Dept. of Agriculture.

No. 289.—Practices in Crop Rotation.
No. 320.—Relation of Sugar Beets to General Farming.

Experimental Study of Root Systems.

1. Pull or dig up full-grown stalks of oats, wheat, rye, barley, corn, tobacco, clover, alfalfa and other farm crops. Many of the roots will break off in the ground, but those that remain will be sufficient for comparison. Which of these penetrate the soil the deepest? Classify them in the order of length.

2. Bring in radishes, turnips, roots of oats, corn, and other farm crops. Measure their length and count the number of small roots on each of these plants.

Note the manner in which these roots grow. Which are "fleshy" and good for food? Which are unsuitable for food because they are "fibrous"?

3. Pull up peas, beans, clover and alfalfa. Examine these roots for little tubercles, like tiny potatoes, the size of a pinhead, or perhaps a little larger. You will probably find them on all of these plants. These little nodules are the homes of tiny germs that feed upon the nitrogen of the air. The plants in turn feed upon this stored-up nitrogen.

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 $0.30 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 $0.08 per lb.?

9. What is the value of one acre of oats, 60 bu., at $0.30 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 $0.40 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?

15. Pupils will 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.

CHAPTER XI

INSECTS AND DISEASES THAT INJURE THE CROPS

Insects and Plant Diseases.—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 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.

Parts of an Insect.—Insects are so called because they are "in sections." They have a head provided with a pair of feelers, a pair of strong jaws or a sucking tube, a body to which are attached three pairs of legs, 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 their sides.

THE FOUR STAGES OF INSECT GROWTH.

Eggs on leaf, caterpillar, chrysalis or resting stage, full grown insect.

The Life of an Insect.—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, in rotten wood, on the bark of trees, or even in the blossoms of plants, or in fruits. This egg hatches into what we usually call a grub or worm. The grub is a great eater and grows very rapidly, as those of you who have watched the young potato bugs grow can testify. It then hides itself somewhere and goes into the resting state, the pupa, 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.

Leaf-Eating and Sap-Sucking Insects.—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.

How to Destroy Insects.—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.

Caution in Using Poisons.—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.

Other Plant Diseases.—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 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 the spores 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.

To Destroy Oat Smut.—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 for a few minutes in a solution of formaldehyde, and then spreading it out on the floor to dry before sowing. The recipe is given at the close of this chapter.

Destruction of Spores.—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, and is usually applied by soaking the seed in the solution before planting.

Excess of Insect Poisons.—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 the plants as one walks 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 two dollars up. The recipes for and the average cost of the mixtures are given below.

Experimental Study of Insects.

Insects may be captured with a net made of mosquito bar attached to a hoop at the end of a long stick. Before examination they should be killed in a "cyanide bottle." This bottle is prepared as follows: Into a large-mouthed bottle, provided with a cork, put a small piece of potassium cyanide, a very deadly poison. Cover this poison with a layer of plaster of paris and allow it to harden. Always keep the bottle tightly corked. Shake the live insect from the net into this bottle and it will soon be ready for examination.

1. Study a wasp, a bee, or a grasshopper. Note the three parts of its body, the head, the thorax or middle section, and the large hind section, or abdomen. Also note that the abdomen is made up of smaller, ring-like sections. From this can you see why they are called insects? Watch the abdomen of a live insect closely and see it expand and contract as the insect breathes.

2. How many legs has an insect? Are they always attached to the same part of the body? How are the legs jointed?

3. Many insects are wingless; some have a single pair of wings and others have two pairs of wings.

Beetles have thick heavy wing covers. Examine insects and note the number and kind of wings on each species.

4. All insects have antennæ or "feelers." In your study of insects compare their antennæ. Are they long or short? smooth or feathered? Of what use are the antennæ?

5. Study the mouth parts of different insects and try to determine the different ways in which they get their food. The butterfly and the grasshopper are good examples.

6. Make a little cage and put into it a live caterpillar with plenty of green leaves of the kind on which it feeds. Watch it spin its cocoon and go into the resting stage. Keep it where you can observe what happens later. In the spring collect cocoons, put them into your cage and wait for the moths or butterflies to come out.

Free Bulletins, U. S. Dept. of Agriculture.

No. 38.—Spraying for Fruit Diseases.
No. 45.—Some Insects Injurious to Stored Grain.
No. 75.—The Grain Smuts: Cause and Prevention.
No. 91.—Potato Diseases and Their Treatment.
No. 99.—Three Insect Enemies of Shade Trees.
No. 127.—Important Insecticides.
No. 132.—The Principal Insect Enemies of Wheat.
No. 146.—Insecticides and Fungicides.
No. 171.—The Control of the Codling Moth.
No. 172.—Scale Insects and Mites on Citrus Trees.
No. 196.—The Usefulness of the Toad.
No. 212.—The Cotton Bollworm.

Spraying Mixtures for Plant Diseases.

(Bordeaux Mixture.)

4 lbs. unslacked lime	$0.04
6 lbs. copper sulphate at 5c	.30
Total	$0.34

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

For Leaf-Eating Insects.

½ lb. Paris green to 50 gallons water. Spray.

Cost	$0.15

For Sap-Sucking Insects.

2 gallons kerosene	$0.25
1 lb. hard soap (1 qt. soft soap)	.10
1 gallon water	
Total cost	$0.35

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	$0.50
36 gallons of water	
Total	$0.50

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 cents, 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 cents per bushel. The other neglects his field and gets but 75 bushels. What is the difference in the value of the two crops?

5. 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?

6. Suppose it takes two applications of two pounds 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 at 30 cents will it take to pay for the treatment?

7. Suppose the yield is increased from 50 bushels to 200 bushels thereby, with potatoes at 20 cents per bushel what does the farmer gain?

8. 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?

9. How much does the formaldehyde solution cost per bushel for seed oats?

10. If three bushels are sown to the acre, what does this solution cost per acre?

11. Suppose it takes a day's work, worth $1, to

treat the seed for twelve acres, what is the total cost of the treatment?

12. How many bushels of oats at 30 cents will it take to pay the cost of the treatment?

13. Suppose the treatment increases the yield twenty bushels per acre, how much does the farmer gain on his crop?

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

15. What is the cost per acre of the treatment? The cost of the treatment for a forty-acre field? For a twenty-four-acre field?

16. Pupils will furnish data for similar problems.

CHAPTER XII

THE DESTRUCTION OF WEEDS

The Nature of Weeds.—The Bible provides that man shall 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 growing where the farmer does not want it might be considered a weed. Why are weeds objectionable? In the first place, they rob other plants of their food. Suppose you go every morning to feed the chickens and as soon as you throw 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 shall"?

Work of Weeds.—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 of 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.

Classification of Weeds.—In order to fight weeds to the best advantage we must know something of their life history. They may be divided into three classes—annuals, biennials, and perennials.

Annuals.—Plants that go to seed every year and then die, coming up from the seed each year, are called annuals. Pigweed, wild mustard, sweet clover 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 get rid of.

Biennials.—Plants that live for two years are biennials. 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.—Plants that go to seed every year but whose roots live on from year to year are perennials, 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 belong 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 the ox-eye daisy. When weeds have driven the farmer off the land is rendered valueless, as it is next to impossible to subdue them if they once have gained control.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 28.—Weeds and How to Kill Them.
No. 188.—Weeds Used in Medicine.

Extracts.

No. 133.—Birds as Weed Destroyers.

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 loss caused by weeds with corn at 35 cents per bushel?

2. What would be the loss on a 20-acre field at the same rate?

3. For how many days' labor at $1 per day will an amount of money equal to this loss pay?

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 as that from a clean field? Why?

7. Suppose clean oats produce 65 bu. per acre and weedy oats produce only 48 bu. per acre, with oats at 30 cents per bushel what is the loss from weeds? What is the loss on a 16-acre field?

8. Are oats grown in a weedy field as good in quality as clean grown oats? Explain.

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 cents per bushel what is the money value of this loss?

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

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 twelve days' work himself, what would he get per day for his time?

15. Pupils will furnish data from their own experience and trom home for similar problems.

CHAPTER XIII

THE STOCK ON THE FARM

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

Why Animals Need Food.—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 animal heat comes from their food. Again, if some special product, like milk, is to be produced; this, too, must come from the food. Why does it pay to take good care of stock?

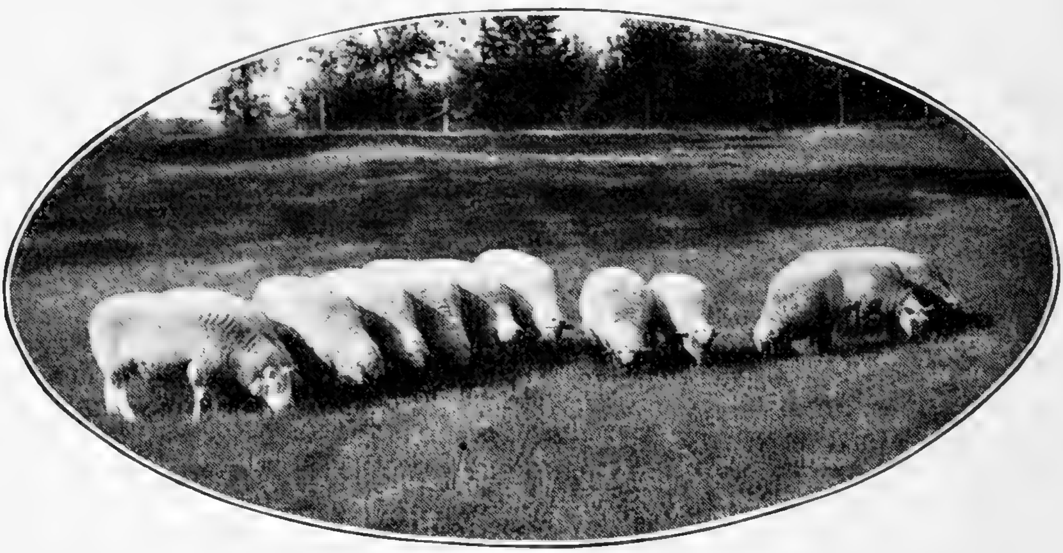
Feeding Stock.—Care is here meant to include food, shelter and general attention. If the animal is to grow rapidly it must be well fed, since the food furnishes the material for this increase in weight. Not only this, but it must be fed regularly. If not, its digestive organs become deranged; that is, it becomes dyspeptic and its food passes off without being properly digested.

The Shelter of Stock.—Stock must be provided with shelter at all seasons of the year to protect them from the heat and storms of summer and the cold of winter. If their stables are cold, then the additional heat required to keep them warm must be furnished by additional food. Animals, like persons, 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 to 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.

Effect of Lack of Care.—We can best prove that it *pays* by imagining the result of a lack of such care. With neglect more food is required to make the animals grow and more food 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 conditions cause great loss to the farmer. No one can doubt that it pays to take good care of the stock.

Advantages of Good 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.

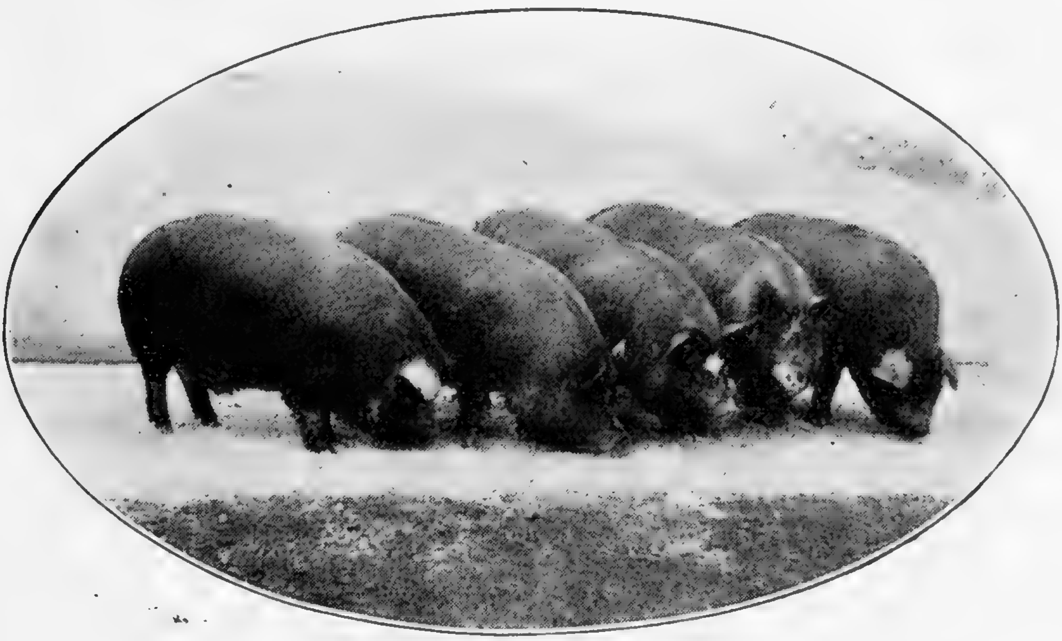


FANCY SHEEP.

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." What does it bring on the market? Not half what a well-bred pig of the same age will bring.

If more evidence of the truth of the two propositions stated at the beginning of this chapter is needed it will be found in the answers to the practical problems which follow.



WELL BRED PIGS.

Fertilizer in Stock Food.—One thing must not be lost sight of, however. Hay and grain fed to stock are 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 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 average 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 food that is eaten.

Free Bulletins, U. S. Dept. of Agriculture.

No. 41.—Fowls: Care and Feeding.
No. 51.—Standard Varieties of Chickens.
No. 64.—Ducks and Geese: Breeds and Management.
No. 100.—Hog Raising in the South.
No. 141.—Poultry Raising on the Farm.
No. 179.—Horseshoeing.
No. 200.—Turkeys: Breeds and Management.
No. 205.—Pig Management.

Extracts.

No. 15.—Some Practical Suggestions for the Suppression and Prevention of Bovine Tuberculosis.

Table IX.

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 X.

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 better 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 2-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 10 cents per sq. ft.?

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

NOTE: In the following examples do not forget to add the value of the manure produced to the value of the product:

9. If a cow eats 3 tons of hay worth $6 per ton, 1,000 lbs. of ground feed worth 80 cents 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" cow will give 15 lbs. of milk, worth

80 cents per cwt., daily for 300 days in the year, 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 cents 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 cents per bu., and \$10 worth of pasture to keep 10 sheep for a year, what is the cost per head?

17. If one "scrub" sheep will shear about 4 lbs. of wool worth 20 cents 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 sheep 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 cents 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 200 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?

24. Pupils will 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.

CHAPTER XIV

FEEDING THE STOCK

Reasons for Feeding 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.

Repair of the Waste.—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 the "spring 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. For this very reason farmers always feed their horses more when they work them hard.

Why Growing Animals Need Plenty of Food.—Growing animals must not only keep this waste repaired, but they must also increase in weight. For this reason they need more food 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.

Food Supply and Energy.—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 endure more of it. So the horse to do work must have muscular energy. His muscles are formed from the food that he eats.

Food Supply and Special Products.—The milk cow must have more food 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 reduced 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 food out of which to make wool, and the hen requires special food from which to make eggs.

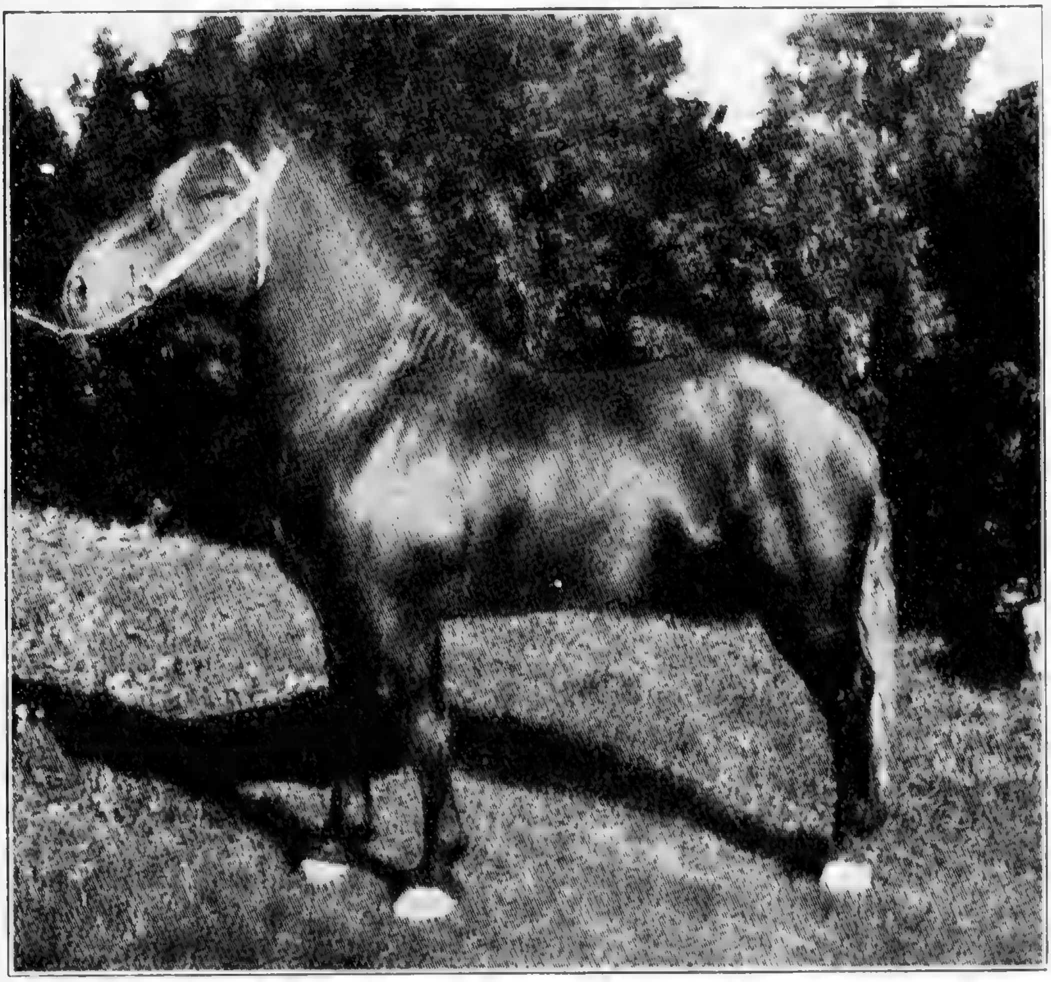
Kind of Food Needed Varies.—If a man were to start a shoe factory he would buy leather, pegs, nails and thread. These are the raw materials out of which he makes shoes. If he were to start a chair factory he would buy lumber instead. That is, his selection of material would depend upon the kind of product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

Importance of Right Selection of Foods.—But, you say, we know that lumber is needed to make chairs; leather, nails and thread necessary in 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 food to be used in order to produce the desired results farming will not pay him its largest returns.

Classification of Foods.—Foods are conveniently divided into three classes—fats, protein and carbohydrates. These are big words, but they are easily understood.

Fats.—Butter, lard, tallow, and all kinds of oils come under the head of fats.

Protein.—The white of an 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 hide, hair, wool and feathers of animals are largely protein. You all know the odor of burned feathers; any kind of sub-



A PRIZE PERCHERON.

stance that scorches and gives off that odor contains protein.

Carbohydrates.—Starch, sugar and vegetable fiber 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.

Difference Between Protein Foods and Carbohydrates.—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 legumes and added to the soil. You will also remember it as the principal one of the three plant foods that become exhausted from the soil.

Balanced Ration.—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 is about six times as much carbohydrates as protein. A ration containing a larger proportion of carbohydrates is called a "wide" ration; one containing less than six times as much carbohydrates as protein is called a "narrow" ration. 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.

Different Uses of Foods.—Foods 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 foods should be fed. Farmers have learned that corn alone is a good grain 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.

Special Foods Needed.—Sheep need food 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 farmer's success.

Special Proportions.—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 foods, with plenty of mineral matter in them to form bone and muscle. Later, when fattening time comes, fat producing foods, 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 grouped with the carbohydrates as it is in this book. This is one reason: One pound of fat will produce about 2¼ times as much heat and energy as one pound of carbohydrates, so that one pound of fat is equal to 2¼ pounds of carbohydrates in feeding value. If we have 1 lb. of fat, 3¾ 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 nutritive ratio, it will only be necessary for you to use the following 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.

Economy in Feeding.—The great problem of economical feeding is to find those foods that will produce the desired results with the least possible expense.

It is not necessarily the cheapest foods that will do this.

The Use of Scales.—In this connection, it may be well to call attention to the farm scales, something that should be found on every well-regulated farm. The farmer may, then, from time to time, experiment with different feeds, both as to quantity and kind, and by frequent weighings of the animals so fed, determine the effect of such feeding. Besides, scales are very handy in selling produce, weighing milk and in a thousand and one other ways. They are comparatively inexpensive, and will, with proper use, pay for themselves in a very short time.

Experimental Study of Foods.

1. Starch and sugar are pure carbohydrates. Get some samples of these, label them and start a collection of carbohydrates. Add to this collection samples of foods rich in sugar and starch. Corn, wheat, rye, barley, mixed hay, silage, and all kinds of straw may be classed as carbohydrate foods. Place these samples in bottles and label them properly.

2. To test seeds for starch, pulverize the seeds, boil them in water for some time, and soak a piece of cotton cloth in the water. Take out the cloth, dry, and iron it. Is it stiff or "starchy"? If so, where did the starch come from?

3. Test corn, oats, wheat and rye for starch. Pulverize a few seeds, pour over them a little boiling water, let stand a short time, and add a drop of iodine.

If the seeds contain starch, the water will suddenly turn blue or black. This is a very delicate and pretty experiment.

4. Many seeds contain sugar, for which every one knows the simplest test. To make the test sure, mastication should be slow and thorough. Even a slightly sweet taste indicates the presence of sugar. Test wheat, oats, corn, peas, squash seeds, and pumpkin seeds.

5. All seeds contain some protein. Every one knows the odor of burning feathers. This disagreeable odor is caused by the burning of the protein in the feather. Remove the germ from a kernel of corn and scorch it over a spirit lamp or on the stove. Does it give off an odor like that of burning feathers? If so, it contains protein. Test other seeds for protein.

6. Lean meat, the white of egg, wheat bran, oats, peas, middlings, cheese, malt sprouts, and clover hay are all rich in protein and may be properly called protein foods. Add these to your collection, labeling them properly. To preserve the meat, eggs, and cheese they should be placed in dilute alcohol.

7. Nearly all small seeds contain much oil. To test for oil, crush the seeds on a piece of clean, white paper. If they leave a grease spot, the seeds contain oil. For further test, crush the seeds on a piece of white paper, and heat gently in the oven, being careful not to scorch the paper. A grease spot on the paper shows oil. Test flax seed, wheat, beans, sunflower seeds, and any kind of nut for oil.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 22.—The Feeding of Farm Animals.
No. 36.—Cotton Seed and Its Products.
No. 49.—Sheep Feeding.
No. 58.—The Soy Bean as a Forage Crop.
No. 170.—The Principles of Horse Feeding.

Table XI.

Table showing digestible nutrients in feeding stuffs:

POUNDS PER TON.

Kind of Feed.	Protein.	Carbohydrates.
Soy beans	210	800
Cow peas	210	800
Clover hay	170	920
Red top hay	95	980
Mixed hay	88	880
Timothy hay	56	920
Corn fodder	50	710
Rape, green	42	170
Corn silage	24	290
Oat straw	24	920
Sugar beet pulp, fresh	13	140
Rye straw	12	830
Wheat straw	8	740

POUNDS PER HUNDREDWEIGHT.

Kind of Feed.	Protein.	Carbohydrates.
*Cotton seed meal	40	40
*Linseed meal	32	42
*Gluten meal	25	60
Malt sprouts	18	46
Wheat bran	12	46
Wheat middlings	12	58
Brewer's grains, dry	10	50
Whole milk	3⅓	13
Skim milk	3	6

*These feeds are very rich in fat and should be fed sparingly.

POUNDS PER BUSHEL.

Kind of Feed.	Protein.	Carbohydrates.
Dry peas	10	32
Rye	5	39
Barley	4	32
Corn	3½	40
Oats	3	19

Table XII.

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 year	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 in the form of grain, like corn and barley.

Problems.

1. How many pounds of protein in a bushel of oats? With oats at 30 cents per bushel, what does this protein cost per pound, disregarding the carbohydrates?

2. How many pounds protein in a bushel of barley? With barley at 44 cents per bushel, what does protein in this form cost per pound?

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

4. What is the cost per pound of protein in rye at 60 cents per bushel?

5. What is the cost per pound of protein in corn at 35 cents per bushel?

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

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

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

9. Which is the cheapest 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 value of all the feeds given in the tables.

12. Which are most nearly "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 ratio is 1 to 10. Let us mix it with some other feed to bring the ratio up to about 1 to 6. We shall try peas. We shall feed 1 bu. of ground peas with every hundred lbs. of hay.

Feed.	Protein.	Carbohydrates.
100 lbs. hay contain..............	4.4	44
60 lbs. peas contain.............	10.	32
160 lbs. mixed contain............	14.4	76

Dividing weight of carbohydrates by that of protein (76 by 14.4) we get a ratio of about 1 to 5. We have more protein than we need. Let us try again with ½ bu. of peas instead.

Feed.	Protein.	Carbohydrates.
100 lbs. hay contain...............	4.4	44
30 lbs. peas contain...............	5.	16
130 lbs. mixed contain.............	9.4	60

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 per ton and peas at $1 per bushel?

19. Suppose she gives 25 pounds 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 the current 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.

25. Pupils tell price of feeds, kinds grown on farm at home, stock to be fed, etc., as data for other feeding problems.

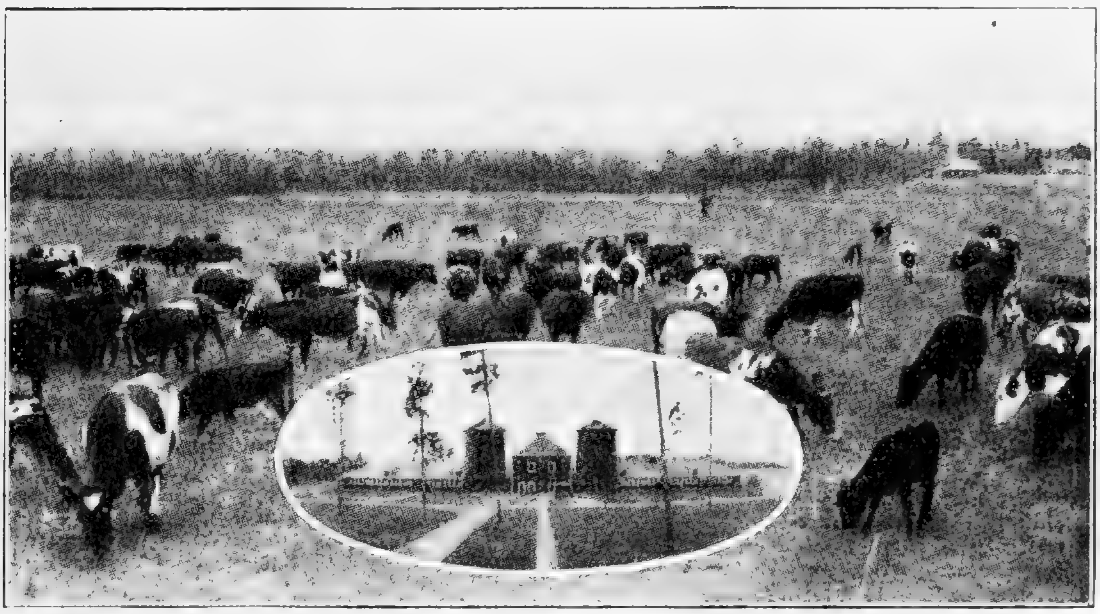
CHAPTER XV

THE THREE C'S—COWS, CORN AND CLOVER

Diversified Farming.—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 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." The greater the number of different things he raises the greater the diversification.

Clover.—But we have agreed that it is not a good thing 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 animals 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



COWS IN A CLOVER FIELD.

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. On average land a larger amount of clover, or some other legume adapted to the soil, can be grown per acre than of any other hay crop, and, since it adds nitrogen to the soil, it is by far the best hay crop to raise.

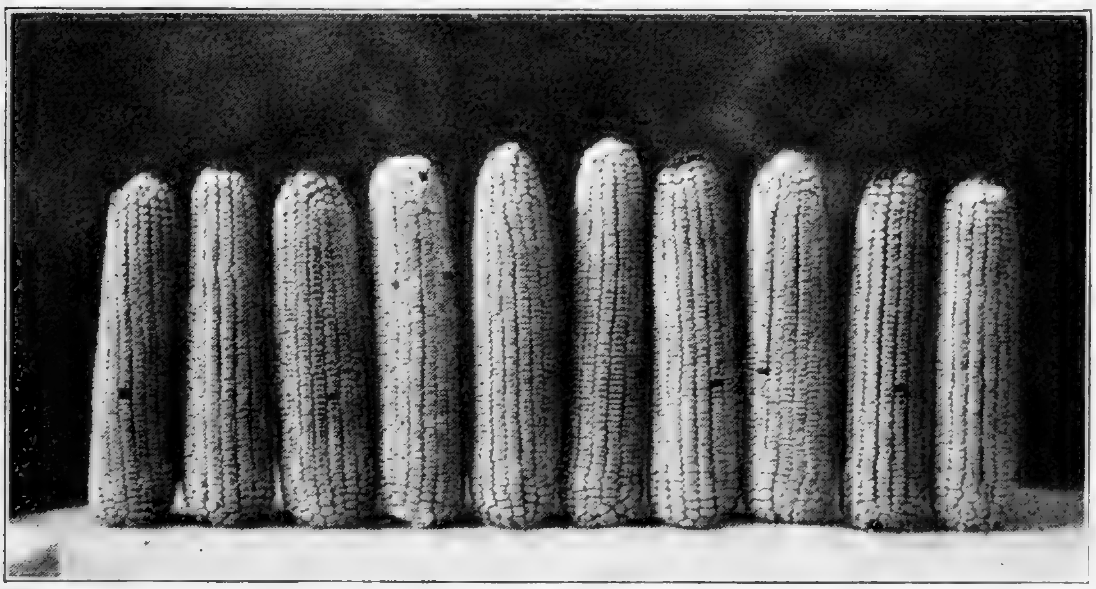
Corn.—Another examination of the table reveals the fact that corn is one of the richest of grains, and since corn is one of the richest of fodders in feeding value, and the yield is heavy, corn is an excellent crop to raise.

Cows.—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 as fertilizer would be nearly $20, besides improving the texture of the soil to a marked degree.

A Good Combination.—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, following corn, offering an excellent opportunity for rotation of crops, the advantages of which have already been pointed out.

Other Advantages of the Three C's.—With cows, corn and clover, the raising of sheep and hogs is made possible and profitable. The cows and clover furnish milk and pasture for the growing animals, while corn is one of the best of fat-producers. 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 good 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.

Kind of Farming Depends on Local Conditions.—The reader must not make the mistake of thinking



A PRIZE PACKAGE.*

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 the North Central States, at least, cows, corn and clover should form the basis of any system of diversified farming.

*This prize package was grown by Frank McConnell, a member of the Boys' Corn Club, of Hamilton County, Indiana.

Free Bulletins, U. S. Dept. of Agriculture.

No. 81.—Corn Culture in the South.
No. 199.—Corn Growing.
No. 106.—Breeds of Dairy Cattle.
No. 143.—Conformation of Beef and Dairy Cattle.

Problems.

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

2. What is the total and daily cost of this ration with hay at $7, corn at 40 cents and oats at 30 cents?

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 bushels of oats and 1,000 pounds 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, oats 30 cents, straw $4 and bran 80 cents per cwt., what is the total cost of this ration? The cost per cow, per day?

7. What is 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 nearer to a balanced ration? Which is likely to produce the better results in feeding?

9. Suppose 20 pounds 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 cheaper ration under these conditions?

11. It must be remembered that in order to get the best results a cow should be fed about 2 pounds of protein daily. How much does she get with each ration, if fed 20 pounds of feed per day?

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

13. A lack of protein means a smaller quantity of milk. Suppose cows fed on 20 pounds of the clover-corn-oats ration gave 20 pounds of milk daily, while those fed on the hay-straw-oats-bran ration gave but 15 pounds of milk daily. With milk at 80 cents per cwt., what is the gain by using the first ration?

14. Find the cost of each ration for a herd of 10 cows for one month. One day.

15. Now determine whether the cheaper ration is the more economical.

16. Which is the better ration to feed under the above conditions?

17. Make rations with different kinds of feeds, and figure the cost of the protein therein.

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

19. Pupils may bring data from home for similar problems.

CHAPTER XVI

THE DAIRY

The Products of the Dairy.—Milk, butter and cheese are the products of the dairy. Whether the farmer should sell his milk, or make it into butter or cheese, depends upon nearness to factories and markets, the relative price of milk products, and other local conditions. It must be constantly kept in mind that the sale of milk to consumers takes from the farm all the soil elements found in whole milk. The sale of cheese returns a portion of soil fertility with the whey, while the sale of butter removes practically nothing of a soil nature. The milk required to produce a ton of butter contains about 450 pounds of fertilizing substances; the cheese made from the same amount of milk contains about half as much of such substances, and the butter that this milk will produce contains less than five pounds of soil fertility. The reason is plain. Butter-fat is a carbohydrate, and carbohydrates, you will remember, come from the air and the water, not from the soil. Hence, with milk at the same price per hundred at both butter and cheese factories, it is far better to make butter than cheese for the market.

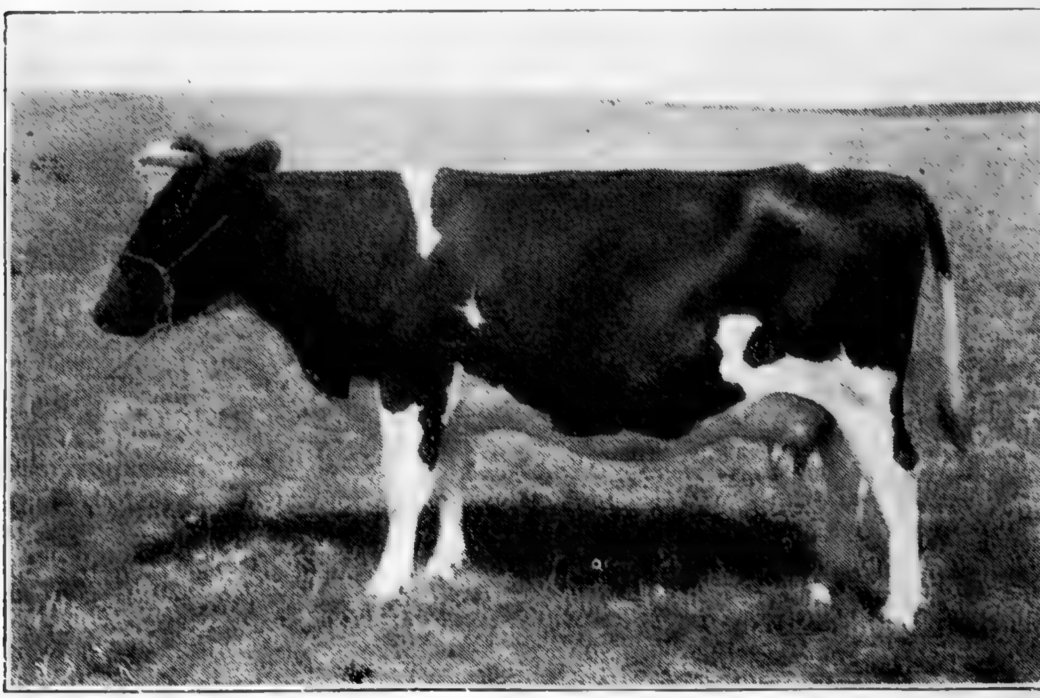
Again, when butter is made, the skim milk is available to feed on the farm. Whey is of much less feeding value.

The Milk Separator.—The use of the milk separator is increasing. This machine is a great time-saver. The skim milk may be fed warm and sweet, soon after being drawn from the cow. Only the cream need be hauled to the factory, and that but two or three times a week.

JERSEY COW.

Cleanliness in the Dairy.—Cleanliness is the watchword of the dairy. This cannot be too strongly stated. Good milk, pure milk, sweet milk is essential, if good butter and cheese, capable of commanding the highest market prices, are to be made. Milk and milk products are spoiled by bad flavors and bad odors. Bad flavors and bad odors in milk are caused by the cows' eating improper food and drinking impure water, and by uncleanliness on the part of the dairyman in the care of the milk. Milk cows should not be allowed to drink stagnant or muddy water, or to eat "tainted" food, as musty hay, cabbage, rape, garlic, wild onions, or ragweed. These will certainly impart a bad odor and a bad flavor to the milk, which the most careful handling will not remove.

Bad Odors in Milk.—In the second place, milk is a very great absorbent, and should never be allowed to



HOLSTEIN-FRIESIAN COW.

stand around the barn, or in any other place where the air is filled with bad odors.

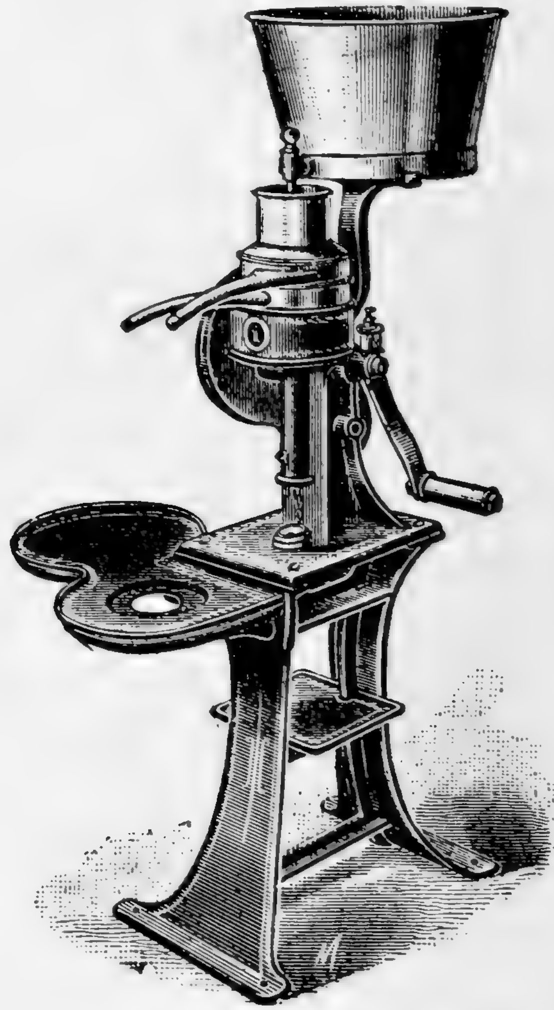
Bacteria in Milk.—But the most fruitful source of bad milk is uncleanliness on the part of the dairyman in the care of the cow, and of the milking utensils. Milk should be kept pure and sweet. Sour milk, or bad milk, is caused by tiny bacteria, too small to be seen with the naked eye; in fact, so small that they can only be seen with the aid of the strongest microscopes. Under favorable conditions these bacteria increase in numbers very rapidly. They seem to thrive best in warm, damp weather. They live everywhere—on the hay, in the bedding, on the clothes and hands of the milker, on the cow's hair, in the milk cans and pails, and in the air. New milk, freshly drawn from the

RED POLLED COW.

cow, contains none of these bacteria, but they soon get into it and begin at once their rapid multiplication. When they have increased sufficiently in numbers, the milk begins to smell and taste sour and "bad." Only care and cleanliness will prevent these bacteria from getting into the milk. If the bacteria are kept out, the milk will keep sweet for a long time. Heating it to the temperature of 150 degrees kills these germs, and is one common way of keeping milk sweet.

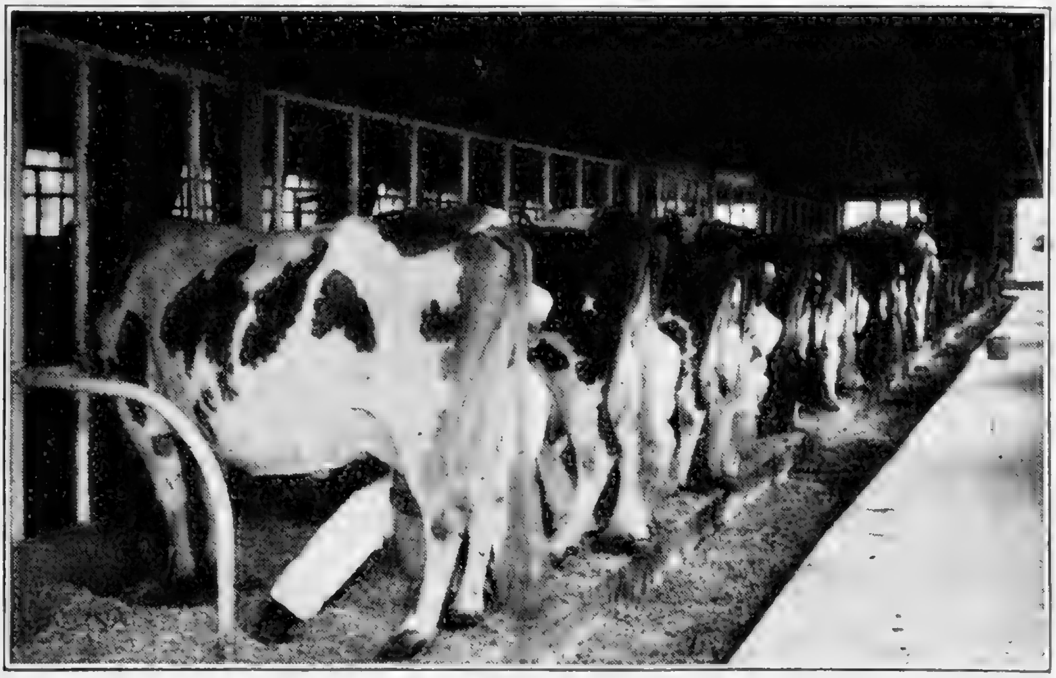
Necessary Precautions.—The milker should see to it that his hands are clean. Before sitting down to

A BABCOCK TESTER.



A CREAM SEPARATOR.

milk he should carefully brush from the cow all dust, dirt, dandruff and loose hair likely to fall into the pail. He should have his milking clothes frequently washed and scalded to destroy the bacteria thereon, and he should remove the milk to a clean place, where the air is pure and free from bacteria, as soon as he possibly can. Aerating the milk—that is, allowing it to drain slowly through a strainer placed several feet above the can, where pure air can blow through it as it falls—will do much to remove any bad odors it may already contain. Pails and cans should be kept scrupulously clean. They should be rinsed with boiling water after each milking to kill all bacteria that may



A MODEL COW BARN.
(Edgewood Farm.)

adhere to them. If little particles of milk are allowed to stick to the rough places in the cans and pails, it is impossible to keep milk sweet in them, because the bacteria live and multiply in these particles. As soon as pure milk is placed in such utensils, these germs at once begin their rapid increase, and the milk spoils in a few hours. The whole secret of keeping milk sweet lies in preventing the bacteria from getting into it.

Selection of the Herd.—Next in importance to the care of the milk comes the selection of the herd. Since most creameries and cheese factories now pay by the test—that is, pay for the amount of butter-fat that the milk contains—it is important to the dairyman that his milk tests well, and that his cows give a reasonably large flow of milk. In general, no cow is profitable to the dairyman whose milk tests much less than 3 per cent of butter-fat. Neither is one which gives less than twelve pounds of milk daily, no matter how rich it is. Every farmer should own a small Babcock tester and test every cow in his herd. Such a tester, with directions and complete outfit for testing milk, can be bought for six or seven dollars. Each cow in the herd should be tested, her milk carefully weighed and her dairy value figured out. All unprofitable cows should be disposed of. The best cows in the herd may then be kept for breeding purposes. In this way the herd will be greatly improved and dairying made much more profitable.

Experimental Study of Milk.

In all comparisons of milk, samples should be taken under the same conditions and set at exactly the same depth. Test tubes are most convenient for experiments with milk. If bottles are used they should be tall and slender, and as nearly the same size as possible. Sample bottles should never be filled above the point where the bottle begins to narrow towards the neck.

1. Compare samples of milk from different cows, noting the color.

2. Follow directions given above in the preparation of samples. Set them aside in a cool place for twenty-four hours. Compare the thickness of the cream layers, being careful not to disturb the milk. Measure the cream with a rule. Which is the richest milk? What color was it when first set? What is always the color of very rich milk? What is the color of poor milk?

3. Take a sample of the first milk drawn from a cow, and another sample of the "strippings" from the same cow. Place these samples in separate bottles, being careful to fill the bottles to exactly the same depth. Note the color of each. Set them aside in a cool place for twenty-four hours and then compare the thickness of the cream layers.

4. After a quantity of milk has stood in a can for thirty minutes, take a sample from the top of the can. Then plunge the dipper to the bottom and get a sample from near the bottom of the can. Place these samples in bottles as before, note the color, and set aside for the cream to rise. Compare the thickness of the cream layers at the end of twenty-four hours. Which is the richer? Explain.

5. Take two samples of milk from the same supply, under the same conditions. Set one in a very cool place and the other in a warm place, for a few

hours, and compare the thickness of the cream layers. Set aside for a few hours and compare again. What difference do you observe?

6. Into an unwashed bottle in which milk has been allowed to sour place a sample of fresh, sweet milk. Into another bottle that has been carefully cleaned and scalded place another sample from the same supply. Set the samples side by side in a warm room and smell and taste them at intervals of from four to six hours. Record definitely the differences in preservation of the two samples.

7. Take two samples from the same supply of fresh, sweet milk, and place them in dishes that have been carefully cleaned and scalded. Set one dish over night in the barn, or in some other place where the air is filled with bad odors. Set the other sample in the open air or in a well ventilated place where there can be no bad odors. Smell and taste of both next morning. Has the bad odor affected the taste or odor of the milk? From this experiment what do you infer regarding the effects of bad air upon milk to be used in making butter, or cheese, or for any other purpose?

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 29.—Souring of Milk and Other Changes in Milk Products.

No. 42.—Facts about Milk.

No. 55.—The Dairy Herd: Its Formation and Management.

No. 57.—Butter Making on the Farm.

No. 63.—Care of Milk on the Farm.
No. 151.—Dairying in the South.
No. 166.—Cheese Making on the Farm.
No. 201.—The Cream Separator on Western Farms.

DEFINITION.—A per cent is a fraction whose denominator is 100. Thus: 1-100 is 1 per cent, 2-100 is 2 per cent, 5-100 is 5 per cent, and so on. There are three ways of writing per cents, thus: 2-100 = .02 = 2%. They all mean exactly the same thing.

Problems.

1. How many pounds of butter-fat in 5,000 pounds of milk that tests 4 per cent?

2. A farmer owns a herd of 15 cows that average 24 pounds of milk per head daily. How many pounds of milk does he get in six months (thirty days each)?

3. If this milk tests 3.5 per cent. and butter-fat is worth 25 cents per pound, what does he receive monthly for his milk? How much per head?

4. A farmer has a herd of 20 cows. The milk for the week weighs as follows: 420 lbs., 418 lbs., 408 lbs., 422 lbs., 417 lbs., 432 lbs. and 423 lbs., respectively. It tests 5 per cent of butter-fat, the price of which is 30 cents per pound. How much do the cows average per head in money for this week?

5. A farmer hauls 43,250 lbs. of milk that tests 3.8 per cent to a factory. The price of butter-fat is 26 cents per pound. How much money should he receive?

6. A farmer owns six cows: Bess, Spot, Brindle, Bos, Kate and Red.

Bess	gives 22 lbs. of milk daily, which tests 3.8%,
Spot	gives 15 lbs. of milk daily, which tests 4.2%,
Brindle	gives 30 lbs. of milk daily, which tests 3.0%,
Bos	gives 20 lbs. of milk daily, which tests 3.5%,
Kate	gives 14 lbs. of milk daily, which tests 3.2%,
Red	gives 24 lbs. of milk daily, which tests 5.2%.

Figure out the dairy value of each. Which is the best cow? The poorest one? Classify them in order of dairy value.

7. Figure out the number of pounds of milk given by each cow in a month, and the value of it in butter-fat at 25 cents per pound.

8. Two herds of ten cows each are compared: The Jerseys average 18 lbs. of milk each daily; the Holstein-Freisians average 30 lbs. of milk each daily. The Jerseys test 5.4 per cent; the Holstein-Friesians test 3.2 per cent. Which is the more valuable herd?

9. With butter-fat at 30 cents per pound, what is the monthly average per cow of each herd?

10. Pupils will furnish actual data from home for other dairy problems.

CHAPTER XVII

POULTRY

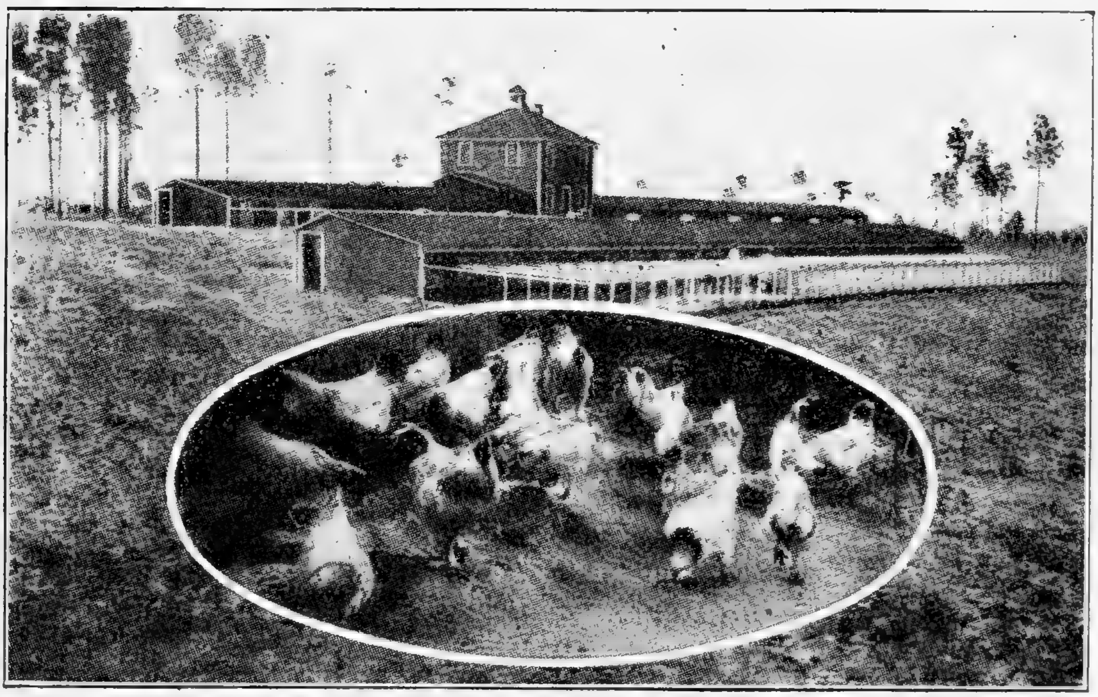
Profit in Poultry-Raising.—There is no department of diversified farming that yields larger returns for the labor and money expended than the poultry yard, if properly handled. No farmer tries to get along without chickens, and many farmers' wives and children are made happy by the revenue derived from a flock of turkeys, ducks or geese. But poultry-raising has not been given sufficient attention on many American farms. There is no more wholesome or nutritious article of food than eggs, and by most people poultry is highly esteemed as an article of diet. There is a steady demand for fresh eggs, and well-fattened young fowls always bring a high price in the market. On many farms the money received from the sale of eggs and poultry amounts to several hundred dollars annually.

The labor involved in this industry is of a kind that can easily be done by women and children. The feed required is raised on every farm, and the necessary buildings are cheap and easily built. All these factors tend to make poultry-raising very profitable when thoughtfully and intelligently pursued.

Care of Poultry.—If necessary, chickens may be confined to somewhat narrow limits, but ducks, geese and turkeys usually thrive best when given free range of the farm. The reason for this is plain. Fowls are insect and seed eaters, and, when allowed to roam, select the kinds of insects and seeds which they like best. But, when kept in confinement, man forces them to eat the things he provides; and, unless a special study has been made of poultry foods, they may not always be the ones the fowls themselves would select. Again, as has been said in another chapter, if hens are to lay eggs, they must be fed egg-producing foods. If confined they should have constant access to a box of grits, oyster shells, gravel, lime, charcoal, sand, ground bone, and the like, to be used in grinding their food, and out of which to make eggshells. They should be fed meat scraps, skim-milk, barley, refuse from the table, and other foods rich in protein out of which to make eggs. In winter time, green foods like cabbage, turnips, and silage should be given to them.

Foods.—To repeat what has been said in another place: "Nature has provided in summer proper foods for most farm animals, and the nearer summer conditions can be duplicated the greater will be the farmer's success." The winter food of chickens should, therefore, consist of four kinds—minerals, which they get by scratching in summer; meat, to take the place of summer insects; grains; and green foods. Ungrateful, indeed, would be the hen who did not respond to this diet with a liberal return of eggs.

Insects as Food for Fowls.—One other fact in connection with the food of fowls is deserving of special emphasis here. Since their food consists so largely of seeds and insects, it is quite evident that they are worth all it costs to keep them in the assistance which they give to the farmer in devouring seeds of weeds and in holding insect pests in check.



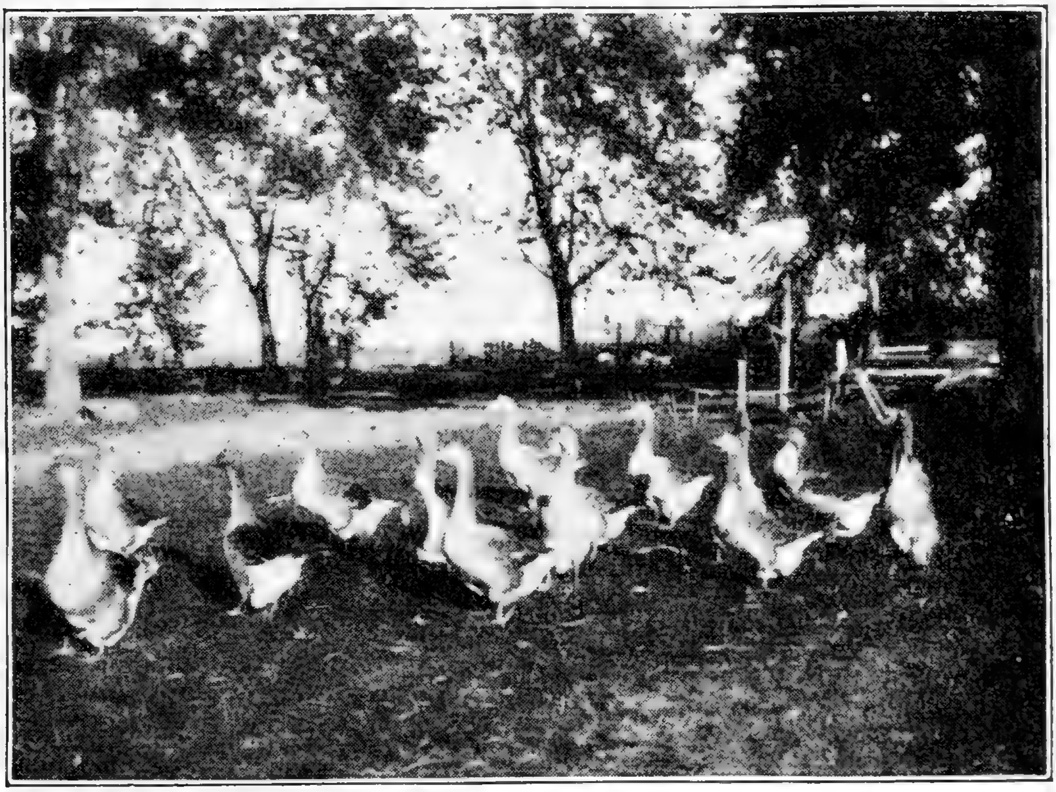
HEN HONORS.

The Poultry House.—Like other farm animals, fowls must be protected from cold and storms. Their houses should be large, light, airy, clean, and dry. Chickens should have a "scratching place" where they can get to dry dirt and scratch and wallow in it. Dust acts as a sort of insect powder, filling up the insect's breathing pores, and thus keeps the chickens free from lice. It is important that chickens have plenty of exercise, and this they can get in winter if they have a warm and dry place where they can go to scratch. It is a common practice among poultry raisers to force them to scratch for their food by strewing it over a floor thickly covered with chaff or short straw.

Cleanliness in Care of Poultry.—Poultry houses should be frequently cleaned and whitewashed to keep them free from bad odors and vermin. They should be well lighted by a row of windows, placed along the south side, and they should be built sufficiently warm to prevent the freezing of the chickens' combs and feet. Above all else, they should be kept perfectly dry to avoid disease.

Laying Qualities of Poultry.—In the wild state, the hen laid but one setting of a dozen or fifteen eggs a year. This number has been greatly increased by domestication until the "two-hundred-egg-a-year" hen is considered an easy possibility by many poultry raisers. If farmers will use care in selecting only the eggs from the most prolific layers for setting, they can, without doubt, greatly improve the laying qualities of their flock. Much, however, depends upon the selection of a breed.

Varieties of Foods.—The variety selected for farm use will depend largely upon the purpose for which the fowls are grown. There are some varieties especially desirable for their laying qualities, others are adapted to the needs of the early spring chicken market, and still others which may be called general purpose fowls. The intelligent farmer informs himself as to the respective merits of the several breeds and selects the one best adapted to his needs. What is true in the selection of a variety of chickens is equally true of turkeys, ducks and geese and is left to the intelligent action of the farmer without further comment here. The bulletins named below will be of great



GOOD MATERIAL FOR A PRODUCE ACCOUNT.

value to the poultry raiser in making his selection and will give him other assistance and direction in the care and management of his poultry.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 51.—Standard Varieties of Chickens.
No. 64.—Ducks and Geese, Breeds, and Management.
No. 141.—Poultry Raising on the Farm.

No. 177.—Squab Raising.
No. 200.—Turkeys, Varieties, and Management.

Problems.

1. A flock of 60 hens average 80 eggs a year each. With eggs worth 15 cents per dozen, what is the value of these eggs?

2. How many bushels of corn will this buy at 40 cents per bushel? Of oats at 25 cents?

3. Suppose it takes only 12 bushels of corn, 5 bushels of oats and $7 worth of other food to keep this flock for one year, besides what they pick up for themselves. What is the profit over and above the cost of the feed?

4. What would have been the profit if they had laid 120 eggs each, instead of 80?

5. Ask pupils to furnish data for at least twenty other similar problems.

CHAPTER XVIII

SPECIAL CROPS

Four Special Crops.—There are a few special crops, which, because of their increasing importance in agriculture, demand our attention. Four of these will be considered in this chapter—tobacco, sugar beets, potatoes and onions. All of these crops are grown in the United States today, but, with the exception of potatoes, not in sufficient quantities to supply the demand. Until we do raise enough for home consumption, these crops will yield larger returns to the farmer than the other crops grown on the farm.

TOBACCO.

Tobacco a Heavy Feeder.—As we have already learned, tobacco is a heavy feeder and hard on the soil. With every crop of tobacco sold off the farm about twice as much fertility is removed as with any grain crop that the farmer raises for market. But we have agreed that grain farming does not pay. How much more unprofitable, then, is it for the farmer to raise tobacco extensively. There is but one way in which he can keep up the fertility of his soil, and that is by the use of commercial fertilizers. In this way soil matter is bought and brought back to the farm to take the place of that sold with the tobacco. Extensive experiments have been made at the different agricultural stations to determine the kind and amount of

A TYPICAL TOBACCO FIELD.
(Oconto County, Wisconsin.)

these fertiliers to use. The results show that they are even better than barnyard manure for this crop. The only way that the farmer can find out the kind and amount best adapted to his soil is by careful experiment. It must be remembered, however, that commercial fertilizers tend to harden the soil, while barnyard manure improves its texture.

Kind of Soil Required.—Tobacco requires fertile, well-drained soil, rich in humus. Not every soil will grow good tobacco. Even on the same farm, places are found which seem to be especially adapted to its growth. Herein another danger lies. The farmer is likely to grow tobacco, year after year, on this same piece of land until its fertility is exhausted, or else he has robbed the rest of his farm by putting all of his fertilizers on his tobacco land. Again, such conditions make crop rotation impracticable.

Cultivation.—Moreover, tobacco requires thorough cultivation and careful attention in harvesting and curing. These things are best learned by actual practice, and a discussion of them is beyond the province of this book.

SUGAR BEETS.

Beets Compared with Other Plants.—Beets, like tobacco, are heavy feeders, and, like tobacco, require thorough cultivation. Unlike tobacco, however, they can be grown so as to retain the fertility of the soil. Sugar is a carbohydrate, and carbohydrates, you will remember, are made by the plant from the air and the water which the plant uses. If the beets are shipped to the factory, the sugar extracted there, and the pulp returned to be fed on the farm or used as a fertilizer, the soil has lost nothing. It is much the same as if the tobacco ashes were brought back to the farm. With tobacco, however, this is impossible, but with beets it is possible to return the pulp, and this should always be done.

Advantages of Beets.—Sugar beets have still other advantages over tobacco. In the first place, the price is fixed by the factory before the beets are planted. The factory usually contracts to give about $4.50 per ton for beets that test 14 per cent of sugar, with an additional 25 cents per ton for each additional 1 per cent of sugar. Thus beets testing 15 per cent will bring $4.75 per ton, and beets testing 16 per cent will bring $5 per ton. They will usually agree to ship the pulp back to the farmer at a small cost, say 25 cents per ton. The farmer knows just what price he is going to get for his crop. What his land brings him per acre depends upon his own efforts, and he will then bend all his energies toward producing a high test and a big yield. With other crops a big general yield usually means a low price, but a big crop of beets does not affect the price.

Again, beets require less care than tobacco. They do not need to be housed or cured. No capital need be invested in sheds or curing rooms.

In the third place, they can be grown successfully on a large variety of soils, and they furnish, when the pulp is returned to the farm, an excellent food for stock.

In the fourth place, their long roots, and the deep cultivation required, bring to the surface fertility from deep down in the soil. In Germany, several years after their cultivation was introduced, more grain was grown per acre on land where the beets had been cultivated than could possibly have been grown before their cultivation was begun.

A comparison of beets and tobacco gives the preference to beets as a farm crop. They grow well on tobacco land and are an excellent crop to be used in

HARVESTING SUGAR BEETS.

rotation with it. Their cultivation is easily learned, and they are less exposed to injury from storms, insects and plant diseases.

POTATO.

The Best Soil for Potatoes.—Potatoes of the best quality are grown on light, sandy land, rich in humus. Heavy clay soils do not give way readily as the potatoes increase in size, hence will produce smaller potatoes.

Yield of Potatoes.—This crop yields heavily, five hundred bushels per acre being not unusual. Potatoes should be planted about four inches deep, in rows three feet apart, and about two feet apart in the row. Extensive experiments, carried on by the different agricultural stations, show that the seed potatoes should be cut in halves or quarters. When the price of seed potatoes is very high, they may be cut in smaller pieces of as nearly equal size as possible. No bad results have come from planting small potatoes, though one would naturally think that small potatoes, used as seed, would give small potatoes in return. It must be remembered, however, that the potato is not a seed, but an underground stem, and that it does not bear the same relation to the crop that the seed does. Like the seed, it serves as a storehouse for the growing plant, and if the *pieces* are of sufficient size to furnish this food matter, the next crop will not be affected by the size of the potato planted.

Prevention of Potato Rot.—To prevent rot or blight the seed should be rolled in sulphur, the vines sprayed with Bordeaux mixture as soon as blight appears, and rotation of crops practiced. In no case should potatoes be planted on the same ground where the previous crop has been affected, as the spores are in the soil and will surely attack them.

ONIONS.

Advantages of Raising Onions.—Not enough onions are grown in the United States to supply the demand. Millions of bushels are annually imported. They yield heavily, sometimes as much as a thousand bushels per acre, and they are not hard to grow. The greatest cost of their cultivation is labor, but of a kind that a child can easily do. Onion raising offers to the children on the farm a splendid opportunity to make their spending money, and for that reason it is discussed here. One-fourth of an acre set to onions should

ONION GROWING FOR PROFIT.
Courtesy of Country Calendar.

yield 100 bushels, which, if the market is good, will bring them from $50 to $75. Hard, indeed, would be the farmer who would not give to his children so small a patch of ground on which to grow onions, and time enough to cultivate them.

Kind of Soil Needed.—Onions, like tobacco, require a fertile soil, rich in humus, but they need considerably more moisture. In the northern states the seed should be sown in boxes in early spring, and the young plants transplanted as soon as the ground is in fit condition. There are several reasons for this: In the first place, onions grow very slowly, and, if sown in the ground, the weeds become too large and thick before the young onions are large enough to cultivate. In the next place, they can be transplanted the right distance apart and do not rob each other of plant food, as they would before thinning, if sown in the row. In the third place, onions require a large amount of moisture, and if started in the house or hotbed the plants may be set out in time to get all the benefit of the spring rains. It has been shown that transplanting will double the yield.

How to Plant Onions.—They should be set in rows from a foot to eighteen inches apart, and the plants should be placed about four inches apart in the row. The soil should be heavily fertilized, and very thoroughly prepared. All lumps should be broken and the surface made smooth. The rows may be laid off by stretching a line across the plat. The plat may be marked out along the string by rolling a wooden wheel (an old wagon wheel with the tire removed will answer), on whose edge wooden pegs about three inches long and four inches apart have been set. The plants should be placed in the holes made by the pegs and the soil pressed firmly around their roots.

Onion Cultivation.—The cultivation can be done with a steady horse, if the rows are far enough apart, with a hand cultivator or with a hoe. Success depends upon cultivation. The soil should be frequently stirred, and it must be kept absolutely free from weeds.

When Ready for Harvest.—When the tops are dead and dry the crop is ready for harvest. The onions should be pulled, carefully cleaned, dried in the sun for a few hours and stored away in a cool, dry place until ready for market. If they are placed in bushel boxes with lath sides they will keep in good condition.

Best Varieties of Onions.—Yellow Danvers, Early Reds, Red Wethersfields, Yellow Globe and Prizetakers are the standard varieties. The first named is the heaviest yielder, an onion of excellent flavor and sells well on the market.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 35.—Potato Culture.
No. 39.—Onion Culture.
No. 52.—The Sugar Beet.
No. 60.—Methods of Curing Tobacco.
No. 82.—The Culture of Tobacco.
No. 83.—Tobacco Soils.
No. 120.—The Principal Insect Affecting the Tobacco Plant.
No. 129.—Sweet Potatoes.

Problems.

1. How many tobacco plants will be required to set an acre in rows three feet apart, the plants two feet apart in the row?

2. Tobacco is usually strung on laths to be cured. With twelve stalks to the lath, how many laths will be needed per acre?

3. If the stalks need four feet of vertical space and the laths are hung one foot apart in the shed, how many cubic feet of shed room will be required to house an acre of tobacco?

4. Give dimensions of a shed for five acres of tobacco.

5. If the average weight of seed potatoes is four ounces each, and if they are cut in halves and planted in rows three feet apart and eigheten inches apart in the row, how many bushels of seed will be required per acre?

6. How many bushels will be needed if whole potatoes are used? Quarters? Eighths?

7. A sugar factory agrees to pay $4.50 per ton for all beets testing 14 per cent, or less, of sugar. They also agree to give an additional 25 cents per ton for each additional 1 per cent of sugar or fraction thereof over 14 per cent, if the fraction exceeds one-half per cent. What is the price of beets testing 13.7 per cent? 14 per cent? 14.3 per cent? 14.7 per cent? 15 per cent? 15.2 per cent? 15.6 per cent? 15.8 per cent?

8. Mr. Smith's beets yield fourteen tons per acre and test 15 per cent. How much does he get per acre for his crop?

9. On two acres of ground Mr. Jones raises 73,680 pounds of beets which test 14.8 per cent. How much do his beets bring him in money per acre?

10. If Mr. Jones spends $56 worth of labor on his crop of beets, what is his net profit per acre?

11. How many onion plants will be required to set an acre in rows two feet apart, plants four inches apart in the row?

12. If a boy can set nine plants per minute, how long will it take him to set them?

13. If these onions average four ounces each, how many bushels are raised on an acre? If they average six ounces? Twelve ounces? One pound?

14. What is the value of the crop in each case, at 60 cents per bushel?

15. If it requires fifty days of a boy's time, worth 75 cents per day, to raise an acre of onions, what will be his profit on an acre of four-ounce onions?

16. Pupils will furnish data for other similar problems.

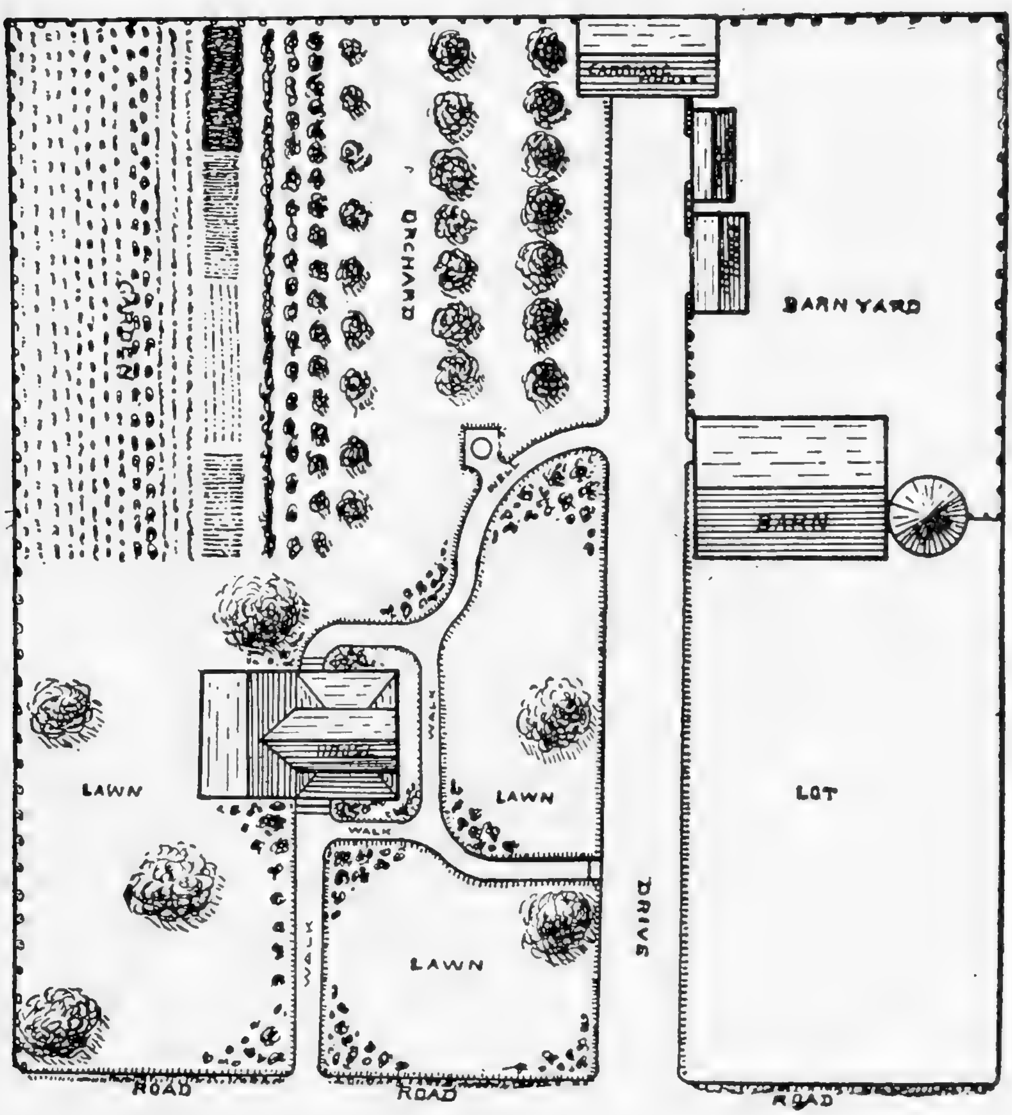
CHAPTER XIX

FARM BUILDINGS

Number and Kinds of Buildings.—That good, substantial buildings are needed on every farm goes without saying. The number and kind, of course, vary with the size and location of the farm, and the special crops raised thereon. But a good house, barn, granary, silo, carriage and tool house are almost indispensable on every farm.

Attention to Arrangement.—Usually too little attention is given to the arrangement of these buildings, and, when they once have been placed, it is next to impossible to correct the bad effect of poor arrangement. The barn in front of the house, or on the windward side of it, the hog house in front of the house, the barnyard between the house and the barn, the carriage house opening into the barnyard, and the vegetable garden in the dooryard, are some of the common mistakes.

Location of the House.—The location of the house should receive first attention. It should be placed on an elevation sufficient to afford good drainage, four or five rods back from the road, leaving room for a nice lawn in front. The barn should be placed at one side and farther back from the road. If possible, it should be so located that the prevailing wind will carry the barn odors away from the house. The barnyard



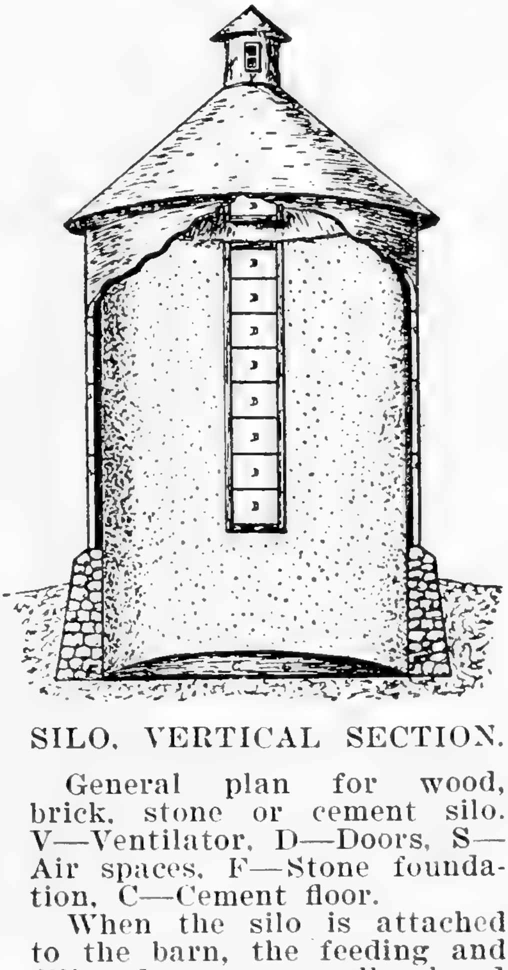
FARM BUILDINGS AND GROUNDS NEATLY AND CONVENIENTLY ARRANGED.

should be in the rear of the barn so that the view from the house will be unobstructed by high board fences, stables or sheds. A drive should lead from the road to the barn, and the horse stable and carriage house should open onto this drive, so that the farmer and his sons will not be compelled to pass through the barnyard every time they hitch up a team. A walk of cinders, gravel or sand should lead from the house to the barn. Such a walk is cheap, easily built, and will always be clean and comparatively dry. The vegetable garden can be placed any-

FILLING THE SILO.

where in the rear, near the house, where it will be convenient. The logical place for the well is between the barn and the house, where it can be used for both places, but not too near the barn. The silo should be attached to or near the barn, and, of course, the granary should be near by. Tool houses, tobacco sheds and all other outbuildings should be kept well back from the road, so as not to obstruct the view from the house.

The Construction of Buildings.—But little need be said about the construction of farm buildings. The careful farmer will adapt the buildings to the size of the farm, and his own special needs. The silo is the one farm building, however, that needs the most careful construction. The importance of silage as a feeding stuff is growing more apparent, but silage will not keep well in a poorly constructed silo. Whatever the type of silo the farmer chooses to build, four things must be observed: It must be air-tight, strong, perfectly smooth on the inside and placed on a strong, solid foundation.



SILO. VERTICAL SECTION.

General plan for wood, brick, stone or cement silo. V—Ventilator, D—Doors, S—Air spaces, F—Stone foundation, C—Cement floor.

When the silo is attached to the barn, the feeding and filling doors are usually placed on opposite sides, the feeding doors opening into the barn.

The Silo.—The silo must be air-tight, because the air contains germs that will set to work upon the silage and cause it to spoil and decay. Silage is something like canned fruit, in this respect. The silo must be strong, because the green feed with which it is filled is very heavy and solidly packed down. This exerts a tremendous side pressure which will spring or burst the walls of a poorly constructed silo and admit air, causing the silage to spoil. It must be perfectly smooth on the inside, because silage should settle evenly. Projections, or rough places on the inner walls of a silo, will prevent this even settling, cause dead air spaces, which spoil the silage. It must rest on a strong, solid foundation, because the side pressure and weight at the bottom are very great. This pressure may burst a heavy stone wall—and the great weight will cause a silo placed on a poor foundation to settle out of shape and crack the walls.

Silage Is a Satisfactory Feed.—If this building is so constructed as to provide for sufficient ventilation and to prevent freezing, and proper care is used in filling the silo, the silage will be a very satisfactory feed to use on the farm.

Free Bulletins, U. S. Dept. of Agriculture.

No. 32.—Silos and Silage.
No. 126.—Practical Suggestions for Farm Buildings.

Measurements.

Rules.

1. To find the area of a triangle multiply the base by one-half the height.

2. To find the circumference of a circle multiply the diameter by 3 1-7.

3. To find the area of a circle multiply the square of the radius by 3 1-7.

4. The square of the hypotenuse of a right triangle is equal to the sum of the squares of the other sides.

NOTE: Make a drawing before attempting to solve any of the following problems.

Problems.

1. How many feet of inch lumber will be required to build a pig pen six feet wide, four feet from peak to ground, and eight feet long? (See rules 1 and 4.)

2. How many feet of inch lumber will be needed to board up the gables of a barn thirty feet wide, the peaks being twelve feet above the eaves?

3. How much lumber will it take to cover a corn crib with four-inch slats, placed one inch apart, the crib being twenty-four feet long, six feet wide at the bottom, eight feet at the top, eight feet to the eaves, and the peak three feet above the eaves?

4. How long will the rafters need to be for this crib if they are to project one foot? How many feet of 2x4 rafters will be required if they are placed two feet apart?

5. How many feet of 2x4 studding will be needed if they are placed the same distance apart? How many feet of roof boards will be required if they are allowed to project one foot at each end?

6. How many cubic feet must a bin contain in order to hold a thousand bushels? Make a list of convenient dimensions for such a bin.

7. How many feet of two-inch plank will be required to build a cylindrical tank fourteen feet across and two feet deep? What will be the cost of the lumber at $30 per thousand?

8. How many feet of band iron will it require to make three hoops for this tank?

9. How many feet of inch lumber will be required to cover the inner wall of a "round" silo twenty-one feet across and eighteen feet high? How many feet of two-inch plank will be needed for a cover? What will be the cost of all this lumber at $25 per thousand?

10. What will it cost to put a cement floor in this silo at 10 cents per square foot?

11. How many 2x4 studdings eighteen feet long and placed one foot apart will be required, and what will be their cost at $24 per thousand?

12. What will it cost for the lumber to floor a barn forty by sixty feet with two and one-half inch plank at $18 per thousand?

13. The peak of this barn is twelve feet higher than the eaves. What will inch lumber for sheeting the gables cost at $24 per thousand.

14. The rafters are made of 2x4, and twenty-seven feet long, placed eighteen inches apart. How much will they cost at $20 per thousand?

15. What will be the cost of the sheeting for the roof at $16 per thousand if the roof projects two feet at each end?

16. What will it cost to shingle this roof with shingles worth $3.25 per thousand, laying them five inches to the weather and allowing for a double course at the eaves?

17. This building is placed on a wall twelve inches thick and eight feet high. What is the cost of the stone for same at $5 per cord?

18. What will it cost to fence a field sixty rods long and forty-five rods wide with a five wire fence, posts one rod apart, worth 5 cents each, staples 6 cents per pound (200 to the pound), wire weighing one pound to the rod, worth \$4.50 per cwt., and labor amounting to \$6?

19. What will it cost to build a five board fence around the same field, using twelve-foot boards, six inches wide, and worth \$16 per thousand, posts 5 cents each, nails and labor, \$15?

20. Pupils make and solve similar problems from data taken from actual conditions.

CHAPTER XX

FARM ACCOUNTS

Keeping Accounts.—There are times when every farmer needs to keep accounts. Sometimes it is desirable to know just how much cash is received and paid out during the year. A simple CASH ACCOUNT will show this. All kinds of accounts require two columns. These columns may be placed side by side at the right of the page, or the page may be divided with double ruling down its center, or two separate pages, facing each other, may be used. Whichever kind of ruling is used, the accounts are all kept in exactly the same way. The divided page method is used in this book.

Cash Accounts.—In keeping a cash account the word CASH is first written across the top of the page. All cash *received* is placed in the cash space in the left hand side, and all cash *paid out* is placed in the cash space in the right hand side. At the extreme left of each side the *date* is placed, and between the date and the cash space the *item*, for which cash has been received or paid, is written. The total amount of cash received, or paid out, is easily found by adding the amounts on each side, and the difference of these two sums represents the cash on hand. Cash on hand should be carried over into the *received* side at the top of the next page, when any page is filled up with entries. If it is desired, the TOTALS may be carried over into their respective columns instead, and the new page kept in exactly the same way as the preceding page. This is all there is in keeping a cash account. It is a very simple and easy thing to do. For example:

CASH.

Date 1905		Item	Rec'd		Date 1905		Item	Paid	
Jan	1	Cash on hand .	$ 24	40	Jan.	2	Groceries	$ 3	00
Jan.	3	For hogs......	102	75	Jan.	15	For coal.........	14	40
Jan.	30	For butter	42	84	Jan.	17	For books.......	5	00
Feb.	1	For eggs	2	25	Jan.	20	For overcoat....	12	00
					Feb.	1	For rubbers.....		75

Study the above illustration, determine how much cash is on hand Feb. 1, 1905, and on a blank sheet of paper, open up a new page in both ways as described above. Submit your work to your teacher to find out whether you are correct.

Personal Accounts.—A personal account is kept in exactly the same way as a cash account. The name of the *person* is first written across the top of the page. Whenever this person *receives* anything from the one keeping the account, this entry is made in the left hand side under the word *debtor*, and whenever he *pays* anything on this account, this entry is made in the right hand side under the word *creditor*, exactly the same as with a cash account. The dates and items are written in their proper places, which are the same as those for cash accounts. For example:

JOHN SMITH.

Date 1905		Item	Dr.		Date 1905		Item	Cr.	
Sept.	22	To 1 pig	$12	50	Oct.	3	By 3 days' work.	$4	50
					Oct.	10	By cash	2	00
					Oct.	25	By 1 days' work.	1	50

Suppose that on Sept. 22, 1905, you sell a pig to John Smith for $12.50, for which he agrees to pay either in money or in labor at $1.50 per day. He works on Oct. 1, 2 and 3. On Oct. 10 he pays $2 in cash, and on Oct. 25 he works another day. The account is kept in this manner.

This account shows, in a brief manner, a complete history of this transaction. It gives all dates, which are of great importance in all accounts. It shows that John Smith owes you $12.50 for a pig, that he has already paid you $8 in labor and cash, and that he still owes you $4.50. When this is paid, it should be entered under the other items in the credit column, both columns added and the account *closed* by drawing two lines across the page below the account, like this:

JOHN SMITH.

Date 1905		Item	Dr.		Date 1905		Item	Cr.	
Sept.	22	To 1 pig	$12	50	Oct.	3	By 3 days' work.	$ 4	50
					Oct.	10	By cash	2	00
					Oct.	25	By 1 day's work.	1	50
					Oct.	30	By bal. cash	4	50
			$12	50				$12	50

PRODUCE ACCOUNTS.

Sometimes the farmer wishes to know his profits on his cows, tobacco, beets or other things produced on the farm. It often happens that his wife wants to keep account of her profits on berries or poultry. Such an account is called a PRODUCE account, and it is kept exactly like a personal account. Suppose that you want to keep an account of your chickens. The word CHICKENS is first written across the top of the page. Whenever the chickens *receive* anything from you like feed or coops, this entry is made in the left hand column under the word *debtor*. Whenever they *pay* you anything in the form of eggs or young chickens, this entry is made in the right hand column under the word *creditor.* Study the following account:

CHICKENS.

Date 1905		Item	Dr.		Date 1905		Item	Cr.	
May	1	To lumber for coops	$ 3	20	May	30	By eggs for mo..	$ 2	50
June	2	To feed........		75	June	30	By eggs for mo..	1	80
June	30	To corn meal..	2	40	July	30	By eggs for mo..	2	10
Aug.	1	To corn........	3	00	Oct.	1	By young chickens ...	6	00
					Oct.	1	By young chickens eat'n	3	00
Oct.	1	Profit	10	05	Oct.	1	By eggs eaten...	4	00
			$19	40				$19	40

The above account shows that these chickens received from you a total of $9.35 in coops and feed, and that they paid you in eggs and young chickens, which you sold, and in other eggs and chickens, which you ate during the summer, a total of $19.40, giving you a profit of $10.05 on the investment.

If farmers would form the habit of keeping accounts of their stock and their crops, much unprofitable farming might be avoided, as attention would thus be directed to those products which, on the average, yield the largest returns for the labor and money expended.

Problems.

1. A farmer's boy hires out to a neighbor for five months at $22 per month. He begins work April 1, with $7.35 cash on hand. He receives his pay at the end of every month. April 2, he pays $2.75 for shoes. April 20, 25c for a straw hat. May 3, he spends $1.25 for a coat. May 31, he buys a colt for $42. July 1, he pays $14.75 for more clothing. July 4, he spends $2.35. July 20, he sells his colt for $55. August 15, he pays $6.50 for a watch, and, during the summer, he spends $4.85 for sundry small articles.

Write out his account and determine how much cash he has on hand when his time is out.

2. Two boys rent for $4 a half acre of land on which to plant onions. They allow themselves 75c each per day for their time. It costs them $2 to get this piece of land fertilized and plowed. They each spend ten days' time planting and cultivating their onions, and four days more each when harvesting time comes. They sell $14.30 worth of green onions, and harvest 142 bushels more. For 100 bushels they get 75c per bushel, and 60c per bushel for the remainder.

Write out their ONION account, and find their profit.

3. A farmer runs an account with George White, a merchant. July 7, he buys a pair of shoes for $2.40 and has them charged on account. July 20, he takes in twelve dozen of eggs at 11 cents per dozen and gets 50c worth of sugar. August 3, he takes in twelve pounds of butter at 20 cents per pound and gets nine

yards of calico at 6 cents per yard, one pound of tea at 50 cents, four pounds of coffee at 18 cents per pound, and a barrel of salt at $1.25. August 14, he gets a pail of fish at 75 cents and 100 pounds of sugar at 5½ cents per pound, and pays $2 in cash. How does his account stand on August 15?

Write out this account with GEO. WHITE.

CHAPTER XXI

FORESTRY

Importance of the Forest.—Next to the soil itself, no other part of the earth, or its furnishing, is of such importance to man as the forest. Indeed, without the forest, past and present, there would hardly be any tillable soil. But it is also our chief source of building material and of fuel. It is, moreover, the great garment of the earth, protecting and adorning it.

Nature of the Forest.—The forest is much more than a collection of independent trees; it is a great organism, composed of many parts, or elements, each dependent on the others. It has a very complex and varied life, comprising not only trees and shrubs, but also herbs, flowers, mosses, lichens, birds, insects, and higher animals in great variety, all dependent for their very life upon their combination and mutual service, in the great living thing we call the forest.

Influence of the Forest.—The forest exercises a great influence upon the earth and its inhabitants outside of the forest limits. It is often the source of streams, and controls the water supply of surrounding regions. It breaks the force of winds and tempers the climate. It supplies vegetable mold which is an indispensable element in fertile soil. And it affords recreation, and the highest forms of enjoyment to those who can get access to it. In short, the forest is one of man's greatest blessings, and yet it is the one which he has abused with most recklessness and ignorance. And in no part of the world has this reckless waste been greater than in the United States, and especially in the North Central states.

THE EDGE OF THE FOREST.

Destruction of the Forests.—The forest was intended for use, but it was meant to serve man for ages, and not to be destroyed in the lifetime of a man. The great causes which have wrecked the forests and wiped them from the earth to so great an extent are (1) unwise and unregulated cutting by lumbermen, and (2) the prevalence of forest fires. These fires, springing up in seasons of drouth, are fed and made destructive by the brush and dead tree tops, left as wreckage on the ground, wherever logging has been carried on. The fires are often started by the criminal negligence of hunters and campers in not putting out all remains of their camp-fires, or in other careless ways. Some of these fires have done immense damage to the standing forest, and have caused great distress and loss of human life. Among the most destructive of these are the great Peshtigo fire of 1871, in Northeastern Wisconsin, and the Hinckley fire of 1894, in Minnesota.

The Economic Use of the Forest.—The science and art of forestry has for its purpose the perpetuation and, at the same time, the economical utilization of the forest. It teaches men how to keep the forest alive by cutting out only the trees that have got their growth and are ripe, in such a way as not to injure or endanger the remaining growth. The younger trees are thus given more light and air and room to grow, while the undergrowth is also preserved. The "forest floor" of decaying leaves, rotten wood, and other debris is preserved as a means of enriching the soil and, especially, of retaining moisture and preventing the rains from running off too quickly in surface wash and floods. Forestry also teaches the best ways of replanting, or "re-foresting," areas in which the timber has already been wastefully destroyed. This art of prudently managing timber lands, so as to keep up their blessings to their owners and others, has long been practiced in European countries, particularly in Germany, and has proved of the greatest advantage. The people of the United States are just waking up to the necessity of such a course, and the United States Department of Forestry is now doing excellent service in educating the people to greater intelligence and foresight in the management of such remnants of our once magnificent forests as yet remain; though we are reminded of the old saying about locking the stable door after the horse is stolen. The new policy of our government in setting off Forest Reserves in the unsold lands of the Western States, particularly in the mountain regions, deserves the earnest approval and support of all citizens interested in the future welfare of our country. Lumbermen, generally, have blindly followed the example of the woman who killed the goose that laid the golden eggs; and the future good of our land ought not to be left longer at their mercy.

The Wood Lot.—But we need not look upon forestry as a matter which concerns only the far off forests of the North and West. Every farmer who has a "wood lot" left ought to understand its principles and apply them to his own possessions.

Care of the Wood Lot.—The importance of caring for the farm wood lot cannot be too strongly emphasized. When our country was new and land had to be cleared to make room for the crops, farmers cared little for timber and less for wood. Great trees were cut down and rolled into the log heap. Good material for lumber went up in smoke, and in those days no one ever thought of saving wood. But now all is changed.

In many places the price of wood is exceedingly high. Good lumber is every year becoming harder to get. We have awakened to the fact that the farmer who has a wood lot on his farm has a valuable piece of property.

Management of the Wood Lot.—A few acres of wood land, if properly managed, will furnish wood and other timber to the farmer for years to come. Now, what constitutes proper management of the wood lot?

First, desirable young trees should be kept growing. Undesirable ones should be cut out and used for fuel or other purposes.

Second, it is not, as a rule, a good plan to pasture the wood lot. Animals injure and destroy young trees by browsing upon them and gnawing their bark. Again, their sharp hoofs injure the roots, and their continuous tramping hardens the soil.

Third, if grass is allowed to get into the wood lot it starves out the young seedlings or, at least, checks their growth. This is another good reason why the wood lot should never be pastured or seeded to grass.

Fourth, old trees and dead trees should be carefully removed, the saw-timber saved, the limbs cut into wood, and the brush piled up neatly. As a rule, it is not a good plan to burn the brush. Many young trees are killed in this way.

Fifth, when bare spots appear in the wood lot, young trees should be encouraged to grow there, either by planting seeds or young trees. Seedlings should be thinned so that they will not starve each other out, and only the most useful, thrifty, and hardy kinds should be planted.

Profit in the Wood Lot.—With a little care and attention on the part of the farmer the wood lot may be preserved and the land devoted to it be made to yield as large returns as other acres of the farm which are more carefully cultivated.

Forests Prevent Droughts.—There are other good reasons why forests should be preserved in agricultural regions. The soil in the woods is very porous, and capable of absorbing large quantities of water, which runs off from cleared land and is wasted. This water is stored away as underground water. It feeds our wells and springs, and, moving upward, it increases the supply of capillary water in the soil, and thus becomes available for the use of plants. It is well known that forest regions are seldom, if ever, affected by drought. Then, too, forests furnish homes for game, which all farmer boys delight in hunting, and for birds which feed upon insects that would injure our crops, if they were not held in check by the birds.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 54.—Some Common Birds in Their Relation to Agriculture.

No. 150.—Clearing New Land.

No. 173.—A Primer of Forestry.

Problems.

1. At $6 per cord, what is the value of a pile of wood 240 feet long, six feet high and four feet wide?

2. A farmer gets six cords of wood from ten trees. With wood at $5.50 per cord, what is the value of these trees?

3. What is the value of a single tree at the same rate?

4. Suppose there are fifty such trees on an acre, what is the value of the wood on this piece of land?

5. What is the value of a wood lot of fifteen acres at the same rate?

6. Suppose a farmer removes the five biggest trees per acre from his wood lot each year. If each tree makes ¾ of a cord of wood, worth $6 per cord, and it costs 80c per cord for cutting, what profit does he make per acre on his wood lot?

7. Compare this with the profit on an acre of oats.

8. Compare it with the profit on an acre of corn.

9. What will the profit on a twelve acre wood lot be at the same rate?

10. Compare this with the profit on twelve acres of meadow.

11. Pupils make and solve similar problems from data furnished by the teacher, themselves or their parents.

CHAPTER XXII

HOME AND SCHOOL GROUNDS

Influence of Home Surroundings.—Beautiful home surroundings exert an educational influence on the young, and add to the enjoyment of life for all. The proper provision of such surroundings is, therefore, a matter of importance to all who have, or expect to have, homes in the country. The tasteful arrangement and proper planting of home and school grounds require much thought and study in order to insure satisfactory results.

Principles of Landscape Gardening.—In all landscape gardening two principles must be observed:

First, care must be taken in the selection of what is to be planted. A bunch of flowers does not necessarily constitute a bouquet; intelligence must be employed in their selection and arrangement. So in the planting of grounds wisdom must be exercised in the selection and distribution of plants, trees, and shrubs in order to produce a pleasing and durable result. Consideration should be given to the nature of the surface and soil; and the location of everything planted should harmonize with the lay of the land, concealing defects and emphasizing the attractive features.

Second, the planting itself should be rightly done, so as to insure proper growth and permanence. Arbor Day has been celebrated by the planting of many thousands of trees throughout the Western States; but, in all probability, not 10 per cent of these are alive and in healthy growth at the present time. The

A CORNER OF A WELL ARRANGED SCHOOL GROUND.
(Whitewater, Wis., Normal School.)

practice of planting trees and naming them after great men, as Grant, Dewey, and the like, is a commendable practice, if followed by proper care of the trees thus planted; but quite otherwise if the trees die and are consigned to the brush pile through neglect of our second principle.

Application of Principles.—In order to apply these two principles successfully, it is necessary to make a study of the grounds and also of the characteristics of trees and plants; their hardiness, their mode of growth, and their adaptation to the soil and other conditions. There are probably not more than a dozen kinds of trees, and as many species of shrubs, that are adapted to planting in small grounds, under ordinary conditions, in this climate. The proper location of drives and walks should receive due consideration before planting begins. Care should be taken not to plant trees too close together, or else there should be a definite plan for thinning them out as they approach full size. We should try to picture, not the small tree that we plant, but the tree that is to be.

Selection of Trees for Planting.—Small, thrifty trees should ordinarily be selected for planting, rather than large ones. They are more likely to live and will be larger and more satisfactory at the end of a few years. If large trees are planted, they should be "headed in" unsparingly, and staked firmly. No tree, large or small, should be planted which is blemished or imperfect, or without a good equipment of roots. Perhaps the majority of trees are practically ruined by the destruction of roots in the digging.

Preparation for Planting.—In preparation for planting, the holes should be dug at least four feet in diameter and two feet in depth. If the soil is hard and poor, it should be replaced by good earth; and in every case the trees should be well mulched with coarse litter that will remain in place. The work of planting cannot be done rightly by one person alone; it requires two, one to handle the spade and one to handle the tree and adjust the soil properly around the roots, which should be spread out in their natural position. Do not use water in planting unless the soil is dry, and even then it is not best to use a great amount.

Handling of the Trees.—In handling the trees between digging and planting, great care is necessary to prevent the fine, fibrous roots—which are the really important ones—from becoming dry through exposure to sun or wind. The cut ends of all large roots should be re-cut smoothly with a sharp knife immediately before planting.

Plants Adapted to School Grounds.—The following trees and shrubs have been planted on the grounds of a certain school, viz.: Arbor Vitæ, Colorado Blue Spruce, Douglas Fir, Hemlock, Norway Spruce, Scotch Pine, Cut-leaved Birch, Norway Maple, Common Barberry, Thunberg's Barberry, Dogwood, Golden Elder, Japanese Tree Lilac, Persian Lilac, Syringa, Rosa Rugosa, Russian Olive, Tartarian Honeysuckle, Spirea von Houttei, Snowball, Clematis, and Woodbine.

Out of over 1,000 specimens planted, less than a dozen failed to live and thrive, since care was taken to follow the directions given above.

Where to Secure Plants.—Some varieties of trees and shrubs may be dug in the woods, in some localities; but it is generally better, for school use, to get them right from the ground, from a reputable nurseryman, or from the gardens of people who are willing to contribute them. Sometimes they can be procured without cost from State Experiment Stations.

The planting of home grounds may, perhaps, be less elaborate than that of public grounds; but it needs no less care and attention to right methods. Such work "pays in the heart;" and no other work pays so well as that which tends toward happy, cheerful life.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 134.—Tree Planting on Rural School Grounds.
No. 185.—Beautifying the Home Grounds.

Extracts.

No. 91.—Lawns and Lawn Making.

Problems.

1. Measure the lot at home on which the house stands. How many square yards in it? How many square rods?

2. Draw a plan by scale of this lot, locating buildings, trees, flower beds, etc.

3. Is there any way in which this plan might be improved or the appearance of the grounds made more pleasing?

4. Draw another plan showing location of buildings, flower beds, trees, walks, and drives as you would like to have them arranged.

CHAPTER XXIII

SCHOOL GARDENING

The Development of School Gardening.—It has been a common practice in several European countries, for fully a century, to conduct gardens in connection with schools. This idea of making gardening a part of school work is rapidly growing in favor in our own country. The garden is a matter of great practical importance to all people living in the country, and it can be made a useful adjunct to the work of almost any school, if intelligently managed.

Value of the Garden.—The study of agriculture has rightly been made a required subject in the schools of some states, and this must include some attention to gardening. The home garden ought to be the best part of the farm. And no department of agriculture is so well calculated to develop in boys and girls the power of keen observation and love for the beauty, variety and harmony which nature exhibits as that of gardening. Therefore, it is important that we do something with school gardening in order to assist and encourage home gardening.

Size and Shape.—The size and shape of the school garden will depend, of course, upon the area and form of the lot. The nature and condition of the soil must be taken into account when we come to the decision of what shall be planted.

Arrangement of School Grounds.—The school garden must not encroach upon the playground; playgrounds are an absolute necessity. If the school lot is

GIRLS' SCHOOL GARDEN, YONKERS, N. Y.

very small, the corners and strips along the fences may be used for garden purposes. If the grounds are large enough, the following arrangement is a good one: Place the flower-beds towards the front of the grounds, on each side of the front lawn. Back of the flower-beds, and next to the playgrounds, is a good location for shrubbery of various kinds. In the rear of the playground we may place the vegetable garden. Shrubs and vines may be planted along the back fence, with perhaps a border of wild flowers, ferns, etc. We shall then have an arrangement like this, viz., front lawn, paths, flower-beds, playgrounds, vegetable garden, wild flowers, vines, etc.

The Flower Beds.—In the flower beds a variety of plants may be grown, but good sense will be necessary in their selection; success will depend greatly on this. Such hardy bulbs as tulips, crocuses, and narcissuses

BOYS' SCHOOL GARDEN, YONKERS, N. Y.

should be included for spring blooming. Peonies, iris, phlox and other hardy perennials should have a place, as they survive from year to year with comparatively little trouble. Of annuals, only the more robust and easily grown should be attempted, such as asters, petunias, poppies, nasturtiums and zinnias. Regard should always be had to the water supply, as it is hard to grow beautiful flowers in hot weather without plenty of water. A flower bed withering for want of moisture is a sorry sight. Weeds, which grow rapidly and rob the plants of light, water and food, should be carefully kept under.

Essentials of Gardening.—In preparing the ground for planting, great care and patience should be exercised in enriching it and thoroughly pulverizing the top soil. Care should also be taken not to plant the seeds too deep, and not to let the surface become too dry while the seeds are germinating. These are fundamental requirements in all gardening.

List of Plants That May Be Grown.

VEGETABLES: Peas, potatoes, sweet corn, pop corn, tomatoes, beans, lettuce, cabbages, cucumbers, radishes, beets, onions, parsnips, turnips, etc.

FLOWERS, PERENNIALS: Phlox, hollyhocks, sweet William, iris, hemerocallis, columbine, monkshood, etc.

ANNUALS: Asters, four-o-clocks, marigolds, petunias, nasturtiums, poppies, mignonette, sweet alyssum, phlox Drummondii, coreopsis, zinnias, sweet peas, etc.

BEDDING PLANTS: Verbenas, geraniums, salvia, etc.

The above list might be greatly extended, but these are the things of easiest culture and surest returns. Probably no one will attempt to grow all of these in the same summer, but variety will be sought from season to season. It is better to grow a few things well than to attempt more than can be given thorough attention.

Free Bulletins, U. S. Dept. of Agriculture.

Farmers' Bulletins.

No. 218.—The School Garden.

Extracts.

No. 113.—Experimental Gardens and Grounds.

CHAPTER XXIV

HOME GARDENING

General Statement.—What has been said about the school garden will, much of it, apply equally well to the management of the home flower garden. In connection with country schools, vegetable gardening will not often be undertaken, as that requires more room and is more naturally connected with the home life; but city school children often develop great interest in the growing of vegetables.

Importance of the Garden.—Every family in the country should pay great attention to the garden, because of the profit and satisfaction which it affords. No other part of the farm of equal area pays one-tenth as well, financially, as a well-cultivated garden. Yet the garden is very apt to be neglected, and left to itself by farmers generally, from the mistaken idea that other work is more important. It is important, moreover, that the children in the home be trained to take an active part in the garden; for this furnishes one of the best means for stimulating a love for the beautiful and inspiring things of life. The treatment of the subject of gardening in this book must necessarily be very general. Gardening includes something of agriculture, horticulture, and floriculture. It is not advisable that the garden should be very large or elaborate, so that its care will become burdensome. The flower garden should not be located directly in front of the house, but at one side. It is not well to place a flower bed in the middle of the lawn. Neither should the front lawn be crowded with trees and shrubbery; there should be a good, clear stretch of grass, with the shrubbery around the skirts of it. The vegetable garden should be at the back of the house, or well to one side of the lawn and flower garden. It should be well fenced against poultry and other domestic animals.

Preparation of the Soil.—The soil should be well fertilized with barnyard manure. Neglect of this is fatal to the best results. Weeds will grow in any soil, but good vegetables require good soil as well as good cultivation. In the preparation of the soil, and in planting, the following points should receive attention:

(1) Plow carefully and well, so that all grass, weeds, manure, or litter will be thoroughly turned under. Do not plow when the ground is very wet.

(2) Harrow and rake until the top soil is fine, removing sticks and stones.

(3) The depth at which seeds should be planted depends, largely, upon the size of the seeds. Small seeds should be covered slightly but evenly. The character of the soil is also to be considered. In light,

sandy soil, or in situations exposed to the wind, planting should be deeper than under other conditions.

(4) Many people err in building up the beds too high above the level of the paths, as the soil dries out rapidly when thus raised. If the beds can be worked from both sides, which is better, they may be made four or five feet wide. If they cannot be worked from both sides, three feet is about the limit of width.

(5) The seeds should be planted in rows far enough apart to admit of passing a hoe freely between them. Flower seeds should, as a rule, be planted in rows crosswise of the beds. Judgment should be exercised as to the time of planting. Onions, peas and potatoes may be planted as early as the ground can be worked. Flower seeds, as a rule, should not be planted until the ground is warm and danger from frost is past. Sweet peas, however, may be planted early and very deep. All peas should be planted at least three, or even four, inches deep. They should be planted in rows running north and south and provided with proper support.

(6) The transplanting of cabbages, tomatoes, etc., should be done on a cloudy day, or towards evening. Plants should be set rather deep, and shaded from the next day's sun by a shingle or other shield.

(7) The surface of seed beds should not be allowed to become dry or hard during the time of germination. After plants are above the surface, the ground should be frequently stirred to prevent its baking or drying out, and to keep down weeds, which are much

more easily killed while they are young. Properly thin out the plants. Great harm is done by over-crowding. This is one of the most common mistakes.

(8) All vines, as cucumbers, melons and squashes should be carefully watched as they show the first leaves, to protect them from the bugs. The best protection is to sprinkle them, dry, with Hammond's "Slug Shot," a preparation which no gardener can afford to be without, as it is especially useful for destroying the slugs on cabbages, currant and gooseberry bushes, and rose bushes. It is much safer as well as cheaper than paris green. For potatoes, however, nothing else is so effective as paris green in water.

Free Bulletins, U. S. Dept. of Agriculture.

No. 94.—The Vegetable Garden.
No. 154.—The Home Fruit Garden: Preparation and Care.
No. 156.—The Home Vineyard, with Special Reference to Northern Conditions.
No. 198.—Strawberries.
No. 213.—Raspberries.

CHAPTER XXV

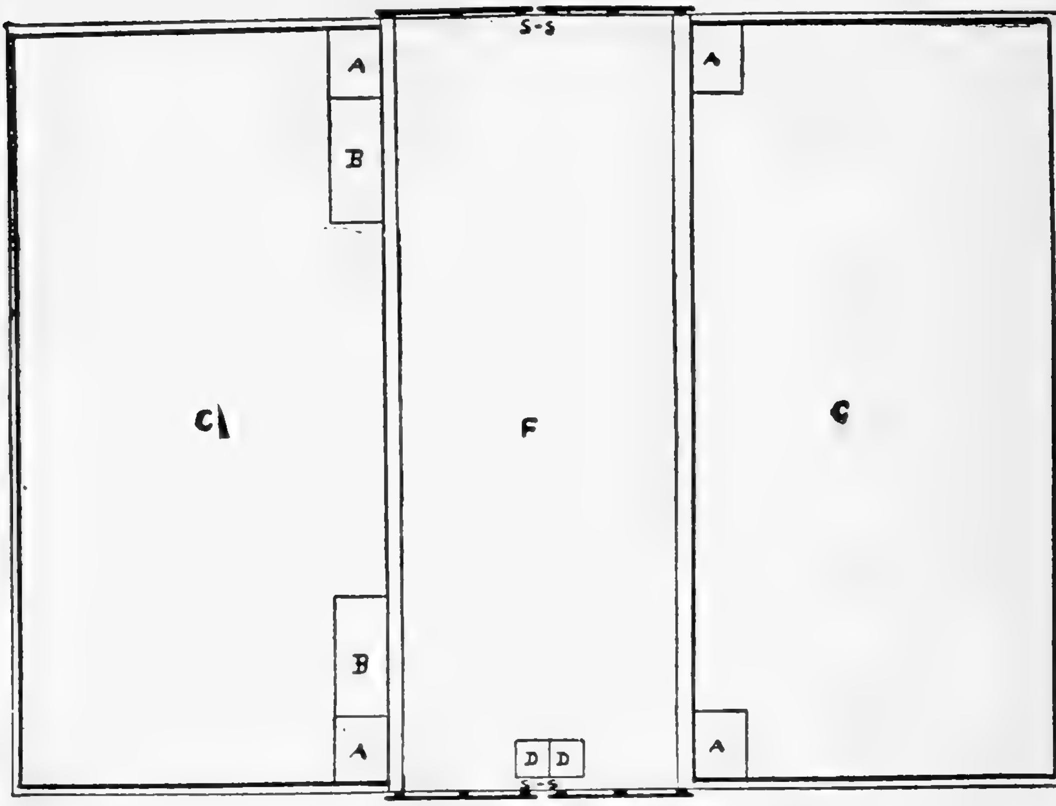
BARN PLAN AND VENTILATION

(Explanation of Barn Plan on Opposite Page.)

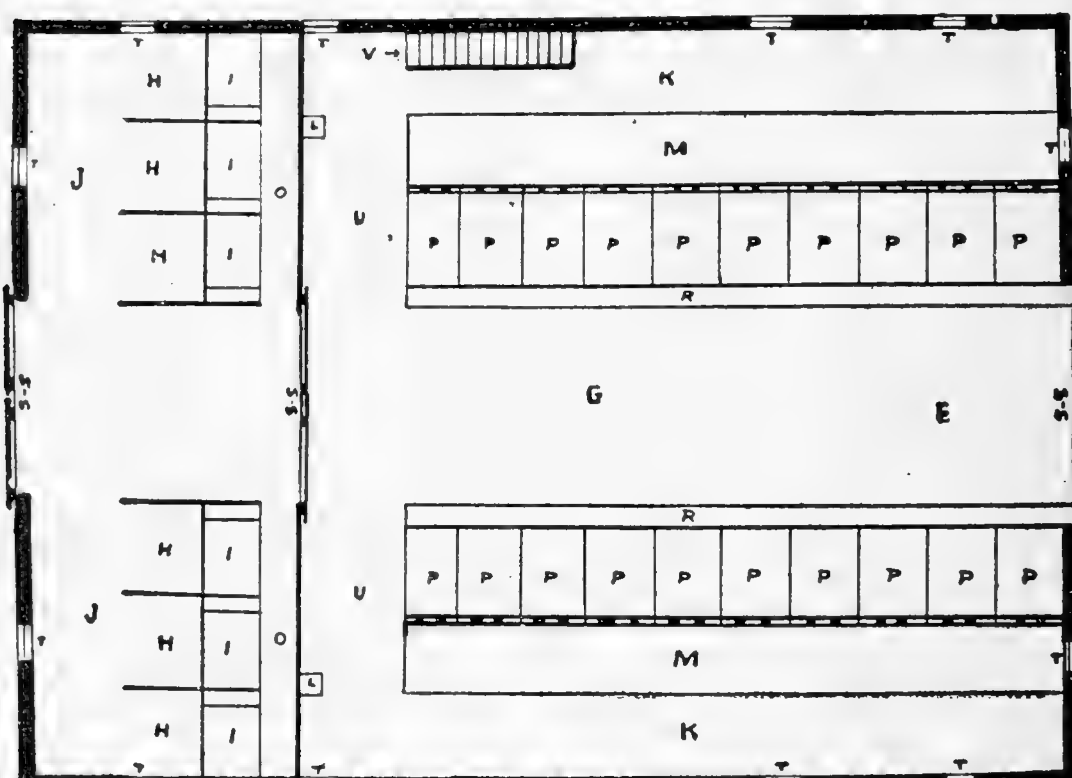
A—Feed chutes and ventilating shafts, 3½x4 feet. B—Feed bins, 3½x7 feet. C—Hay mows, 20x40 feet. D—Trap doors to stairs, 3x3 feet. F—Barn floor, 14x40 feet. G—Driveway, 10x55 feet. H—Horse stalls, 5x5 feet. I—Mangers, 3x5 feet. J—Alleys, 5x15 feet. K—Alleys, 5x40 feet. L—Small feed spouts from bins. M—Mangers, 3½x35 feet. O—Alleys, 2x15 feet. P—Cow spaces, 3½x4½ feet. R—Drop, 1x35 feet. S—S—Double doors. T—Windows hinged for ventilation. U—Alleys, 5x15 feet. V—Stairs to second floor.

Suggested modifications of plan to suit convenience of builder:—Position and number of bins and feed chutes may be changed. Dimensions may be cut down by making alleys narrower. Horses may face wall. Partition may be left out. Doors may be hung on hinges instead of rollers, etc., etc.

Importance of Ventilation.—In our efforts to provide warm and comfortable quarters for our stock, we have overlooked, in many cases, the most important matter of all,—proper ventilation.

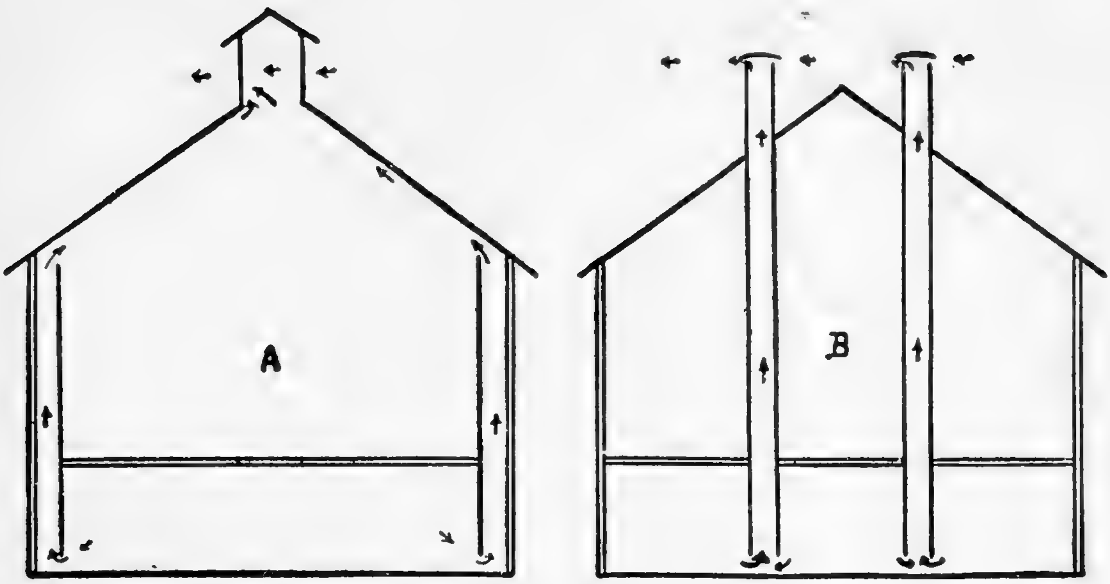


SECOND FLOOR PLAN



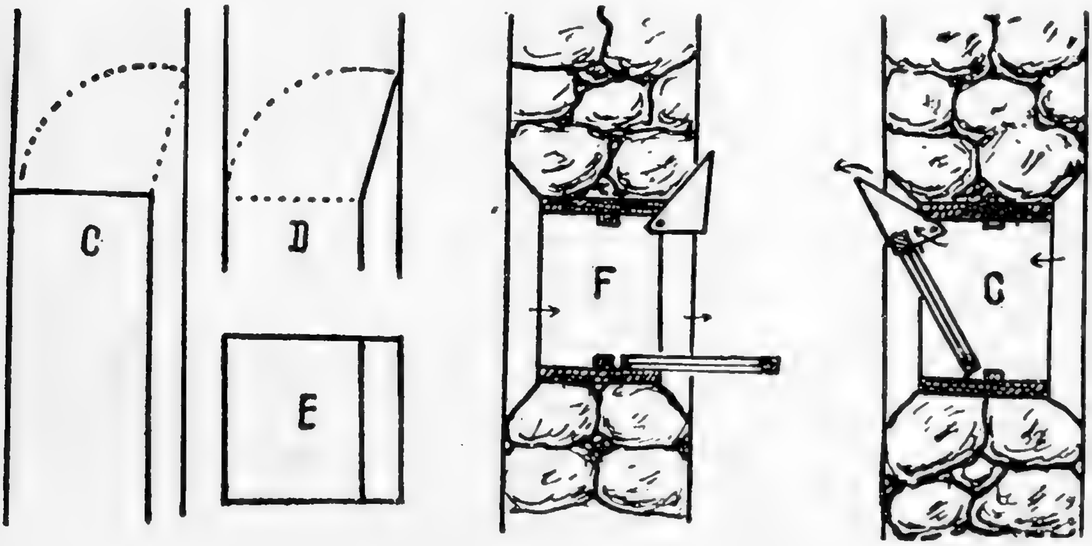
FIRST FLOOR PLAN

PLAN FOR CONVENIENT TWO-STORY BARN.
Dimensions 40x55 Feet.



VENTILATION PLAN.

As we enter some stables on a winter's morning, after the barn has been closed all night, we are almost stifled by the odors and impurities that fill the air. These must be very harmful to the animals that are forced to breathe them over and over again. In such



WINDOW VENTILATION PLAN.

NOTE: The above is a modification of the "King System" of ventilation, a system in successful operation on some of our best dairy farms.

stables no provision is made for admitting fresh air, or for drawing off that which has become charged with impurities and robbed of its life-giving oxygen. Without doubt the alarming prevalence of tuberculosis among cattle is largely due to this neglect.

Plan for a Ventilated Barn.—This neglected feature of barn construction is deemed worthy of special mention in this book. On the following pages will be found detail plans for a barn provided with an adequate system of ventilation.

A—Cross section, through feed chutes and ventilating shafts, of the barn shown on preceding page. B—Cross section of the same barn, through ventilating shafts, placed at the ends, on either side of the double doors. This method will, doubtless, be preferred by some farmers, as it will allow of keeping feed chutes filled with hay, sufficient for several feedings. However, it is not a wise plan to leave hay thrown down in the stables, as it will absorb the impure air and bad odors of the barn. In both cases feed chutes must be kept closed, in order to insure proper draft to ventilating shafts. C—Vertical section through floor, feed chute and ventilating shaft, showing trap door closed to insure proper circulation of air. D—Same, showing trap door open for feeding. E—Cross section of same at the second floor. Size of chute, 3x3½ feet. Size of ventilating shaft, ½x3½ feet. F—Section through wall and window, showing sheetiron wind-shield, thrown back, and window open for summer ventilation. G—Same, showing shield in place for winter ventilation.

Note I. This shield is made of sheet or galvanized iron, bent, as shown in sections E and F above, and screwed to the window frame. When in place it deflects the air upward towards the ceiling, preventing drafts. The opening between this shield and the window frame for the admission of air should be about two inches in width. When the shield is raised slightly, it allows the window to drop forward on its hinges at the bottom and to open fully.

Note II. If round iron pipes are used for ventilating instead of flues, they should be not less than fourteen inches in diameter. Their tops may be covered with revolving hoods, specially constructed to create drafts. If less than *four* ventilating shafts are used, they should be large enough to have the same capacity.

The bottoms of all ventilating shafts should open not more than one foot above the floor, and these openings should always be kept free from hay, straw or anything else that will prevent a free circulation of air.

CORN AND STOCK JUDGING

The following score cards for *corn* and *stock* judging are the ones in use at the University of Wisconsin and are here reproduced, by permission, with the hope that they will prove of value to those who are interested in these more advanced phases of agriculture. They are easily understood and require no additional explanation.

OFFICIAL CORN SCORE CARD

NOTE: Ten ears of corn constitute a sample for scoring.

EXPLANATION OF POINTS IN CORN JUDGING

1. TRUENESS TO TYPE OR BREED CHARACTERISTICS: The ten ears of the sample should possess similar or like characteristics and should be true to the variety which they represent.
2. SHAPE OF EAR: The shape of the ear should conform to variety type, tapering slightly from butt to tip, but approaching the cylindrical.
3. COLOR: A. GRAIN; B. COB: Color of grain should be true to variety and free from mixture. White corn should have white cobs, yellow corn red cobs.
4. MARKET CONDITION: The ears should be sound, firm, well matured and *free* from mold, rot or injuries.
5. TIPS: The tips of the ears should not be too tapering and should be well filled with regular, uniform kernels.
6. BUTTS: The rows of kernels should extend in regular order over the butt, leaving a deep impression when the shank is removed. Opened and swelled butts are objectionable.
7. KERNELS: A. UNIFORMITY OF; B. SHAPE OF: The kernels should be uniform in shape, size and color, and true to the variety type. The kernels should be so shaped that their edges touch from tip to crown. The tip portion of the kernel is the richest in protein and oil and hence of the highest feeding value. For this reason the tip portion should be full and plump.
8. LENGTH OF EAR: Northern section 8 to 9 inches, central section 8¼ to 9¼ inches, southern section 8½ to 9½ inches. Long ears are objectionable because they usually have poor butts and tips, broad, shallow kernels, and hence a low percentage of corn to cob.

9. Circumference of Ear: Northern section 6 to 6½ inches, central section 6¼ to 6¾ inches, southern section 6½ to 7 inches.

10. a. Furrow Between Rows; b. Space Between Furrows at Cob: The furrow between the rows of kernels should be small. Space between kernels near the cob is very objectionable.

11. Proportion of Corn to Cob: The proportion of corn to cob is determined by weight; depth of kernels, size of cob and maturity all affect the proportion.

OFFICIAL CORN SCORE CARD

		1		2		3		4		5	
1 Trueness to Type or Breed characteristics	10										
2 Shape of ear	10										
3 Color: a. Grain	5										
b. Cob	5										
4 Market condition	10										
5 Tips	5										
6 Butts	5										
7 Kernels: a. Uniformity of	10										
b. Shape of	5										
8 Length of ear	10										
9 Circumference of ear	5										
10 Space: a. Furrow between rows	5										
b. Space between kernels at cob	5										
11 Proportion of Corn to Cob	10										
Total	100										

BEEF CATTLE SCORE CARD

SCALE OF POINTS	Possible Score	Points Deficient: Score	Points Deficient: Corrected
GENERAL APPEARANCE—26 POINTS			
Weight, estimated ....lbs. according to age..........	6	....	....
Form, straight top line and underline; deep, broad, low set..........	8	....	....
Quality, firm handling, hair fine, pliable skin, fine bone; evenly fleshed..........	8	....	....
Style, active, upstanding..........	1	....	....
Temperament, quiet, docile..........	1	....	....
HEAD AND NECK—8 POINTS			
Muzzle, good size, mouth large, lips thin, nostrils large	2	....	....
Eyes, large, clear, placid..........	1	....	....
Face, short, quiet expression..........	1	....	....
Forehead, broad, full..........	1	....	....
Neck, thick, short; throat clean..........	2	....	....
Ears, medium size, fine texture..........	1	....	....
FOREQUARTERS—13 POINTS			
Shoulder Vein, full..........	3	....	....
Shoulder, covered with flesh, compact on top, snug	4	....	....
Breast, wide; brisket prominent..........	2	....	....
Dewlap, skin not too loose and drooping...	1	....	....
Legs, straight, short; arm full; shank fine, smooth	3	....	....
BODY—28 POINTS			
Chest, full, deep, wide; girth large, fore-flank full	6	....	....
Crops, full, even with shoulders..........	3	....	....
Ribs, deep, arched, thickly fleshed..........	5	....	....
Back, broad, straight, evenly fleshed......	6	....	....
Loin, thick, broad..........	5	....	....
Flank, full, even with underline..........	3	....	....
HINDQUARTERS—25 POINTS			
Hips, smoothly covered, distance apart in proportion with other parts..........	4	....	....
Rump, long, even, wide; tail head smooth; not patchy	5	....	....
Pin Bones, not prominent, far apart.......	3	....	....
Thighs, full, wide, deep..........	5	....	....
Twist, deep, plump..........	4	....	....
Purse, full, indicating fleshiness..........	2	....	....
Legs, straight, short, shank fine, smooth...	2	....	....
Total		....	....

DAIRY CATTLE SCORE CARD

SCALE OF POINTS	Possible Score	Points Deficient: Score	Points Deficient: Corrected
GENERAL APPEARANCE—17 POINTS			
Weight, 800 to 1,000 lbs., estimated........ lbs., actual........lbs.	......	....	....
Form, wedge shape as viewed from front, side and top...........................	5	....	....
Quality, hair fine, soft; skin mellow, loose, medium thickness, secretion yellow; bone clean, fine.........................	4	....	....
Temperament, nervous, indicated by marked refinement in head, neck and forequarters; backbone prominent.......	8	....	....
HEAD AND NECK—13 POINTS			
Muzzle, clean cut; mouth large; nostrils wide	2	....	....
Eyes, large, bright, full....................	2	....	....
Face, clear cut, long, quiet expression.....	2	....	....
Forehead, broad, slightly dishing..........	2	....	....
Ears, medium size; yellow inside; fine texture	1	....	....
Neck, fine, medium length; throat clean; light dewlap	4	....	....
FOREQUARTERS—7 POINTS			
Shoulder, light, sloping, very thin at top...	4	....	....
Breast, pointed; brisket light.............	2	....	....
Legs, straight, short; shank fine...........	1	....	....
BODY—20 POINTS			
Chest, deep and moderately wide..........	4	....	....
Ribs, broad, deep, wide apart; large barrel.	10	....	....
Back, prominent, open jointed............	3	....	....
Loin, broad with roomy coupling..........	3	....	....
HINDQUARTERS—43 POINTS			
Hips, far apart, prominent; level with the back	2	....	....
Rump, long, wide; pelvis, roomy	4	....	....
Tail, set high, long, tapering, heavy switch	1	....	....
Thighs, thin, long, wide-apart; twist very open	6	....	....
Escutcheon, spreading over thighs, extending high and wide; large thigh ovals....	1	....	....
Udder, broad, symmetrical, extending well forward, well up between the thighs, free from fleshiness, well held up and quarters even in size.......................	18	....	....
Teats, good size, evenly placed...........	4	....	....
Milk Veins, large, tortuous, branching, milk wells large, numerous.............	6	....	....
Legs, straight, far apart, shank fine.......	1	....	....
Total	100	....	....

DRAFT HORSE SCORE CARD

SCALE OF POINTS	Possible Score	Points Deficient	
		Score	Corrected
Age	.....	....	....
GENERAL APPEARANCE—29 POINTS			
Height, estimated .... hands; actual	.....	....	....
Weight, over 1,600 lbs.; estimated........ lbs., score according to age..............	6	....	....
Form, broad, massive, evenly proportioned, symmetrical, blocky	4	....	....
Quality, refined; bone clean, large, strong, tendons clean, defined, prominent; skin and hair, fine; "feather," if present, silky	6	....	....
Action, walk; fast, elastic, regular, straight; trot, free, springy, balanced, straight	10	....	....
Temperament, energetic; disposition, good.	3	....	....
HEAD AND NECK—8 POINTS			
Head, proportionate size, clean cut, well carried; profile straight..................	1	....	....
Muzzle, neat; nostrils large, flexible; lips thin, even, firm.........................	1	....	....
Eyes, bright, clear, full, same color........	1	....	....
Forehead, broad, full......................	1	....	....
Ears, medium size, well carried alert......	1	....	....
Lower Jaw, angles wide, space clean......	1	....	....
Neck, muscled, arched; throat-latch fine; windpipe large	2	....	....
FOREQUARTERS—22 POINTS			
Shoulder, moderately sloping, smooth, snug, extending into back.....................	3	....	....
Arm, short, strong muscled, thrown back, well set	1	....	....
Forearm, long, wide, clean, heavily muscled	2	....	....
Knees, straight, wide, deep, strong, clean..	2	....	....
Cannons, short, wide, clean; tendons clean, defined, prominent	2	....	....
Fetlocks, wide, straight, strong, clean.....	1	....	....
Pasterns, moderately sloping, strong, clean.	3	....	....
Feet, large, even size, sound; horn dense, waxy; soles concave; bars strong, full; frogs large, elastic; heels wide, one-half length of toe, vertical to ground.........	8	....	....

DRAFT HORSE SCORE CARD—Continued

SCALE OF POINTS	Possible Score	Points Deficient	
		score	Corrected
BODY—9 POINTS			
Chest, deep, wide; breast bone low; girth, large	2	....	....
Ribs, deep, well sprung; closely ribbed to hip	2	....	....
Back, broad, short, strong muscular	1	....	....
Loins, short, wide, thick muscled	2	....	....
Underline, low, flanks full	1	....	....
HINDQUARTERS—32 POINTS			
Hips, broad, smooth, level, well muscled	2	....	....
Croup, wide, heavily muscled, not markedly drooping	2	....	....
Back, broad, short, strong, muscular	3	....	....
Quarters, plump with muscle deep	2	....	....
Stifles, large, strong, muscular, clean	2	....	....
Gaskins (lower thighs), long, wide, clean, heavily muscled	2	....	....
Hocks, large, strong, wide, deep, clean, well set	8	....	....
Cannons, short, wide, clean; tendons clean, defined, prominent	2	....	....
Fetlocks, wide, straight, strong, clean	1	....	....
Pasterns, moderately sloping, strong, clean.	2	....	....
Feet, large, even size, sound; horn dense, waxy, soles concave; bars strong, full; frogs large, elastic; heels wide, one-half length of toe, vertical to ground	6	....	....
Total	100	....	....

SWINE SCORE CARD

SCALE OF POINTS	Possible Score	Points Deficient	
		Score	Corrected
GENERAL APPEARANCE—25 POINTS			
Weight......... estimated......... actual lbs., according to age....................	6	....	....
Form, deep, broad, low, long, symmetrical, compact, standing squarely on legs......	8	....	....
Quality, bone clean; hair silky; skin fine...	6	....	....
Disposition, quiet.........................	5	....	....
HEAD AND NECK—10 POINTS			
Snout, medium length, not coarse.........	1	....	....
Eyes, large, mild, full, bright, wide apart..	1	....	....
Forehead, broad	1	....	....
Face, short, cheeks full..................	1	....	....
Ears, medium size, fine, soft..............	1	....	....
Jowl, strong, neat, broad.................	2	....	....
Neck, thick, medium length..............	3	....	....
FOREQUARTERS—13 POINTS			
Shoulder, broad, deep, full, compact on top	6	....	....
Breast, wide, prominent....................	2	....	....
Legs, straight, short, strong; feet medium size	5	....	....
BODY—32 POINTS			
Chest, deep, broad; girth large............	7	....	....
Sides, deep, lengthy, closely ribbed........	8	....	....
Back, broad, straight, thickly and evenly fleshed	7	....	....
Loin, thick, wide..........................	5	....	....
Belly, straight	3	....	....
Flank, even with underline...............	2	....	....
HINDQUARTERS—20 POINTS			
Hips, wide apart, smooth..................	3	....	....
Rump, long, wide, evenly fleshed, straight.	4	....	....
Hams, heavily fleshed, deep, wide.........	8	....	....
Legs, straight, short, strong; feet medium size	5	....	....
Total	100	....	....

MUTTON SHEEP SCORE CARD

SCALE OF POINTS	Perfect Score	Points Deficient	
		Score	Cor-rect d
Age .... **Teeth**..............			
GENERAL APPEARANCE—24 POINTS			
Weight......... estimated ....actual lbs., according to age..................	6	....	....
Form, low, long, symmetrical, compact, and evenly covered with firm flesh......	10	....	....
Quality, clean bone; silky hair............	6	....	....
Temperament	2	....	....
HEAD AND NECK—9 POINTS			
Muzzle, fair size; nostrils large; lips thin; mouth large	2	....	....
Eyes, full, bright........................	1	....	....
Face, short, bold expression..............	1	....	....
Forehead, broad	1	....	....
Ears, fine, erect........................	1	....	....
Neck, thick, short; throat clean..........	3	....	....
FOREQUARTERS—13 POINTS			
Shoulder Vein, full........................	2	....	....
Shoulders, covered, compact..............	3	....	....
Chest, deep, wide, large girth.............	3	....	....
Brisket, full, prominent, breast wide......	2	....	....
Legs, straight, short, wide apart, strong; forearm full, shank smooth.............	3	....	....
BODY—13 POINTS			
Back, straight, wide......................	4	....	....
Loin, broad, thick........................	4	....	....
Ribs, deep, arched........................	3	....	....
Flank, low, thick, making underline straight	2	....	....
HINDQUARTERS—17 POINTS			
Hips, smooth, far apart....................	3	....	....
Rump, long, level, wide...................	4	....	....
Thighs, full, well fleshed.................	3	....	....
Twist, plump, deep.......................	4	....	....
Legs, straight, short, strong; shank smooth	3	....	....
CONSTITUTION—10 POINTS			
Girth, large	3	....	....
Skin, pink color.........................	3	....	....
Fleece, dense and even over body, yolk abundant	4	....	....
WOOL—14 POINTS			
Quantity, long, dense, even...............	6	....	....
Quality, fine, soft, pure, even............	4	....	....
Condition, bright, strong, clean..........	4	....	....
Total	100	....	....

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