SCHOOL
BOOK
OF
FARMING

L. H. BAILEY
The Rural Text-Book Series
Edited by L. H. Bailey

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Bailey: School-Book of Farming.
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B. M. Dugger: The Physiology of Plant Production.
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Warren: The Elements of Agriculture.
Warren: Farm Management.
Wheeler: Manures and Fertilizers.
White: Principles of Floriculture.
Widtsoe: Principles of Irrigation Practice.
I. GOOD TILLAGE. — A plantation of young soybeans, with maize at the right
STATEMENT

The essence of this book is to develop a point of view on farming and country life in the minds of the young, to explain the relationships of the parts, and to state the main reasons underlying the growing of the leading crops and the raising of the common animals.

The author has had good help with the subject-matter, particularly from the following persons in their specialties: Professor L. E. Hazen, Oklahoma Agricultural and Mechanical College; Professor DeVoe Meade, Maryland State College; E. F. Phillips, Bureau of Entomology, United States Department of Agriculture; C. A. Rogers, Bergen, N. Y.; Professor H. O. Buckman, M. W. Harper, H. E. Ross, E. S. Savage, W. M. Wilson, College of Agriculture, Cornell University. The text has been read by Professor F. L. Griffin, College of Agriculture, University of California, and he has also prepared much of the pedagogical material at the ends of the chapters.

The Census reports have been quoted freely. Although not now recent, these reports give comparable statements in many subjects; and it is the desire to develop in pupils the habit of using and quoting figures correctly and of consulting the Census. It is hoped that the book holds the business and money-getting activities of farming to approximately their proper emphasis.

L. H. Bailey.

January 1, 1920.
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THE SCHOOL-BOOK OF FARMING

TOPIC 1

THE FARM AND THE FARMER

The country round about is divided in many ways and devoted to many uses. If one were in an airplane high enough to see many miles in all directions, these divisions would be very striking. Even if we cannot ride in an airplane or look from a mountain top, we can imagine how the country looks when seen at one glance, perhaps as a bird sees it.

All the pictures one sees taken from a height show the country in its different parts, with many dividing lines. There are villages, hills, streams, woods, fields of corn or cotton or apples, pastures with herds of cattle, roads, perhaps buildings of many kinds and sizes. In some regions mountains are seen; in other regions apparently only endless stretches of plain; in others are rivers and lakes.
Each of the parts supports its own activity and its own kind of people. We would think the parts very different if we were to drive from the one to the other, rather than to see them all at once from a high place.

The region that lies beyond the cities and towns is often called the "open country." It is the real farming country, and the woods and streams. The open country is very beautiful and productive, and we shall try to understand it.

I. THE FARM DIVISIONS

In this book we are interested in the divisions known as farms. Other persons might be interested in the villages, or the highways, the streams and ponds, or
the factories. In one region the farms occupy practically all the country that we could see from an airplane; in another region the farms might appear only as patches here and there on hillsides or in forests. In the one case the farms would look to be square or rectangular; in the other they would probably present very irregular outlines.

A farm may be of any shape, as well as of any size.

2. What is a Farm?

We may define a farm as a piece or bit of the earth’s surface on which crops or animals are grown for a livelihood or an income. Usually we think of a farm as a tract of dry land; yet it may be water in which fish are bred or reared, or water-soaked and devoted to the growing of marsh plants. The Chinese, for example, are skillful water farmers, utilizing marshy places and ponds for many kinds of water-loving plants and for mollusks and other animals. Many of them are duck farmers, living on boats and pasturing the ducks along the shores.
The farms themselves are of many kinds, known by the products raised on them.

Most of the farm products of the world are grown on land that is humid, or wet by frequent rains, and the rainfall provides all the moisture that the crops receive or require.

In the Irrigated Country

Other farms are in arid or dry regions and are maintained by irrigation, or the artificial application of water. When irrigation is not available, the small rainfall may be saved by providing a deeply tilled soil to hold it and by certain methods of tillage, and a crop may be obtained only every other year: this is dry-farming.

A farm is usually also a homestead, providing the residence yards and grounds that make up the dwelling place of a family. Sometimes the headquarters is spoken of as a farmstead; it comprises dwelling, barns, inclosures, and other established parts from which the farm is administered.
3. A Farm Homestead is not Necessarily Permanent

Conditions may so change from one generation to another that certain farms may be combined with others under a single ownership, or one farm may be divided into several. Similarly, certain farms may pass out of active cultivation or use because it is no longer profitable to operate them; they may return to woodland or merely lie fallow. The homesteads on a given area of land may become either fewer or more numerous.

If all the new or unoccupied land in any country were on high and rocky hills or mountains, nevertheless the people would make farms on these elevations as population increased; then if level and more fertile areas were added to the country by exploration, the farmers would tend to move away
from the hard hills, and their farms, becoming attached as rear fields to other properties or even falling into the possession of the town, might be spoken of as "abandoned." It is no more surprising that farms should be abandoned than that mills along the streams should be deserted as times change, or that stores and shops should be vacated on streets from which business has moved. Even in cities there may be deserted or tumble-down houses. As times change, we must expect habitations and business places to change also.

It is not a good solution, as a rule, to endeavor to settle other farmers on these small semiabandoned farms. Good farming requires good land and good outlets. It is only when population becomes dense that poor and inaccessible lands should be brought into tillage. Not all the earth is fit for farming. These partially utilized lands may be attached to neighboring farms in many cases for pasture or other uses; or they may be purchased by the town, county, or state for the growing of timber. It is sometimes an indication of progress when these lands are abandoned for ordinary cropping, or at least when no longer used as homesteads.

Uses of abandoned lands

4. What is a Farmer?

One who makes a living or income by raising plants and rearing animals, and whose attention is devoted to these occupations, is a farmer. Yet this definition does not distinguish the different classes of farmers.
One who owns the land and rents it is a landlord, although often called a farmer. One who does not own the land but works on farms for wages is a farm-laborer.

The one who owns or rents the land and conducts the operations on it for the proceeds it yields, is frequently spoken of as the real farmer. We may recognize another important group known as farm managers; these persons are paid by salary to conduct the farm for the owner. A tenant is a farmer who leases or rents the farm from another, either for cash rental or "on shares." These three classes comprise the farm operators, — the farmer who owns and works his land, the farmer who rents his land, the farmer who is employed to manage the land. These are distinguished from the landlord on the one hand, and from the farm-laborer on the other, although many of the laborers may be renting or buying farms of their own. The operating farmer is the bulwark of the nation.

Sometimes several persons, having money to invest, form a corporation or partnership for the purpose of owning and administering a farm. That is, "Syndicate farming" rather than by one person; but the way of farming remains the same as under a single ownership.

In this book we are not to study statistics; yet the pupil should acquire the habit of learning what the Census figures mean. The tenure or occupancy of the farms in the United States as reported by the last Census, 1910, was as follows:
All farms in United States 
Operated by owners, who, however, may rent additional land 
Operated by tenants of all kinds 
Operated by managers

In Canada, the land in farms in 1911 was 109,948,988 acres, the number of farms being 714,646. Of the total acreage, 98,866,067 acres were owned and 11,082,921 acres rented.

5. Particular Kinds of Farmers

The amateur is a person who devotes himself to an object or occupation for the love of it, not as a means of livelihood. The word “amateur” means a lover or admirer; yet it is often improperly used as if it meant merely a novice or beginner. A person may be an amateur in plants or animals; even if he grows them for food or other uses, his enterprise
is not farming, for the farm elements of cost and of labor and of marketing do not enter. However successful the suburbanite or the home gardener may be with his operations, however great his yields or the produce of his bees or poultry, if he secures his livelihood or maintenance-income by other means he cannot be called a real farmer. He may properly undertake things that it would not pay the farmer to attempt.

The fancier is a person who devotes himself to one particular crop or animal, making collections of the different kinds. One may be a fancier of pigeons, of particular kinds of sheep or dogs, of peonies, tomatoes, or cherries. The fancier may be an amateur or a real farmer; in the latter case he makes his livelihood by selling his products to other fanciers or as breeding-stock to farmers and amateurs; in any case he becomes an authority on the particular kinds of animals or plants that he fancies.

The specialist in farming is one who devotes oneself to a single product, or to a particular group or combination of products, rather than to general or miscellaneous operations. Often he devotes himself to varieties or breeds rather than to their products. One person might study the varieties of wheat and desire to grow as many kinds as possible,
making a collection of them, perhaps selling the grain for seed; another might specialize in growing wheat in quantity for the market, limiting himself to one or two varieties; another might be a broader specialist, growing wheat and other cereals exclusively, and he would be a grain-farmer. So there are apple-growers, dairy-farmers, poultrymen, sheep-breeders, seed-growers, market-gardeners, rose-growers.

6. **Kinds of Farming**

Mixed farming is the growing of a more or less miscellaneous combination of staple crops and products rather than one line or specialty. This is the usual type of farming. Its basis is mostly grass or other forage; it comprises cattle and other farm animals, grains, potatoes, beans, and the like; the farm generally has a garden for vegetables and sometimes for flowers; also fruit-trees, poultry, and perhaps bees. The farm carries a general line of machinery and other equipment. It produces a large part of the
food for the farmer's family. Mixed farming is sometimes called diversified farming.

Most farming in North America is conducted on an extensive basis, with many acres and large field operations. Usually the acres do not produce all the yield of which they are capable, and the total desired produce is secured from many acres. Mixed farming and stock-raising are mostly extensive in their method.

Other kinds of farming are intensive, the word signifying that much attention is given to every acre or part so that its yield may be very high; the farms are small, usually only ten or twenty acres or even less. The most perfect kinds are the various forms of gardening, such as market-gardening and glass-house cropping. The commercial growing of lettuce under glass and of carnations, roses, violets, and the like are excellent examples of intensive farming.

The immense farms in a new country tend to break up into smaller units as population increases. These farms call for good business management, but they are seldom well farmed so far as the best use of the soil and resources is concerned. On the other hand, the general mixed farms in the older parts of the country tend to grow larger, as farmers employ more machinery and learn how to make the best use of their capital and equipment. About cities, where land is high-priced and markets for special produce are close at hand, very small areas may be utilized as farms; practically the entire area may be covered with glass in some cases. The average size of farms in the United States in 1910 was 138.1 acres; in Canada in 1911 it was 153.8 acres.
Whether a farm shall be extensively or intensively operated will depend on the size, the tax-value of the land, the market, labor supply, and other factors.

7. **High vs. Low Yields**

Extensive farming is as good of its kind as is intensive farming. Usually it does not pay to produce the highest acre-yields. This is true when land is relatively cheap and labor dear, when the invested capital is small, when fertilizer cannot be had at reasonable rates, when markets are far away, when the product is one of the staple foodstuffs and the price is determined by general trade conditions, and so on. It is sometimes more economical to produce a given yield on two acres than on one acre.

The farmer may exercise his skill and apply his knowledge in extensive farming as completely as in intensive operations. The true measure of the effectiveness of farming is not the yield to the acre but the yield to the man.
8. Agriculture

Farming is the actual business or occupation of producing supplies from the earth. Agriculture is a broader term, including the practice of farming and the general situations and conditions under which farm people live. Thus we speak of agriculture as one of the great affairs of the people; its yield in supplies is the main support of civilization.

Agriculture may be variously divided. All the kinds of farming we have mentioned are included in it. The growing of fruits, flowers, vegetables, and ornamental plants is a division of it known as horticulture; the growing of timber is forestry; of flowers, floriculture; of vegetables, vegetable-gardening or olericulture; of fruits, pomology or fruit-growing; of grapes, viticulture; of bees, apiculture; of silk, sericulture; of birds, aviculture. The pasturing of animals is grazing; the term is applied particularly to pasturing of cattle and sheep.

Agriculture is sometimes spoken of as husbandry, although the term refers more particularly to the practical operations of farming. It was used more commonly in former times than now; at present its most frequent use is in the terms animal husbandry and poultry husbandry.

9. The Extent of Agriculture

The fundamental or most important single occupation of mankind is agriculture. Probably three-fourths of the human race, among civilized men, are engaged in agriculture of one form or another. As knowledge and invention increase, each farmer is able
to raise more produce. To a certain extent machinery takes the place of men. In highly developed agriculture, therefore, many men may be released from food-production to the trades and manufactures, in which they are much needed; the proportion of farmers tends to become less; but we increasingly need better farmers.

The Thirteenth Census of the United States (1910) reports 46.2 per cent of the total land area to be in farms. The acreage in farms was 878,798,325; of this acreage somewhat more than one-half is reported as improved land and the remainder as woodland and otherwise unimproved. The improved land at that time represented only one-fourth of the total land area of the country. The total value of farm property was nearly 41 billions of dollars. The capital invested in manufactures was about 18½ billions of dollars, and in mines and quarries nearly 3½ billions. It will be seen how greatly the capital in farms exceeded that in other forms of industry; the difference is seen to be even greater in Canada.

In Canada the value of farm property in 1911 was more than 4 billions of dollars; in 1910 the capital invested in manufactures was upwards of 1 billion dollars.

Of the total population of the United States in 1910, — nearly 92 millions of persons, — about 42½ millions were classed as urban (city) and about 49½ millions as rural (country). Not all the people reported as rural were farmers. The Census reported 38,167,336 persons of ten years and above engaged in all occupations. Those occupations or classes comprising more than 2 million persons are as follows:
Transportation .......................... 2,637,671 persons
Trades .................................. 3,614,670 "
Domestic and personal service ......... 3,772,174 "
Manufacturing and mechanical industries 10,658,881 "
Agriculture, including forestry ........ 12,659,203 "

In Canada the total population in 1911 was 7,206,643; of this, 3,281,141 was urban and 3,925,502 was rural.

10. The American Farmer

In many parts of the world the working farmer is a peasant, forming a lower class, of inferior social rank. One of the marks of progress in recent times is the giving to the peasants of greater political freedom and of equal rights with other citizens before the law.

In North America the farmer has the same rights and standing as other men, and there are no established limitations on his ambition or fixed social standards to which he must conform. His place among his fellows is determined mostly by his own ability, preparation, and efforts.

11. Who May be a Farmer?

The occupation of farming calls for persons of good health and strength, of industrious and saving habits, of thorough knowledge of the business, and of a genuine desire for the work and for life in the open country. It is not a refuge for those poor in health, for those unsuccessful in other pursuits, or those tired of the city. The occupation needs conviction, ability to stand alone, and positive vigorous preparation.
Much of the preparation lies in the type of mind, or the way in which one looks at it. One must think in terms of the country, rather than in terms of the city. The intending farmer must accept the situations as they are, adapt himself to them, and improve them gradually as best he can. No longer should a person fall into farming because there is no other occupation for him. He should fit himself for the business as carefully as the engineer or the physician prepares.

The preparation for farming is of two kinds,—experience and education, each of which is now essential. The experience is gained by working on a farm before one begins to farm for oneself. If this experience is gained before college, the course of instruction will have more meaning. Here the farm boy has the advantage; yet the city boy may learn the business well if he undertakes seriously to gain the necessary experience. Schooling cannot take the place of experience.

The farmer undertakes a life work. He cannot change occupation often and still be successful. It requires years to put land in the best and most productive condition, and to gather the equipment, grow the orchards, build up the herds. Every year’s experience counts toward additional success with the land on which it was acquired. To succeed in farming, as in anything else, one should “feel the call.”

To one who is adapted to the occupation and who has a good farm, the vocation of farming offers a very satisfactory way of making the passage of life.
REVIEW

What are the parts in the open country? What are the natural divisions of it?
What are the leading parts or divisions in the school district in which you live?
What are the shapes of farms as one would see them on a map?
Define the word "farm"; give your idea of what a farm is. Consult the dictionary.
What is grown or raised on farms?
What are humid and arid regions? What is irrigation?
Dry-farming?
What is a homestead and a farmstead?
What is meant by "abandoned farms"? Are the same lands always retained year after year as separate farms?
Give your idea of a farmer; of a landlord; tenant; farm operator; manager.
What do the figures mean on page 8?
What is your idea of an amateur? fancier? specialist? Do you know any such persons?
Describe some of the kinds of farming, as: mixed or diversified; intensive; extensive.
What do you say about heavy yields and low yields? Does it always pay the farmer to produce the heaviest possible yields to the acre? Why?
Give your idea of the meaning of the word "agriculture." How does it differ from farming? Name some of the different kinds of agriculture.
In three or four sentences, state how extensive or important agriculture is.

THOUGHT-QUESTIONS AND INQUIRIES

What is the kind or type of farming followed by most of the farmers in your community? What are the five most important types of farming in the State?
Have the farms in your part of the State increased or decreased in size within the past ten years?
How many farm operators in your county own their farms? How many rent the land they cultivate? What is the percentage of farm owners in the State? (Consult the published Census returns or ask your county agricultural agent for this information.) Has the percentage of farm owners in your State increased or decreased in the past ten years?

What is meant by the Census? How often is it taken, and by whom?

Make a list of the farmers in your school district and classify them under the headings: Amateurs; Fanciers; Specialists; and Diversified Farmers.

In what part of your State is farming conducted on an extensive basis? on an intensive basis? What is the average size of the farms in your county? in the State?

Endeavor to find out the number of hours of human labor it required to produce a bushel of wheat before the invention of the binder and thresher. Now.

Make a list of the more important crops raised in your county and place after each crop the average acre-yield. What is the average yield in the State? The average yield for the United States?

Make a list of the more important manufacturing industries of the United States that are directly dependent on agriculture for their raw material.

Make a list of the things you think a farmer should know. Why should the farmer of the future have more education than the farmer of to-day?

SPECIAL PROBLEM

Make a map of your school district, or township, drawing it to scale. Indicate on this map the improved and unimproved highways, streams, railroads, schools, churches, and farms. Within the space occupied by each farm place the name of the farm operator (or a number to represent him); also mention (perhaps on the margin) the kind of farm, — whether it is a dairy, poultry, fruit, or mixed farm. See map on page 32.
TOPIC 2

THE LAND

One cannot think of a farm without land. In a greenhouse the pots and the benches contain earth. If one were raising oysters, yet they rest on the earth, and much of the food of the oyster comes directly or indirectly from the land. The solid earth is verily the basis of farming.

The good farmer knows his land. It is one of his greatest joys to know what every field is like and what it will produce best. He knows his fields in summer and winter, when they are dry and when they are wet. Every year he learns something new about them.

12. THE SUBDIVISIONS OF THE LAND

Rarely is a farm comprised of a single field. It would be a strange farm were it so.

At first the farmstead is set off. This is on the highway. It is on land "high and dry." Let us hope that it commands good views, that the buildings do not obstruct these views, and that it is also midway of the side that lies on the highway rather than on one corner of the property.

The fields should be easy to reach from the farmstead. Much time may be lost in going back and forth to small
remote fields. It is easy to compute time expended in such travel and to estimate its value.

The divisions should be as few as possible, and oblong in shape with no long points or irregular corners. The object is to save useless turns of teams and men, and to allow the freer use of machinery.

If the property is a mixed farm, the regular fields should be of somewhat equal size to promote good rotation of crops.

In the level country of the Middle West, where the townships and subdivisions are rectangular, the layout of the farm is usually simple. In other parts of the country the original lines of survey may be irregular, and fields have been added piece by piece as cleared from the forest; the result is usually too many fields, too much land occupied by fences, and too great cost for upkeep.

The taking down of old fences, subduing of fence-rows, and redividing of the land is one of the first requisites in many farms to make them "handy" and economical. In some cases the existing subdivision is so faulty that a direct outlay may be necessary to reorganize the property at one time; usually,
however, the most economical way is to rearrange the fields and division lines gradually, as time and labor can be spared. In either case, the work should follow a definite plan, and a map should be made.

The farm should be so organized as to allow live-stock and teams to be driven to any part of it. If the property is large, a lane or farm road may lead down the fields. Such an interior road allows access to any part at any time, whatever may be the crops on the fields. The lane need not be waste land; it may be pastured, or used in part for bees, colony-houses for poultry, or other purposes. The lane sometimes skirts a bluff or a creek, on land that is not tillable.

This road-division or lane is better than to go through one field to reach another, if the land readily lends itself to such a layout; but some farm lands are so valuable that even a narrow driveway cannot be spared. Sometimes the land so lies that the public highway is utilized as the farm road.

The point is that all fields, by one means or another, should be accessible for hauling and for the transfer of animals, with good gates or bars and a graded entrance; and there should be bridges or culverts over ditches and streams.

13. THE CLEANING OF THE LAND

In the most effective field every foot of land inside the fences is of use in the growing of crops. This means that stumps, rocks, brush, and rubbish are removed. In permanent pastures, however, there may be trees.

The farmer should be able to plow a straight clean furrow, and to make a seed-bed free from clods and
weeds. The coming of the tractor will demand better cleaning of the fields. It cannot be used readily in rough, stony, and stumpy fields.

Bad weeds of a permanent nature usually follow some fault in the farming. The tillage, for example, may not have been good; the seeding may have been poor and the seed foul; the rotations may have been too long in grass and the sod become thin; roadsides, ditch-banks, and waste places may not have been cleaned; the manure may have scattered the seeds. A few weeds here and there or on the lawn or in the garden may be destroyed one by one, but usually a change in the farm practice is the only remedy for bad weeds that are abundant on the property.

A weed is a plant that is not wanted. It may be oats growing in a potato field or potatoes growing in an oat field. Dandelions are weeds when growing in lawns but are coveted plants when, in improved form, they are grown in vegetable-gardens for food. Yet some plants are always known as weeds. The pigweeds are examples, but not the burdock, which is grown by the Japanese for its edible root.

Ten general principles for the control or prevention of weeds may be mentioned (Georgia, Manual of Weeds):

1. Allow no seeds to ripen.
2. Kill while in the seedling stage.
3. Induce autumn germination of the seeds of annual plants by surface tillage after harvest.
4. Never plow under weeds bearing mature seeds.
5. Thoroughly compost all stable manures that are known to contain the seeds of bad weeds.
6. Sow clean seeds.
7. Be on the watch for weeds new to the locality.
8. Call in the aid of grazing animals, particularly sheep.
10. Enact better weed laws and enforce them.

Certain weeds are killed by poisonous applications, called herbicides. These should be applied only by persons who are skilled in their use.

14. THE DRAINING OF THE LAND

We drain the land for two purposes, — to improve it directly for crop-production, and to remove "bad spots" that interfere with the working of the remainder of the field. Often the efficiency of an otherwise good field is greatly reduced by a very few wet or springy places that prevent the fitting of the land in proper season.

Drains are of two kinds, — those on the surface, or "open drains"; those beneath the surface, often called "covered" or "blind drains," usually laid with tile.

The surface drains or ditches may provide the outlets for tile drains, particularly on flat lands where natural outlets are few. They remove flood water, affording
protection to crops in the break-up of winter and in heavy rains. They are really creeks, taking away the surplus surface water much as natural brooks and rills remove it from other places.

The underdrain not only removes the surplus water, but it deepens the soil because it lowers the place of standing water (or the water-table). It therefore makes the land more productive. It introduces air, which standing water may exclude. By these actions it stimulates the activities in the soil and improves its structure. As roots may extend deeper in tile-drained land, so may the crops stand drought better as well as escape the effects of too much water. Even on hillsides there may be wet and springy places badly in need of underdrainage. Good tile drainage practically increases the size of the farm by making the land deeper.

Tile-drains may be single, or they may be combined into a system; in the latter case there is one main drain into which one or more side drains are connected. The water enters the drain through the joints between the tiles; therefore, hard-burned tiles should be used, as they are more durable. The grade should be as uniform as possible, and the fall need not be great: one foot or less in five hundred will carry the water readily if the tiles are well laid in an accurately leveled ditch, although a greater fall is to be preferred. The tile may be two to three feet deep in heavy clay land, and three to four feet deep in looser land. In clay lands, the drain should be usually three to four rods apart; in sandy or loamy lands, twice this distance.
15. THE TILLING OF THE LAND

Tilling is performed by the use of many implements, such as hand-weeders, hoes, rakes, spades, plows, harrows, rollers, and various kinds of cultivators. We till the land to provide the proper conditions for the growing of plants. After the land is cleared, drained, and cleaned, the surface of it is inverted by the plow, burying the vegetation, and exposing the bare earth for the preparation of a seed-bed.

By heavy implements, if the land is hard and rough, the bare surface is crumbled, mellowed, and leveled; then by smaller-toothed harrows the soil is put in condition to receive the seeds. In the garden the seed-bed is prepared with hand tools and the surface is made very fine and soft; under such conditions, the plants should make a quick and strong start. Tillage is sometimes spoken of as "cultivation."

Aside from preparing the seed-bed, tillage also keeps the land in condition after the plants are established. Some crops are tilled until midsummer or later: we speak of them as the "tilled crops," as corn, potatoes, cotton, beans. Those not tilled we usually call "sowed crops," as the small grains (wheat, oats, barley, rice), although in some countries these crops may be tilled by hand. When labor is high priced, the tillage is performed by horse tools rather than hand tools; we now seldom see persons hoeing corn.

Tillage sets many forces at work, as we shall see in Topic 3. It also destroys insects and weeds, buries litter, decreases the breeding-places of vermin. It prepares a deep root-hold for plants,
thereby increasing the producing-power of the land and the size of the farm.

One of the great betterments in agriculture within recent time is the improvement of land-working tools, and the use of them in the place of slow and expensive hand labor. In principle the tillage tools of to-day may be like those of centuries ago; but they have been greatly developed, and will now perform work for which the former tools were not fit.

Once the plow was a crooked stick; now it is one of the most effective, as perhaps it is the most useful, of the implements made by man. Once the harrow was a piece of brush drawn by a man; now it is an implement of many patterns, each type adapted to a particular kind of work.

Once it was the practice to let the land lie fallow now and then, to "rest" and recuperate and to allow it to be cleaned of weeds; "summer-fallowing" was a familiar practice. Now we have better tools and machines with which to prepare the land and work it, and to keep it always in order; and we have learned how to fertilize it.

We may classify the tillage tools as follows:


2. Tools for preparing the seed-bed: rake, harrow, roller.

3. Tools for maintaining the land in proper cultivation: hoe, wheel-hoe, weed-killers, cultivator.

We may also classify these tools by the way in which they perform their work. The breaking tools (as the plow) tear up, cleave, and invert the earth, burying whatever may grow or lie on top of it. The cultivator is really a group or company of small plows attached to one framework; it lifts and pushes the
soil, sometimes turning it to some extent, but it cannot perform the breaking of hard land or sod. Some of the harrows, with wide blades, are practically cultivators on a large scale; others have straight small teeth that break the soil surface into fine particles and leave it mellow. The roller compacts loose lands, forcing the lumps together and perhaps crushing them. The hoes are used in human hands and therefore may perform many kinds of labor. They lengthen a man’s arms, give him greater leverage, and provide a cutting edge for chopping the soil and weeds and for shaping the surface.

Man would be powerless were it not for his tillage tools.

16. The Manuring of the Land

By experience man has learned that the producing-power of the land is increased by the use of barn manures. These materials improve the structure or physical character of the soil, and they also add plant-food. This being true, a farmer should no more waste the manure than the crops after they are grown.

In the early days on the fertile prairies, manure was piled in great heaps and burned. This destruction has now passed. Yet manure may be wasted even when it remains in piles, by losing its valuable parts. This loss arises from the heating or firing of the manure in the piles (which is a process of fermentation), and by leaching from rain and particularly by the water from roofs.

The fermentation or heating may be prevented by keeping the pile firm or compact, by forking it over
frequently, and by adding sufficient water to keep the mass moist but not to result in leaching.

The loss in manure by leaching is easily prevented. It is one of the commonest leaks on the farm.

The best way in general to utilize barn manure is to spread it on the fields as fast as the wagon-loads accumulate. The manure-spreading machines are very useful in this work. It should not be dropped in small piles and left, for this fertilizes the field very unevenly.

**How manures are used**

In practice, however, it is impossible to drive on the fields at some times of the year, and at other times they may be in crop. Therefore, the manure must be stored. The best storage, when there is plenty of bedding, is undoubtedly in a covered barnyard, which is a shed or basement with a cement floor on which the manure, with plenty of bedding, is spread. The cattle or sheep are allowed to tramp on it,
for the place is made an exercise yard for the animals. The liquids are then likely to be absorbed and saved. From here the manure may be taken directly to the field, or it may be stored temporarily under an outer shed, or even out of doors for a time if away from the eaves.

Sometimes the manure is composted, which means that it is allowed to decay so that it is more readily mixed with the soil and its plant-food is more available. The pile is forked over two or three times, to prevent heating and to mix all the materials thoroughly. Gardeners usually have a compost pile, to which they add leaves and garden refuse as well as manure; sometimes sod is mixed with it. When the material is thoroughly rotted, which requires a year or more, it becomes finely divided and friable. It is then very useful in the garden, as dressing on the lawn, or in any special plantation. Every farmstead should have a compost pile in some rear corner.
While the importance of animal manure is recognized, it is difficult to state the value in figures. The value varies with the kind of animal and its age, the kind of feed, the way in which the manure is kept, and the quantity and kind of bedding or litter that is in it.

The quantity of manure to be applied to the acre varies widely, depending

How much manure to use
1. on the quality of the manure;
2. on the condition or fertility of the land;
3. on the crop to be grown.

Market gardeners are heavy users of stable manures. They must have large yields and quick results. Usually their lands are light. They sometimes apply forty to fifty tons to the acre, whereas ten to fifteen tons may be considered the average application. When the supply is insufficient, it is applied to certain fields or even only to the hardest or least fertile places in those fields.

The careful farmer takes much pains to save the manure. He keeps the barns, stables, and yards clean; they are then attractive as well as efficient.

REVIEW

What is the basis of farming?

How are farms subdivided? In what part should the farmstead be?

What can you say about size of fields? shape? arrangement? What do you understand by the layout of the farm?

If the layout is not satisfactory, how may it be remedied? Of what use is a map of the farm?

What about the lane?

What is meant by clean land?

What is a weed? Why are some farms so weedy?

Name the ways in which weeds may be destroyed.
What do you understand by the draining of the land? How does draining improve the land?
What are the kinds of drains?
How are tile-drains laid?
What do you mean by tillage? What does tillage do?
How have improved tools aided tillage? What is summer-fallowing?
Name the classes of tillage tools. Describe the work of the plow, cultivator, harrow, roller, hoe.
What is meant by the manuring of the land?
What is the heating of manure?
Describe the ways of handling, applying, and storing farm manures. How much is applied to the acre?

THOUGHT-QUESTIONS AND INQUIRIES

Find out, by actual measurement, the average amount of land occupied by a fence-row on your farm or a neighbor's. How many square feet of land is occupied by the boundary land, and cross fences, or field fences on your farm? What part of an acre is this?

Collect and mount five of the most common weeds that grow on your farm or in your section. Label properly, giving both the common and scientific names of the weeds. (Names may be found in many bulletins and books.)

Observe some of the common weeds that grow in the field or along the roadsides. What peculiarities of each (structure of the plant or fruit or habit of growth) enable it to become a nuisance or pest?

Demonstrate some of the benefits of tillage by planting wheat, oat, or barley seeds in each of two tin cans, one filled with good garden soil and the other with rough cloddy soil.

Make a list of the tilled crops and the sowed crops in your section, and opposite each crop give the names of the tillage implements used.

How is stable manure stored and spread in your section? For what crops is it commonly used? How many manure-spreaders are there in your school district? What is the cost of a manure-spreader? What kinds of manure do the farmers like best?
SPECIAL PROBLEM

Make a map of the home farm, or of some neighboring farm, drawing it to scale (for example, let one inch represent ten rods), showing the arrangement and relative sizes of the various cultivated fields, woodlots, pastures, lanes, and the farmstead.

A Rural Community (Minnesota, adapted from Warber).
TOPIC 3

THE SOIL

The soil beneath us and the atmosphere above us,—these provide all the conditions for life on the earth. We do not know any living thing independent of soil and air. The farmer works particularly with the soil, and now we must study it.

Soil is the thin soft layer of the earth in which plants grow. In proportion to the size of the earth, the soil is not as thick as the skin of an apple. Roots extend only a few feet at most. Of the agricultural crops, alfalfa probably goes deepest. The roots of it have been traced, in dry climates, to more than twenty feet deep. Most crops, in ordinary moist climates, do not extend their roots more than three or four feet, and often very much less.

The soil is not “dirt.” It is a very complex body, formed from many materials. It abounds in chemical changes. It is full of microscopic life, each kind of organism performing a definite part.

It contains air and water. It absorbs the heat of the sun. All living things return to it. Nothing is more wonderful than the soil on which we walk.

17. WHAT THE SOIL IS

Speaking in the broadest way, the soil is formed of two substances,—mineral material and organic matter.
The former, coming from the crumbling or breaking down of rocks, usually makes up the greater part. The latter, coming from the decay of plants and animals, occurs in smaller amounts, in the best soil not often exceeding ten per cent of the mass.

This mixture of mineral and organic material is more or less open or porous. Even the hardest soil is not solid. A good soil may contain as much as fifty to sixty per cent of pore space, which is partially filled with water. Without the water, plants could not use the earth either as a foothold or as a source of food.

The earth and its atmosphere are made up of "elements," or substances that cannot be divided or separated into other substances; they are not compounds, but are of simple chemical nature. Between eighty and ninety of these elements are now recognized. Iron is one of them; sulfur is one, and copper, gold, silver, nickel, lead. These that we have mentioned are solids at the temperature in which we live; mercury is fluid; others are gases.

Some of the gases, as oxygen, nitrogen, hydrogen, exist in nature as elements (not in compounds), but most of the eighty and more elementary substances are naturally in combination with other elements. Thus iron ore is a combination, and the iron is freed by the processes of smelting. So the soil is made up of endless compounds. The elements in fertilizers are all in combination.

To make it easy to write about these elements and compounds, the chemist uses symbols (letters) in place of the entire word. Thus,
N = nitrogen  S = sulfur
O = oxygen    Ca = calcium
H = hydrogen  Mg = magnesium
C = carbon    Fe = iron (Latin ferrum, iron)
P = phosphorus K = potassium (kalium)

Combinations are readily expressed, as H\(_2\)O, water; KNO\(_3\), nitrate of potassium or saltpeter; HNO\(_3\), nitric acid; H\(_2\)SO\(_4\), sulfuric acid; C\(_6\)H\(_{10}\)O\(_5\), starch.

Ten elements are absolutely necessary for good plant growth. They are:

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<tr>
<th>From Air and Water</th>
<th>From the Soil Itself</th>
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</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Phosphorus</td>
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<tr>
<td>Hydrogen</td>
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<td>Nitrogen</td>
<td>Calcium</td>
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<td>Magnesium</td>
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<td></td>
<td>Iron</td>
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<td>Sulfur</td>
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While all of these elements are necessary, three need particular attention because they are so likely to be either lacking or unavailable. These three, called the “primary agricultural elements,” are nitrogen, phosphorus, and potassium. Materials containing these elements and called “fertilizers” are often added.

The nitrogen exists in the soil in the organic matter, in very complex combinations. Bacteria (which are “germs”) break it down into simple products that can be utilized by roots. Common soils usually carry less than .2 per cent of nitrogen and one-half that amount of phosphorus. Potassium is abundant in most soils, often above 2 per cent. However, it is generally very securely locked up (that is, it is in such insoluble form that plants cannot use it) and the crop often needs an addition in a fertilizer.
When the elements or compounds are soluble in soil water and are otherwise acceptable to the plant, they are said to be "available." That is, the plant can use them. No matter how much of the desirable elements may be in the soil, only those parts that are available or capable of becoming so are of interest to the farmer.

18. Soil Particles

Soils are made up of particles or grains of varying size. The largest may be the size of gravel or small stone, while the smallest may be invisible even under the best microscope. The names often used, according as the grains are very coarse or fine, are as follows:

- Stone and gravel
- Fine gravel
- Coarse sand
- Medium sand
- Fine sand
- Very fine sand
- Silt
- Clay

The clay and silt particles are exceedingly small, mere shreds of minerals. When rubbed together they become sticky. When dried, they shrink, and on wetting swell enormously. Their presence in large quantity makes what is called a "heavy soil," one difficult to plow, becoming sticky when wet, cloddy and hard when dry; air and water move through it very slowly. The water-holding capacity of clay or silt soil is high.

The sand and gravel particles operate as separate grains. They are little influenced by drying or wetting. They do not stick together. Their water-holding capacity is low; air and water move through such soils very rapidly. They soon dry out. Sandy soils plow easily, are not likely to puddle
II. A Tractor at Work. — Plowing under clover for winter wheat.
or clod, are generally in a mellow, loose, friable condition, and are usually well drained.

Sands generally carry only small amounts of the necessary food elements, while clay and silt particles are usually rather rich in calcium (lime), "Weak" and phosphorus, and potassium. Clay and silt, "strong" soils therefore, are classed as "strong soils," while the sands are likely to be deficient in plant-food and are called "weak soils."

Midway between clays and sands are the loams, having both clayey and sandy properties. They are mixtures of various sizes of particles. Loamy soil is desirable because it has all the good qualities of the sands and clays without many of the bad qualities. Such a soil may be a clay loam, silt loam, or sandy loam, according as one or the other kind of particles predominates.

19. THE ORGANIC MATTER OF THE SOIL

The organic matter comes largely from the roots and tops of plants. When they die they become part of the soil, soon decaying and losing their original form. Three classes of organic matter exist in soils:

(1) Original plant tissue.
(2) Partially decayed tissue.
(3) Simple compounds suitable for plant-food.

The partially decayed products are called humus. They improve the physical condition of the soil and are beneficial to plant growth. Without humus, soils will not produce crops. Humus makes the soil mellow and easy to work, and gives it a dark color.
Organic matter may be increased by applying farm manures, plowing under green crops, or by adding wastes (as litter).

20. Soil Structure

The structure of the soil has to do with the arrangement of the particles. The structure may be loose or compact, hard or friable, granular (combined grains) or non-granular. What is known as granulation, in heavy soils, is most important. It is the drawing together of the fine particles or grains so that a crumb is formed.

A compact or hard soil becomes loose because of these larger units, or crumbs, air circulates more freely, and water moves more easily. This granular (or grain-like) condition must be encouraged in all soils, especially in the heavy ones. Tillage opens the soil and pulverizes it, tending to make it granular by breaking it up. Organic matter acts as a loosening agent in heavy soils and as a binding agent in sands. Lime tends to promote granulation, rendering the soil more open and crumbly.

21. Soil Water

The pore space of the soil, as already stated, is occupied by air and water. Two kinds of water exist in the soil,—film and free.

The film water lies around the soil particles and in the spaces between the grains. That in contact with the particles does not move, but the outer part of the film is free to move from place to place; this change of place of the moisture in the pores is called capillary movement.
The free water is that which runs through the large pore spaces, going downward by the force of gravity. In many soils it does not naturally move fast enough or far enough, and drainage must be employed to carry it down. This downward movement of the free water is known as percolation. The finer the soil, the slower is the percolation, and the more likely is the need of drainage.

A pound of soil contains 1000 billion to 10,000 billion particles. Every particle is surrounded by a film of water, while the spaces between act as reservoirs. The rootlets do not touch every one of these reservoirs.

The soil water, with substances dissolved in it, must be drawn to the roots by capillary action, much as water soaks up in a sponge. Such an action, although it does not take place over any great distance, is of immense importance to plant life. It enables the plant to draw on stores of food and water which it would never be able to reach directly.

22. Control of Soil Moisture

Most of the farmers' efforts in the growing season are to provide the proper moisture conditions. Tillage, drainage, mulching, weed-killing, and the like are simply means for controlling the soil.

Water may be lost from the soil in four ways:

1. by run-off from the surface;
2. by percolation or leaching through the soil into the subsoil;
3. by evaporation from the surface;
4. by being taken up by the plants and lost by transpiration from their leaves.
Of these losses, only the loss through the crop should generally be encouraged. The more water used by the plant, under normal conditions, the greater is the growth and the harvest. Water conservation (or saving) consists in checking the other three losses.

The escape of water by run-off is objectionable because of the washing and gullying of the land as well as the actual loss. While such loss cannot be prevented and is often encouraged by means of open ditches, it is generally not considered to be good soil management. When such removal is necessary, tile-drainage is preferable. The gullying is specially serious in the South, where the soil is not held by winter frost.

By maintaining a loose, open, friable condition of the soil, the surface water enters readily and little run-off takes place. The soil then retains moisture, and if there is still an excess it can be taken away by underdrainage. As the water enters the soil it quickly becomes capillary moisture and is held. Deep tillage provides a good water reservoir.

Loss by evaporation occurs in the growing season and consequently directly lessens the moisture available to crops, even to a greater extent than percolation or run-off. Evaporation losses may be controlled by the soil-mulch; this subject we shall consider by itself.

23. The Soil-Mulch

Any material placed on the soil with the object of preventing weed growth and loss by evaporation is called a mulch. While straw, leaves, manure, and other materials are sometimes used, the most common mulch is made of the soil itself. The sur-
face is stirred to the depth of two or three inches with a
harrow or cultivator, causing the soil to dry out very
rapidly. The moisture beneath does not move readily
into this loose, dry, granular layer. As long as the mulch
is dry, little moisture is lost into the air from below.

The soil-mulch is simply a loose, dry, tilled surface. It
must be renewed by frequent tillage. In clayey soils
the loose surface soon hardens, while sandy surfaces
will remain dry and effective for a long time. The mulch
must of course be renewed as quickly as possible after
every rain.

In general, soil-mulches should be shallow, as the dry
layer is of little importance in supplying plant-food,
although it is probably the richest part of the soil. Usually a mulch should be two to
three inches in depth. In the later part of the season
the mulch should be especially shallow to prevent root
injury by tillage. When the land is plowed, the soil-
mulch (or surface soil) is turned under and yields its
fertility to crops, although heavy rains carry some of
its plant-food down even when it is on top.

24. DRY-FARMING AND IRRIGATION

Two great systems of farming are determined by the
water supply, — one to save the water of rainfall in
regions in which it is insufficient to produce crops every
year, and the other to apply to the land water from out-
side sources or regions. The former is dry-farming (page
4); the latter is irrigation.

In regions of twenty inches of rainfall, more or less,
known as semiarid, good crops usually cannot be se-
cured. If the rainfall of two years can be saved, how-
ever, one good crop may be grown in that time. The method consists in providing a water reservoir by plowing and fitting the ground deep; in continuous surface tillage to form a soil-mulch; and sometimes the subsurface packing to prevent leaching. At the same time crops are chosen that are adapted to dry climates.

The methods of dry-farming are special, and cannot be discussed here. Much of the country in western Nebraska and Kansas and beyond requires dry-farming practices.

Irrigation is a practice of arid and semiarid regions. Water is applied to the land from rivers, lakes, reservoirs, on higher ground, and from wells. Usually the water is conveyed by ditches and let on the land in furrows between the rows; sometimes the entire surface is flooded. Irrigation involves engineering as well as farming. It is a highly developed practice in many parts of the Great West.

Irrigation is sometimes practiced in humid countries to provide against droughts; and special kinds of irrigation are employed in the cultivation of rice and cranberries, as well as in market-gardening operations.

25. Soil Air

It has been stated that the average soil contains 60 per cent and less of pore-space (page 34). This space is filled partly with water and partly with air. When the soil is dry, the air predominates; when it is wet, the water is dominant. A soil saturated with water contains little air. When a soil is in good tilth, the pore-space is about equally divided between air
and water. One of the objects of tillage is to control the soil air. A soil well supplied with air is said to be "ventilated."

The soil air differs from ordinary atmospheric air in containing more carbon dioxide and less oxygen. The nitrogen is about the same. Since roots as well as soil organisms need oxygen, the necessity of good ventilation is apparent.

Tillage, drainage, liming, and supply of organic matter are agents in maintaining the supply of air in the soil. Even changes in air pressure (as recorded by the barometer), in temperature, and in wind velocity influence the circulation of air in the soil and its interchange with the atmosphere above.

26. Soil Heat

The soil must be warm in order to support plant life. Chemical and biological changes require warmth. As a great factory, the soil becomes still and dormant without heat. This heat comes from the sun; when absorbed it furnishes the energy for the wonderful changes that are continually taking place.

A number of factors influence the temperature of the soil. Most important of these is moisture. A wet soil is cold. Drainage tends to hasten the warming of the soil by reducing the excess water.

Color is also a factor. A dark soil absorbs heat very rapidly and becomes warm. Light-colored soils reflect much heat and remain cool.

The slope of the land in relation to the sun’s rays may also be considered. In the northern hemisphere, south
slopes are warmer than north slopes. This is to be taken into account in locating lands for the growing of certain vegetables and fruits.

27. THE SOIL-SOLUTION

In discussing the water in the soil, we have considered it without regard to the materials it carries in solution. Such dissolved materials are used by plants, and therefore the soil water is often spoken of as the soil-solution. Roots do not take their food in solid form, but always dissolved in water.

The soil-solution never becomes very concentrated or “strong.” In fact, it is so very dilute or “weak” that its strength is usually expressed in parts to the million. The phosphoric acid in the solution is about 7 parts to the million parts of water, and of potash about 21 parts.

Nitrogen is variable, due to the action of bacteria. As bacteria are most active in summer, soils often contain nitrates as high as 150 parts to the million. In the winter, of course, the nitrogen content is very low. This explains why it is often advisable to top-dress oats or meadows with a soluble form of nitrogen early in the spring.

28. AMOUNT OF FOOD REMOVED BY CROPS

When crops are harvested, considerable food is removed. The following table gives some idea of the number of pounds of nitrogen, potash, lime, and phosphoric acid removed from an acre:
It is to be noted that the removal of plant-food is not only large, but that the drain on the different elements varies with the different crops. Clover needs much lime, while potatoes, as well as clover, demand abundance of potash. Such facts also give us a general hint as to the fertilizer needs of the crop, and the necessity of studying the plant as well as the soil.

29. THE NITROGEN SUPPLY

When we speak of soil exhaustion we think mostly of the mineral elements (as potash, phosphorus, lime). The nitrogen is derived from the atmosphere. It is not used directly as simple nitrogen, however, but in combination or compounds; it is utilized mostly in the form of nitrates, which are combinations of N, O, and a mineral element. The change of nitrogen into a nitrate form is known as "nitrification"; the process is the work of bacteria.

Certain organisms, capable of taking free nitrogen from the air, live in the roots of leguminous plants, such as clover, cowpeas, alfalfa, peas, and beans.
Because they produce galls or nodules on the roots of such crops, they are called “nodule” or legume bacteria. As much as 40 to 60 pounds of nitrogen may be “fixed” and thereby added to an acre each year by these organisms; they are consequently of great importance in farming.

The nitrogen is in part stored in the legume plant, which gives up the nitrogen when it decays and becomes humus. This accounts for the prominent place of legumes in almost every good rotation as well as for the use of such plants in green manures, catch-crops, cover-crops, and the like.

Some soils do not contain the particular kind of organism required for the making of legume nodules. It then becomes necessary to inoculate either the soil or the seed. Spreading a few bushels of soil from an inoculated field over the land is one practice. Sprinkling the seed with water containing bacteria obtained from natural or artificial cultures has also been employed very successfully.

30. Soil Acidity

Many soils are acid or sour. This is of great practical importance because most of the common crops need an alkaline soil condition (the opposite of acid).

Most bacterial or germ action is greatly aided by plenty of lime, which is alkaline. Nitrogen fixation, as well as nitrification, is also greatly aided by lime. This accounts for the extensive use of lime in the growing of such crops as clover and alfalfa. Ordinary farming operations tend to lower the supply of lime. Any soil low in lime is likely to become acid, while all lands are slowly tending in that direction.
A good test for acidity can be made with blue litmus paper, which turns red when the soil is acid, blue again when it is alkaline, and shows no change if the soil is neutral. To test, the soil is generally worked to a thick paste with a neutral solution (neither acid nor alkaline) of potassium nitrate. The litmus paper is then placed directly on the paste, and its rate of change is noted. The soil may be slightly acid, acid, or very acid; if the last, the paper turns red at once; if the first, it may require considerable time.

31. LAND LIME

The remedy for acidity is the addition of an alkali. Lime is commonly used to “sweeten” the soil. It is very effective, easy to get, and cheap.

While lime corrects acidity, it also has many other effects. It tends to improve the physical condition of soils by promoting granulation. It thus lightens clay soils. It also liberates other mineral plant-foods, such as potash. It tends to stimulate bacterial action. Lime is a compound of the mineral calcium.

Lime generally comes on the market in three forms:
(1) Calcium oxide or burned lime (CaO).
(2) Hydrate or water-slaked lime Ca(OH)₂.
(3) Carbonate of lime or ground limestone (CaCO₃).

These materials differ in the amount of calcium, which is the active element in them. It requires about two pounds of ground limestone, or 1½ pounds of the hydrate, to equal in effectiveness one pound of the burned lime.

Lime is generally bought on the basis of its calcium or calcium oxide content, the farmer taking the form that
gives him the most for his money. He must consider not only the composition, but price on board cars, freight and cost of handling, hauling, and application. In general, these three forms applied in equivalent amounts are equally effective.

The quantity of lime to the acre varies with the degree of acidity, texture of soil, the organic matter in it, the crop to be grown, the fertilizer to be used. A sandy soil rather strongly acid usually receives 1500 to 2000 pounds of limestone to the acre. A clay soil of about the same acidity would receive more, possibly 3000 to 5000 pounds.

Lime in any form is best applied on the surface and worked in. It is a good plan to put it on just after plowing and work it in as the seed-bed is prepared. Generally lime should be applied at a definite place in the rotation and should very closely precede the hay crop. In starting alfalfa, the land should be limed unless the soil is distinctly alkaline.

32. Fertilizers and Their Application

Fertilizers supply the materials that are either lacking or unavailable. These materials are chiefly three: potash, phosphoric acid, nitrogen.

There must be the right available proportion of each of the three constituents to permit of normal growth. Moreover, if one element is in too small quantity, the others do not produce their best results, and their influence is partially wasted. In other words, the growth of a plant is governed by the element that is present in least quantity.
The materials that carry or supply the various elements, and which are mixed together to make a “complete commercial fertilizer,” are called the carriers. They are the carriers of nitrogen “carrier” and the rest. A number of the common ones are listed in the order of their availability under each head:

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium nitrate</td>
<td>Acid phosphate</td>
<td>Sulfate of potash</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>Basic slag</td>
<td>Muriate of potash</td>
</tr>
<tr>
<td>Dried blood</td>
<td>Bone meal</td>
<td>Kainit</td>
</tr>
<tr>
<td>Calcium cyanamid</td>
<td>Phosphate rock</td>
<td></td>
</tr>
<tr>
<td>Tankage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To meet the demand, manufacturers have put fertilizer mixtures on the market. Such mixtures are called brands, and are given names. By law these “Fertilizers” must also show the name and address of the manufacturer, the number of net pounds of fertilizer, and the guaranteed analysis of the mixture. The last item is very important and should be so stated as to give a good idea of the availability of the elements.

Often the farmer finds it cheaper to buy the separate carriers or materials and mix them himself. This is known as home-mixing. To do this, the farmer must be familiar with each carrier, he must understand which ones may or may not be mixed, and he must also be able to calculate the amounts to use for a certain formula.

The mixing itself is a simple operation. Besides the possible saving of money, home-mixing tends to increase the farmer’s knowledge of his own conditions. He is
forced to study crop, soil, and fertilizer. Often it encourages him to try simple experiments to increase his knowledge of fertilizer needs and to test the wisdom of his practice.

Each soil needs its own fertilizer for each different crop. Exactly what mixture to use can be determined only by experimenting. Nevertheless certain formulae have proved to be of practical value. The table gives some idea of the formulae which may be used for different crops, the numbers meaning percentages:

<table>
<thead>
<tr>
<th>Kinds of fertilizers</th>
<th>Nitrogen</th>
<th>Phosphoric Acid</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>3</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Grass</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Roots</td>
<td>3</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Legumes</td>
<td>1</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Fertilizers are generally broadcasted by machinery and when possible worked into the surface soil. The amounts applied are extremely variable. For ordinary farm crops, the amounts range from 150 to 350 pounds to the acre. For vegetables, the amounts often go as high as 1000 pounds. Potatoes are generally fertilized heavily, 1000 to 2000 pounds to the acre being a not uncommon application. It is always best to keep the amount of fertilizer low enough to prevent waste and yet high enough to give a good return on the money invested.

The successful use of fertilizers consists —
(1) in abundant applications of minerals, balanced from time to time with nitrogen;

(2) in the fertilizing of the money crop. In other words, the motto is “fertilize the rotation.” It is usual to fertilize the tilled or hoed crop in the rotation, as corn or potatoes; or the fertilizer may be applied with wheat, being drilled in.

**REVIEW**

What is “the soil”? How is it formed?
What do you understand by mineral matter and organic matter?
Name the elements indispensable to the growing of plants. Which ones are mostly needed in fertilizers, and why?
What is a soil particle? Did you ever see one? How large are the particles in coarse sand? in fine sand?
What is a heavy and a light soil?
How do sandy soils differ from clayey soils?
What is a loam?
Whence comes the organic matter? What is humus and what does it do?
What is the structure of the soil? Granulation? How does granulation improve soils?
Explain how water exists in the soil. What is capillary water and free water?
Give your idea of percolation.
Explain how the water enters the plant.
How is moisture controlled? How is it lost?
Explain what you mean by conservation of moisture. How important is it? What does the word “conservation” mean?
How does deep tillage save moisture?
Describe the soil-mulch and tell what it does.
What is dry-farming? irrigation? Give reasons for their practice.
How is air contained in the soil?
Explain the heat of the soil, and its action.
State your conception of the soil-solution. Why is this solution important to the farmer?
What amounts of plant-foods are removed by crops?
Whence comes the nitrogen supply?
What do you understand by nodules? How are soils sometimes inoculated?
What is meant by acid soils? What is the test for acid in the soil? How is acidity corrected?
Explain the liming of the land, and tell why.
What is a fertilizer? Why are fertilizers necessary?
Name some of the leading fertilizer materials.
What are mixed fertilizers? Brands? What does the law require?
What are home-mixed fertilizers?
What amounts of fertilizers are applied to the acre?

THOUGHT-QUESTIONS AND SPECIAL PROBLEMS

Most soils may be placed in one of five groups according to the way in which they were formed. They may have been (1) laid down by glaciers, (2) formed or deposited by rivers, (3) drifted by winds, (4) formed as the result of the decay of the underlying bed-rock, (5) or the result of decaying vegetation that filled in old lakes or swamps. How do you think the soil on your farm originated?

Obtain a generous sample of soil from your field. Spread it out on a piece of paper under the stove until it is completely dry. Fill a pint or a quart fruit-jar to within one inch of the top with the dry earth, compacting it by pressure of the fingers. Pour in a measured amount of water until the soil is completely saturated and the water stands on the surface. Estimate as nearly as you can the amount of pore-space there was in the soil sample.

What kinds of commercial fertilizers, if any, are used by the farmers in your neighborhood? Which of the primary plant-food elements, if any, appear to be deficient in your soil? What does your father think about it?

What kinds of soils are to be found in your neighborhood? Describe the soil improvement methods practiced by the best farmers of your community.

Obtain a sample of the surface soil from your garden or field. Spread out in the sun or under the stove until all the moisture...
has evaporated. Weigh out a definite amount of the dry soil and place in a metal pan or on a shovel and put on a bed of coals or over a fire. Heat until the soil mass glows throughout. When the burned soil is cool, weigh again. What was the percentage of loss in weight? What part of the soil disappeared?

If heavy clay soil is obtainable, divide a sample into three parts of about one pint each and label them A, B, and C. Mix one-half spoonful of lime with A; mix a small handful of dry well-rotted manure with B; leave C untreated. Place each sample in a metal saucer or shallow can; add water and stir until the material in each is in a “soft mud” condition. Place the samples in an oven or in the sun until thoroughly dry. Then examine each sample carefully and note any difference in structure. Try to crush each dried sample with your fingers. Report your results in writing.

Obtain four tin cans of the same size and make twelve drainage holes in the bottom of each with a small nail. Label the cans A, B, C, and D. Fill A with air-dry clay soil; B, with air-dry sand; C, with dry pebbles; D, with a mixture of equal parts of air-dry sand and dry well-rotted manure. So arrange each can that any drainage water may be caught and measured. Pour a measured and equal amount of water into each can. Keep adding water until drainage begins in can A. Which soil retained the most water? How may the water-holding capacity of sandy soil be increased? In which soil is percolation freest?

Find three tall lamp chimneys. Tie a piece of cheesecloth over the bottom of each. Label the chimneys A, B, and C. Fill A with dry clay soil; B with dry fine sand; C with dry coarse sand or fine pebbles. Place A, B, and C in a shallow pan and fill the pan with water. Note the rapidity with which the water rises in each chimney, and the heights to which it ascends in a given time (one hour). In which soil is capillary movement greatest?

Describe the methods and the tillage implements used by the best farmers in your section for controlling soil moisture. Why is it not a good practice to cultivate corn or potatoes deeply in mid-summer?

If you live, or have lived, in a dry-farming section, describe the special methods used by the farmers for catching and conserving the rainfall. What crops are especially adapted to a dry-farming region?

If you live, or have lived, in a section where irrigation is practiced, tell how the land is prepared for irrigation and how the water is applied to the crops.

Find out what nitrogen, potash, and phosphoric acid cost a pound when purchased in the form of commercial fertilizers. Apply these
figures to the average yield of crops grown on your farm. What is the acre-value of the plant-food removed from your farm by the crops?

What kind of leguminous plants are grown on your farm? What kind will grow in your neighborhood? Carefully dig a clover, alfalfa, or bean plant and examine the roots for nodules. Do not pull up the plants, or the nodules may be torn off. Do legumes have a place in the crop-rotation plans on your farm? Why?

Obtain a few sheets of red and blue litmus paper from the drug store. (Enough may be obtained for one cent for this demonstration.) Bring a sample of the field or garden soil to school from home. Moisten the soil sample with rain or snow water, and imbed a piece of red and a piece of blue litmus paper to one-half its length in the moist earth. Note carefully whether there is an acid or alkaline reaction. If no definite results are obtained, moisten the earth with dilute vinegar. Note the change in color of the litmus paper. Then moisten with limewater (made by slacking a piece of quicklime in water). Describe the change that occurs.

Do you think the soils in your section need lime? Do clover, alfalfa, and other legumes grow well? What plants prefer an acid soil? What plants do best in an alkaline soil?

If commercial fertilizers are used on your farm, get some of the fertilizer tags and bring to school. Study the guaranteed analysis of the different brands. How many pounds does each brand have of available nitrogen, potash, and phosphoric acid to the ton?
TOPIC 4

THE IMPLEMENTS

Try to imagine a farmer with no tools — without an ax, hoe, knife, spade, saw, plow. What single crop could he raise, or what animal could he tame and keep? He would be powerless against weeds and roving beasts, and unable to till the soil. The civilized man is distinguished from the savage by his tools.

A tool is an instrument used mostly by hand. It is the simplest mechanical aid that the farmer applies to his work. We all know what is meant by "carpenters' tools." Usually the tool is smaller and lighter than a man, but some tools are used by two men. An implement is understood to be a larger instrument not used by hand.

When several or many pieces or parts are so joined that they work together and perform certain labor, we have a machine. In a machine, motion is transmitted from one part to another. Follow the movement in a sewing-machine or feed-cutter from part to part.

The working parts of a machine are known as its members. These we shall now discuss. Some of these
members, as the blades or shovel on a cultivator, are themselves tools attached in a framework so that they can be held in place and drawn by a team. A cultivator is usually called an implement rather than a machine; it is simpler than a machine since it has no motion or movement within itself. A grain-drill is a true machine; a plow is a true implement. In common speech the word "implement" is often used as a general term for tools and machines together, as when we speak of an "implement dealer." The word "machinery" is often used in a general way to include tools, implements and true machines.

33. THE MACHINE

A machine, with one part transmitting motion to another part, is made up mostly of the following parts variously joined: framework, lever, link, strut, shaft, wheel and axle, crank, inclined plane, cog, cam, sprocket, eccentric, pitman.

The purpose of the frame is to hold the parts together, in proper relation to each other.

The lever is a member designed to transmit force or power by prying. A man uses a lever when he lifts or pries up a rock with a crowbar. He puts one end of the lever under the rock, places a
stone under the bar, and pries down. The lever consists of two parts working over a support or fulcrum,—the weight-arm and power-arm. When a man drives the point of the bar into the earth to hold it and pushes against the rock, the fulcrum is at the point of the bar.

A very simple lever is the common singletree or whiffletree. In this case the two lever arms are equal, and the horse pulls one-half his load from each tug. The fulcrum is in the center where the whiffletree is attached. The evener is a lever. If we have one big horse and one small horse, we give the big horse the short end of the evener and the small horse the long end, so that each horse will be pulling in proportion to his weight.

Other examples of levers are on the mowing machine. When we want to lift the cutter-bar over an obstruction, we pull back on the gag-lever. The hand must move through a long distance to lift the cutter-bar a few inches: the man has the long end of the lever. Another lever tilts the knives so that the grass will slip off the cutter-bar. The handles of a plow act as levers by means of which to tip the implement from side to side according to the ground it is passing over.

A link is a member that transmits force by means of tension or pulling. When we use a link we attach it to its hold by means of a hook or pin or another link. For example, the horse's tug is joined to the singletree by means of a hook, and the singletree is joined to the evener by means of a clevis. Both hook
and clevis act as links. These two links make the part free so that it may move one way or another.

The clevis itself is of two parts, — the U-shaped part and the pin. It is by the pin that the clevis secures its hold; this kind of pin, that screws into place or is otherwise securely held, is called a clevis-pin.

The inner shoe on the mower is lifted from the ground by a link hanging from the gag-lever on one end and attached to the yoke on the other.

A strut is a member designed to transmit the force by means of compression or pushing. When a wagon goes down hill we hold it back with the tongue. The tongue pushing against the neck-yoke acts as a strut. A post in a barn which holds up the weight of the haymow is also a strut. The push-bar on a mowing machine is another example; also the frog on a plow. The plow-beam presses against the frog and the frog presses against the plowshare. The spokes in a wagon wheel act as struts, but the spokes in a bicycle wheel act as links.

A shaft is a member to transmit force by means of torsion or twisting. The large wheels of the mowing
machine drive the main shaft, and this shaft in turn drives a big spur-gear, which is fastened to it by means of pins or keys; when the shaft rolls, the gear must turn with it. The shaft imparts a twisting motion. Another example is the line-shaft, driven by an engine. From this line-shaft is taken off power for different machines, such as a corn-sheller or a cream separator.

An axle is the pivot on which a wheel revolves. The most familiar example is in the common wagon or cart. The wheel turns and the axle stands still. When the wagon is pulled forward by the horses, the axle presses against the inside of the hub of the wheel and pushes the wheel along. Since the rim of the wheel rests on the ground and the hub moves forward, the wheel is revolved about its axle.

A wheel acts like a lever and the axle acts like a fulcrum; or, we may consider that the distance from the hub to the ground is one power-arm, and the distance from the hub to a chain or whatever is fastened on the wheel, as the weight-arm.

Another example of the wheel-and-axle is the windlass, with which water is lifted in a bucket from an open well.

Another example, more complicated, is that part of the mowing machine by which the main drive-wheel imparts motion to a pawl, and the pawl to the ratchet, and the ratchet to the main shaft, the main wheel of the mowing machine itself being free to turn on the end of the main shaft just as the wagon wheel is free to turn on its axle.
Practically all machines contain wheels of one kind or another. Sometimes they are used merely for locomotion, as on a wagon, automobile, railway coach, and other vehicles.

A crank is a special kind of lever to transmit motion to a shaft. It is used in a bucket or chain pump, and to crank or start an automobile. The motion may be supplied by a boy (and often unwillingly), as at a grindstone.

The inclined plane is a sloping surface or body, up which or down which something travels. The plow-share is an excellent example of the inclined plane. As the plow moves forward, the furrow-slice is lifted until it comes on the moldboard. Then the moldboard acts as an inclined plane and throws the furrow-slice over to one side; in fact, the moldboard acts as an inclined plane in two different directions, approaching the screw in form.

Teeth on wheels meshing with each other and transmitting motion are known as cogs. The motion is by direct contact of cog with cog, making a gear.

When teeth on one wheel mate with corresponding teeth on another wheel and the shafts of the two wheels are parallel, we have a spur-gear. Such gears are found on the mowing machine, the cream separator, the corn-sheller, hay-press, and many other machines.
Gear-teeth cut on a bevel or angle so that one shaft is at right angles to the other shaft, are known as bevel-gears or miter-gears. We find these on the mowing machine, harvester, and in many other places. Bevel-gears are used in the differential of the automobile.

Another form for driving a shaft at right angles to the other is the "worm-and-wheel." A portion of the spindle of the cream separator bowl is cut as a worm to be driven by a bronze worm-wheel. (The loss due to friction is less between bronze and steel than between steel and steel.)

When one wheel imparts its power directly to another wheel without teeth or cogs of any kind, the two are called friction wheels. This device permits slipping, thereby lessening the jerk when the parts come together. This principle is employed in the clutch of the automobile, the parts slipping somewhat before they "take hold."

A cam is a member to impart to a follower a certain prescribed motion. It always has a curved edge or face against which the follower works. It is never perfectly
circular. It is often of irregular shape. The desired motion is first determined; then a cam is devised that will produce it. Some cams are cylinders, as the device used in certain sewing-machines to drive the needle.

One example of a cam is the heart-shaped member used on the sewing-machine for the purpose of winding thread on the bobbin. In this case the follower travels at a uniform rate along the bobbin and then reverses its motion instantly at the ends so as to prevent the thread from piling up at the ends of the bobbin, as it would do if the follower were to pause.

Another kind of cam is found in the binder, for dropping the trip-hook so that the bundle can be discharged. This is called the tier-head cam. Its prescribed motion is to hold the hook stationary while the bundle is being tied, then drop the hook when the discharge-arms come around and push out the bundle. This cam gives its motion to the trip-hook through a lever, a link, and a shaft. This tier-head cam is circular for the most part, but has a depression for dropping the bundle.

Another cam is the tightening device for placing quickly detachable shares on plows. When we turn the handle, the share is drawn firmly into place. Another form is sometimes seen on the tailboard of a wagon-box for fastening the gate in place.

When a wheel is arranged to impart power to another wheel by means of a chain it is called a sprocket-wheel,
and the teeth on which the chain-links work are sprockets.
Since the parts of the chain transmit force by means of tension, they are links. The term cog is never applied to a sprocket, but is confined to those teeth that impart the motion from one wheel to another by direct contact (page 60).

An eccentric is a circle mounted off-center, so that it does not revolve evenly. It is a specialized form of crank. The eccentric is often used in the fanning-mill for moving the riddles or sieves, and sometimes on the manure-spreader for driving the apron. It is employed on the steam traction engine to drive the valves.

A pitman is a rod or bar for changing circular or round-and-round (rotary) motion into back-and-forth (reciprocating) motion. Examples of the pitman are shown on the mowing machine, binder, and printing press. It is attached at both ends and transmits motion from one part to another, but modifies the form of motion.

34. THE PLOW

Aside from hand tools, the plow is probably the oldest farm implement. In its original form it was a trunk of a small tree with a branch cut off near the crotch and somewhat pointed. History tells us that women pulled the implement. Later, oxen took up the burden. The plow itself made little development until
well within the era of written history. It has now become a highly developed implement, although simple, made of the best materials, and in forms adapted to many kinds of work. The plow is one of the most useful implements known to man.

A plow may be defined as an implement designed to cut free and turn over a slice of the tillable part of the earth’s surface. The part or strip turned over is the furrow-slice; the channel opened in the ground is the furrow. The plowman walks in the furrow.

The plow consists essentially of three parts, — the hitch, the bottom, the steering mechanism.

The hitch is represented in the beam. At the front end of this beam is a member for attaching an evener, known as the clevis. This clevis has two adjustments, one in the vertical known as the “vertical clevis” or “depth hitch”; the other the “horizontal” or “cross clevis,” commonly called the “width hitch.” Notice the peculiar curved shape of the plow-beam to give it clearance over the furrow-slice. The beam must transmit the pull of the horse to the plow-bottom; it thickens in the curve for
stiffness; and, if made of steel, we get a stronger member with an I-section than with any other form.

The rear end of the beam attaches to the framework of the bottom, known as the frog. To the face of this frog two members are attached; one is for cutting the furrow-slice free, known as the share; the other member is for inverting the furrow-slice, known as the moldboard. If the plow is drawn forward, the furrow-slice, pressing against the face of the moldboard, tends to push the implement sidewise. To avoid this there is placed on the opposite side of the frog a member called the landside, whose purpose is to transmit this thrust from the furrow-slice against the opposite side of the furrow, holding the plow steady and in place.

As the horses pull upward more or less on the beam, the tendency is for the plow to be lifted out of the ground. To prevent this, the point of the share (the "plow-point") is slanted downward; this tends to pull the plow into the earth, and the tendency is called "the suction." Most plows have a slight heel or projection on the lower
edge of the landside; this also serves to hold the plow in place.

Let us run hastily over the parts that transmit the power: from the whiffletree to the evener and clevis, from the clevis to the beam, from the beam to the frog, from the frog to the share and moldboard; and the thrust of the share and moldboard is taken up by the landside.

To steady the plow, we attach the handles. These enable us to supplement the horses in steering the device across the field.

The diagrams show the parts of the plow. It looks like a simple implement, and so it is; but it is the simplicity of centuries of experience. Every farm boy knows that the plow will not work well unless the eveners, clevis, handles, point, and other parts are "hung just right." Even a slight fault will make a great difference in the ease and thoroughness of the plowing. The violin is a simple instrument; yet it must be perfectly adjusted, and few persons can play it well. So the plow is simple in line and part; yet every part is essential and much skill is essential to plow well.

35. CARE OF MACHINES AND IMPLEMENTS

Suppose you put the one-horse cultivator in good condition. In the first place, use a putty knife or a

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scraper to clean off all the dirt. Then with a wrench tighten loose nuts and bolts. Right here make it your rule never to use a wrench on a nut unless it fits \textit{wrenches} and closely. If you are a little careless about \textit{nuts} this point, the loose-fitting wrench will soon round off the corners of nuts or bolts. Then they will be very difficult to hold or turn with any wrench. You may find that some nuts stick and refuse to turn on the bolts. Put a few drops of kerosene on them and leave them; they will turn more readily the next day. In putting nuts or other metal parts together, apply a little oil or grease. Thus they will come apart more easily next time.

Procure a stiff wire, such as a wire hairpin, and clean the dirt and the grass seed out of the oiling places of the mowing machine. No, do not use the end of the oil-can snout for this purpose or you will soon find that the can will not feed any more oil.

Do not remove the packing that you may find in one or two of the big oil-cups. This packing is to hold the oil so that it will run down slowly to the bearing as needed. Although cotton is sometimes used here, it is not desirable, for it fills the feed hole too tightly; wool just as it is clipped from the sheep's back is the proper material to use. Put a few drops of oil into each hole. Every part that runs or rubs on another part when a machine is working should receive oil. To this rule there is one exception in the case of a mowing machine: it is not considered necessary to oil the knife where it runs back and forth on the finger guards. Be sure to put your wire and the can of oil in the mower box. The driver will need to use them in an hour or two.
REVIEW

What is a member?
What are the main parts or elements in a machine?
Explain what you mean by the frame. What is the frame in a sewing-machine or a feed-cutter?
Describe a lever, with examples.
What is meant by a link?
What is a strut? shaft?
Describe the action of the wheel.
What is a crank? inclined plane?
What are cogs? cams? sprocket? eccentric?
Define pitman.
What can you say about the character and importance of the plow?
What are the three fundamental parts of the plow?
Describe the beam of the plow; the bottom.
How is a plow steered and handled?
What are the cutting and turning parts of the plow?
How should tools and machinery be housed?
Explain the reasons for oiling and painting.

THOUGHT-PROBLEMS AND INQUIRIES

Make a list of the tools, implements, and machines used on your farm or on the farm of a neighbor.
What is the average life of the different farm implements and machines used in your section?
Find out to what extent farm machinery has reduced the amount of human labor necessary for producing a bushel of wheat.
Make a list of the different kinds of plows that are used by the farmers in your region. Describe the special use of each.
How are farm implements and machines cared for during the winter, or season when not in use on your farm?
How many square feet of roof or wall space will be required to house a grain binder, hayrake, mower, plow, and harrow? If the life of the implements mentioned can be increased 100 per cent by such protection from the weather, and the building will last twenty years, will it pay to erect such a structure?
How many places are there to be oiled or greased on a grain binder? stationary gas engine? tractor?

SPECIAL PROBLEMS

Each of the older pupils should undertake the task of keeping the farm implements and machines in the best of working order. The project may be resolved into three phases.

1. To see that the implements are properly housed or protected when their work for the season is completed. This includes the painting or greasing of exposed parts that may rust or rot.

2. The careful examination of all implements previous to the season of their use so that broken or missing parts may be detected and ordered in plenty of time.

3. The oiling or filling of the grease cups at morning and noon, or as frequently as needed, of the bearings in all machines in service. Make this your job so that the machine operator may have his time for other duties.

Let some pupil bring a plow to the schoolroom. Place it on a table or bench, where it may be seen from all sides. The pupils should take it apart, naming every piece and explaining its use. The same pupils should put the parts together again.
TOPIC 5

THE WEATHER

Plants grow in the atmosphere as well as in the soil, deriving from it part of their nourishment. Animals live in the atmosphere, obtaining food directly or indirectly from the plants. Men live in the atmosphere. Even animals that burrow in the earth must have air; so must the fish even though they never come to the top. No life could exist and no fire could burn were it not for the atmosphere.

36. THE ATMOSPHERE

The atmosphere is the air surrounding the earth. We live at the bottom of the ocean of air, much as certain animals live at the bottom of the sea. As these animals cannot live at the top of the sea, so we cannot live at the top of the atmosphere.

Men cannot live at a height greater than about six miles because of the thin air and the insufficient supply of oxygen. When we ascend high mountains we experience the sensation of "rare air," which is insufficient air. The heart may be affected, the nose may bleed, the person may be "out of breath." Some persons cannot make a high ascent. Many of them are affected in going on the railroad to the top of Pikes
Peak, which is about 14,000 feet above the sea. The atmosphere is appreciable upwards for perhaps fifty miles, but there is evidence that it extends four times this distance.

The air is composed of certain gases mixed together, much as one might mix sand, sawdust, and ashes. The principal gases are nitrogen, oxygen, and carbon dioxide. About four-fifths of the volume of air is nitrogen.

The air also contains moisture in the form of invisible vapor of water. When sufficiently cooled the vapor condenses into visible particles of water, forming clouds and rain, sleet, hail, dew, frost, snow. The steam in a tea-kettle or a steam engine is vapor and is invisible: if the kettle or the cylinder of the engine were of glass, we could not see the steam inside; when the vapor or steam escapes, it condenses into a cloud which we erroneously call steam.

The air also contains numberless particles of dust. These particles assist in the changing of vapor to water. They are assistants of the sun in the warming of the atmosphere. They are the chief cause of twilight, the blue of the sky, and the brilliant colors at sunrise and sunset. The dust particles and the gas particles take part in the wonderful changes always proceeding in the air.

The condition of the atmosphere, whether warm or cold, moist or dry, cloudy or clear, makes the weather of any hour or day. The work of the farmer depends largely on the weather; in fact, it is often controlled by the weather.

The science of the weather is known as meteorology.
37. The Climate

The climate of any place is the sum or average of all the weather for a year or a series of years. We usually speak of weather in terms of time (as the weather of yesterday or to-day), but we talk of climate in terms of place or region (as the climate of Chicago or New Orleans or the sea-coast).

We also speak of climate in terms of crops. One climate may be cold, another dry, another sunny; and we know that the kind of climate largely controls the kind of vegetation. We speak of a good climate for wheat, cotton, fruit, sheep; of one that is too dry for hay or too wet for oats; of seasons too short for corn.

We do not know the climate of a place until we have lived there for some time, say five or ten years, and know about what kind of weather to expect. We learn the extremes of temperature and of moisture, the length of seasons, the likelihood of storms, the probabilities of rainfall in the different months, the winter weather, summer weather, and the like. A clear knowledge of the climate is a great aid to the farmer in determining his plan of cropping.

The changes in weather are the results of natural causes. They are not accidental nor beyond the power of man to find out and to understand. Once it was thought that the weather changes were the work of imps living in the atmosphere, but we now know that they are variations in temperature, pressure, and moisture.

Man may not be able to control the weather to any great extent, but he can better adapt himself to it if he
understands why the changes occur and if he can know of them a few days or even a few hours in advance.

Therefore, we may study the weather intelligently, as we study any other subject that follows the operation of natural law. The weather changes are wonderful, and they add much to the interest of life.

38. Pressure of the Atmosphere

The great body of air above the earth bears down on everything. Even though it seems to us so thin and light, it has weight, as does a pile of stones or a building. At the level of the sea the weight of the air is about fifteen pounds on every square inch.

So accustomed are we to the weight or pressure of the atmosphere that we realize this pressure only when it is removed, much as a fish may be supposed not to know that he lives under water until he is taken out of it. We utilize the pressure of the atmosphere in many ways, as when we pump water, fill a fountain pen, or use a siphon. We could not take a drink of water or even walk were it not for the pressure of the air.

Even at the same elevation above the sea the pressure or weight of the atmosphere at different places may vary, principally because of difference in temperature and moisture. The air does not heat uniformly. It varies in density. But, in general, the pressure is greatest at the bottom of the atmosphere (as sea level) and decreases as we rise. The pressure is measured by a barometer.

Certain places or regions in the atmosphere may be
specially heavy or specially light, differing in pressure. When the atmosphere is light, we say the pressure is "low"; when heavy, it is "high."

A marked low-pressure area, or a "low," is a storm center. A "high" is usually a clearing condition, often accompanied by a cold wave.

These "lows" and "highs" do not remain stationary. They move across the country, usually at the rate of 600 to 700 miles a day, accompanied by characteristic winds, precipitation (fall of rain or snow), and temperature changes. This is the distance covered by a railway train moving at the average speed of twenty-five miles or more an hour.

39. The Wind

Wind is air in motion. Wind moves toward the warmer areas, from which areas the air rises, much as the leaves are drawn into a bonfire by the upward movement of the flame and its draft of air. The wind moves over such a large territory that we may not be able to recognize its rush toward an area of low pressure; but studies of the atmosphere over large areas, by means of weather maps, disclose such movement.

The winds are named from the direction from which they blow. The south wind comes from the south and the west wind from the west. A breeze is a light wind, one that moves perhaps six to eight miles an hour. A zephyr is a very light breeze. A wind that moves the leaves on trees travels three to five miles an hour. A gale is forty or fifty miles an hour; a hurricane eighty miles or more. The strongest winds cannot be measured. A wind above
one hundred miles may blow down all ordinary structures, and usually uproots trees, exerting a pressure of perhaps forty pounds to the square foot. It has been estimated that winds may move two hundred miles an hour or even more.

The trade-winds of the tropics and the prevailing westerly winds of the temperate zones are a part of the general circulation of the atmosphere over the earth. They are general currents or rivers in the atmosphere, much like the currents in the ocean.

These rivers are largely the distributors of moisture, which they bring from the oceans. The sun’s heat evaporates the water; the vapor is carried far and wide; when condensed again into water it falls as rain perhaps thousands of miles away, supplying the plants and animals and making streams and lakes.

40. STORMS

Storms are more or less violent disturbances of the atmosphere. They are sometimes called low-pressure areas. Some storms are local disturbances of small extent and soon pass away; thunderstorms and tornadoes are of this kind.

Other storms involve great areas and move across the country in more or less regular routes or tracks; these are general storms and are called cyclones. Knowing the atmospheric pressure where these great storms are centered, the direction of their movement, the nature and velocity of the winds, and the temperature, the information may be telegraphed ahead of them and we say that a storm of a certain character is predicted.
A falling barometer is an indication of the approach of a storm. The character of the storm is indicated by wind velocity, temperature, rain or snow, and other features. A rising barometer indicates clearing weather and the passing away of the storm.

![Chart of a Storm or Cyclone](image)

**Chart of a Storm or Cyclone.** — Note the winds moving toward Low, which is near Chicago. The High is advancing from the Montana region. The dotted lines show the high temperatures east of Low and the low temperatures on the west.

In common speech, the word cyclone is often used for the violent tornadoes or "twisters" that work such havoc in narrow belts and for short distances, but this is an erroneous usage. The real cyclones, except hurricanes and typhoons, which originate only in the tropics, are not often violent enough to cause damage. In the meteorological sense, a cyclone is the name applied to storms that cover a large area, perhaps
four or five states in the Union. It is a movement of air, but it may be accompanied by rain or snow, and it involves change of temperature. The word cyclone itself signifies "whirling in a circle" or around a center.

The cyclonic storms are characterized by winds that blow more or less spirally around low-pressure areas rather than moving straight into the areas. Areas or locations of storms. The storm areas are so large (perhaps a thousand miles across) that we do not recognize the flow of air spirally; but when we collect the wind observations from all parts of the storm and chart them on a map, we discover their law of motion. In the northern hemisphere the storm-center is always to the right hand as one faces the wind. The lower air in these cyclones is forced upwards, cooled, and discharges its moisture in the form of rain or snow.

The positions of the storm-tracks or cyclones on the continent of North America have been well determined. Prediction of storms is not a mysterious or uncanny power possessed by a "weather prophet," but the result of accurate knowledge based on the study of the laws of the atmosphere.

41. THE TRACKS OF THE STORMS, AND FORECASTS

The continental storms of North America mostly move from west to east. They originate chiefly in the North Pacific ocean. Some of them start in the region of the West Indies islands and the Gulf of Mexico, and are known as West India hurricanes. They move first westward, then turn northward and move up the Mississippi Valley or the
Atlantic Coast. They are the most severe cyclones that invade the United States.

The "highs" do not follow the tracks of the storm-centers, although they may move in the same general direction and more or less parallel to them. It is not always known when a storm-center is reported off the Pacific Coast or in the northern Rocky Mountain territory, which one of the several transcontinental routes it may take; there may be cross tracks from one storm to another: therefore, it is sometimes difficult to forecast the weather for any great length of time ahead of the storm-center. When the storm has been moving two or three days, its character usually becomes well enough determined to enable a fairly definite prediction to be made; yet it may change suddenly or may lose its momentum and die away.

The path of a storm is determined by the general current or river of air in which it exists, and by the form of the country over which it passes, modified by the cloud and the precipitation that accompany it. Mountain chains, wide openings in the ranges, broad plains, modify or change the courses.

Not all the storms arise from moving storm-centers of low pressure. Some of them are wholly local, and move relatively very little. Summer thunderstorms may be of cyclonic or low-pressure origin, or they may arise from the strong upward movement of heated air on a hot day. Even if they are local and practically stationary, they may be foretold with some degree of accuracy from a knowledge of the temperature, humidity, and other conditions prevailing at a given time.
Farmers and sailors become weather-wise, and are able to forecast the weather of the day or of the succeeding day with a good measure of success. They depend on certain "signs"; but these signs are only the indications or marks of the natural conditions, and the forecaster is unconsciously employing the scientific method of good observation in making his predictions.

Every farmer should be able to foretell the usual weather changes in his locality. He learns the weather of his neighborhood, and knows about what to expect when the indications are so and so.

The telegraphic forecasts of the United States Weather Bureau, issued daily (separate from the weather maps), are good guides for the weather of the localities or regions to which they apply.

42. Lightning and Thunder and Rain

So many and so complex are the changes in the atmosphere and so far are many of the causes removed from observation, that it is very difficult to explain some of the commonest occurrences.

Perhaps the pupil has seen in school the electrical discharge that passes between the two points on the electric machine; or he has observed the spark on the wire when the trolley loses connection; or he has seen the sparks when, in a dry atmosphere and with dry hands, he rubs the cat's fur. A flash of lightning is an electric spark on a gigantic scale, as proved by Benjamin Franklin with his kite in 1752. The light is caused by the heating of the air along its track. The lightning burns a hole through the air. The discharge
may take place between two clouds, between a cloud and the earth, or between parts of the same cloud.

Protection of buildings from lightning consists in drawing off the electrical energy from the buildings, and in providing a route over which a discharge may pass to the earth and yet not work damage. The charge is taken up readily by moist earth but not by dry earth. Metal roofs are good protection if they are connected with permanently moist ground by rain-water conductors or other metal pipes. Strong metal rods along the peak of the roof, with points at not less than forty feet apart and standing six feet high, may be expected to conduct a discharge to the ground if strong metal connections run deep into the ground. The rods and fixtures should be insulated from the building, and sharp or right-angle turns should be avoided. Moist earth conducts the electricity away; therefore the rod is attached to a metal plate which is deeply buried. The equipment of a building for lightning protection should be under the direction of a reliable expert.
Thunder is the result of lightning. It is caused by the violent expansion of the atmosphere which takes place because of the sudden heating along the course of the lightning discharge. It is in all respects similar to a violent explosion. The thunder is the noise of the explosion.

Rain is drops of water condensed from the vapor of the atmosphere, and which become so large and heavy that they fall to the earth. It is supposed that the condensation begins to form around dust and electric particles. Rain washes the dust from the atmosphere and thereby cleans the air; and it brings down certain gases that may be of use to plants.

Rain-drops never are larger than about $\frac{1}{4}$ inch in diameter; if larger, they fall so rapidly as to break into smaller drops. They can never fall faster than twenty-six feet a second. On the other extreme, they may be so small as to fall only five feet or less a second; and when very small they float as fog and cloud.

43. Clouds and Their Kinds

When the invisible moisture of the atmosphere is changed into numberless drops or particles of water and these particles are so small that they float, then we have clouds. If the cloud rests on the earth, it is called fog. Standing on the plain, we see a cloud about a mountain; the man on the mountain, standing in the cloud, says it is foggy.

Clouds are of many kinds, depending on the sizes of the particles of water, the height above the earth, and the shaping by currents of air and by wind. We look
upward at the underside of clouds, and they look more or less flat to us. They would look very different if we were on the same level with them. They would present still another appearance if we were above them.

We may classify clouds roughly into three groups or families. There are many combinations of these three species of clouds and many intermediates, for no two clouds are alike.

The low-lying dull gray forms, more or less stratified or in layers, are stratus clouds. Sometimes they are no higher than the tree tops and steeples. They lie against the sides of mountains and hide their tops. From these clouds the rain comes, and then they are called nimbus clouds.

The thunder-heads or wool-packs of summer, rising like domes and castles and floating on a flat base, are the cumulus clouds. They are wonderful objects in the sky.

High above the others are the cirrus clouds, thin feathery delicate white bands and bunches, sometimes like horse tails and again like films of frost. They are indeed frost. Usually they are five or six miles above the earth, where the water freezes into crystals of ice. Sometimes these clouds may be seen through rifts in the stratus, lying far in the heavens. A storm is to be expected a day or two following cirrus clouds.

It is well to study the animals and birds and the soil; it is equally well to study the clouds, to name their forms, to describe the colors, and to watch the shadows that they cast on the earth and on each other.
44. **The Weather Map**

For many years the United States Weather Bureau has charted the tracks of the general or continental storms, and the routes and movements are now represented on weather maps. These charts are posted in public places and may be obtained for school and other use.

On an outline map of the United States, lines and symbols represent the weather conditions as telegraphed at 8 A.M. and 8 P.M. each day to Washington. The positions of equal atmospheric pressures are shown by heavy black lines; some of the lines inclose “lows” and some “highs.” Equal or similar temperatures are represented by dotted lines. Arrows indicate the direction of the wind. Symbols indicate the state of the weather, whether clear, cloudy or partly cloudy, rain or snow.

The reading-matter or text on the map presents the forecasts, and such further information as one may need to enable one to understand the weather movements across the continent and to be advised of the probable condition in one’s own region.

45. **Weather Bureau Forecasts**

Aside from the issuing of the weather maps, the United States Weather Bureau sends forecasts twice a day to all parts of the country by telegraph, telephone, and mail, as indicated in the preceding section (44). These forecasts are printed slips or cards to be seen in post-offices and other public places, with such information as this: “Generally cloudy to-night and
Thursday; colder to-night." These indications are usually printed also in the daily newspapers.

Weather flags are also displayed, with signals as follows:

No. 1, square white flag, alone: fair weather, stationary temperature.
No. 2, square blue flag, alone: rain or snow, stationary temperature.
No. 3, square, white above, blue below, alone: local rain, stationary temperature.
No. 4, triangular black, refers to temperature.
No. 5, square white, with black center: cold wave.
No. 1, with No. 4 above it: fair weather, warmer.
No. 1, with No. 4 below it: fair weather, colder.
No. 2, with No. 4 above it: warmer weather, rain or snow.
No. 2, with No. 4 below it: colder weather, rain or snow.
No. 3, with No. 4 above it: warmer weather, with local rains.
No. 3, with No. 4 below it: colder weather, with local rains.
No. 1, with No. 5 below it: fair weather, cold wave.
No. 2, with No. 5 below it: wet weather, cold wave.

Whistle signals are these:
The warning signal, to attract attention, is a long blast of fifteen to twenty seconds' duration. After this warning has been sounded, long blasts (of four to six seconds' duration) refer to weather, and short blasts (of one to three seconds' duration), to temperature; those for weather are sounded first.

One long: fair weather.
Two long: rain or snow.
Three long: local rain or snow.
One short: lower temperature.
Two short: higher temperature.
Three short: cold wave.

Interpretation of Combination Blasts:
One long, alone: fair weather, stationary temperature.
Two long, alone: rain or snow; stationary temperature.
One long and one short: fair weather, lower temperature.
Two long and two short: rain or snow, higher temperature.
One long and three short: fair weather, cold wave.
Three long and two short: local rains, higher temperature.

Canadian signals:
No. 1, gale at first from an easterly direction.
No. 2, gale at first from a westerly direction.
No. 3, heavy gale at first from an easterly direction.
No. 4, heavy gale at first from a westerly direction.

46. Frosts

In the daytime the earth and vegetation are warmed by the sun. At night the heat is radiated (or lost) into space, and the temperature may go so low that the plants are injured by frost. The radiation or loss of heat is most rapid in a clear still night. If the night is cloudy, the earth's heat will not pass off so quickly; the clouds act as a roof. The loss of heat is less rapid if a slight breeze is moving or if the air is very moist.

The two most usual ways of preventing light frosts are by smudging, whereby a cloud of smoke is produced, and by heating the air. Separate plants or small areas may be protected by covering, and certain plants (as pineapples) may be grown under
slat sheds. Only valuable plants or crops will pay the cost of either protection of the crops or of prevention of frost.

In productive orchards, particularly in the Far West and on the Pacific Coast, the actual heating of the air by specially designed small portable heaters burning fuel-oil or coal has been successful, and many publications have been issued on the subject.

47. Local Climate

The success of farming depends as much on the climate of the locality as on the tillage or on the seed. It would be useless to prepare the soil well and to choose seed with ever so much care were the climate such as to make success impossible or very difficult. Persons often fail by trying to grow crops not adapted to the climate.

The farmer should know about what to expect in his climate,—the probability of late spring and early autumn frosts, the rainfall and its distribution throughout the season, the cloudiness and sunshine, the occurrence of hot and drying winds, the likelihood of sufficient snow to protect his wheat and other winter planting. One should know whether the climate is likely to be "steady." See also the statement on page 72.

All this is a larger question than daily weather; it is the average character of the locality from year to year. When records of pressure, temperature, wind, humidity, and other features have been made in any region for a series of years, one is able to measure the climate and to understand the relation of crop-production to it.
These records are also of great value to others than farmers. If an engineer, for example, were to undertake an important work out of doors, he would want to consult records of rainfall and flood, and perhaps also of temperature and wind velocities.

The work of making and keeping records of weather and climate lies with the public weather services; yet every farmer should make observations at least of rainfall and temperature for his own benefit, much as one keeps a diary or a line-a-day. The weather services also desire a certain number of local observers.

A rain-gage may be placed near the house, where the observations may be made easily. A thermometer shelter may be erected topped with a weather-vane. A habit of morning-and-night observations would soon be formed, and the keeping of the records would become a source of much satisfaction. A weather station might easily become an institution on a good farm.

Every farmer's boy should have a weather-vane. A vane is easily made, usually in the form of an arrow or dart. Very ornamental ones may be purchased in the market. Every morning the direction of the wind should be noted before the day's work is begun.
The careful observation of the weather should not be confined, however, to the records made by instruments. The conditions that precede both storms and continued fair weather should be noted. It is good practice to write down the appearances of oncoming thunderstorms, of wind squalls, or whirlwinds and eddies, and the like. Likewise of interest are conditions that follow the storms and that presage the coming of "settled weather."

**REVIEW**

Explain what you mean by the atmosphere. How extensive is it?

What happens when one goes to a high elevation?

Detail the composition of the air. What is vapor?

What about the dust in the air?

Tell what you mean by weather; by meteorology; by climate.

What causes changes in the weather?

What do you understand by atmospheric pressure? Where is it greatest?

Contrast low pressure and high pressure. What do they signify?

What is the wind? Name some of the kinds.

What is a storm?

Explain what you understand by a cyclone; by a tornado.

What is a storm-center?

What does a rising barometer indicate? A falling barometer?

What does "the track of the storm" signify to you?
In what directions and paths do the highs and lows travel? Discuss local storms.
Why are farmers and sailors said to be weather-wise?
What is lightning? thunder?
How may buildings be protected from lightning?
What is rain? fog?
Explain the size of raindrops and how rapidly they fall.
What are clouds? Name the kinds of clouds.
Why do clouds look flat and thin to us?
What is the system of weather maps and predictions in the United States, or in Canada if you are a resident in the Dominion?
Explain the weather map.
Describe the weather flags; the whistles or blasts.
How do light frosts occur?
What are the means of protecting plants and crops from frost?
What is meant by local climate?
How are observations and records made? What may be their value?

SPECIAL PROBLEM

What is the climate of your school district? If there are records of your region, consult them to find out the average temperature of each month, average rainfall, and other facts that may be indicated. The highest and lowest temperatures for a series of years may be tabulated or charted. What are the prevailing winds? What natural features influence the climate of your region, as hills, mountains, valleys, plains, forests to break the force of winds, lakes?

Do you keep a diary of the weather? Have you a good thermometer? barometer? Did you ever make a weather-vane?

Do you have weather maps in your school?
TOPIC 6

THE PLANT

Living things are classed into two groups, the plants and the animals. As we see them day by day these groups are distinct enough, and we could not possibly mistake one for the other; yet in their lower forms all the outward distinctions disappear, and even the investigators may have difficulty in separating them.

48. Differences between Animals and Plants

It is in the way the organisms subsist, the plan on which they are nourished, that the real distinction lies.

Green plants are able to use materials directly from the earth, when dissolved in water, and from the atmosphere. They organize these materials and make them into food for their sustenance; with the aid of sunlight they use the carbon dioxide (carbonic acid gas) of the air in the making of starch; giving off oxygen in the process. They use the nitrogen of the air, which they get, however, through their roots. Plants use only gases and dissolved materials.

Animals, on the contrary, cannot make food from the original earthy materials, and they do not use the carbon dioxide of the air in the making of starch; their food is
mostly organized, that is, derived from plants or from other animals which, directly or indirectly, have subsisted on plants. They use solid foods as well as the liquids and gases. They take in the oxygen of the air in breathing, and give off carbon dioxide (CO₂). Plants breathe or respire similarly, but since they are inactive, and for other reasons, they use much less oxygen in the process and give off much less carbon dioxide.

It is usually said that plants take in CO₂ and give out O₂, thus purifying the air, and that animals take in O₂ and give out CO₂, polluting the air; and this statement is practically correct.

The microscopic bacteria are plants; some of them are the cause of disease, as of tuberculosis. The protozoans are animals; some of these, also, are the cause of disease, as of malaria.

Plants are usually green, above the lowest forms or kinds; the green coloring matter (chlorophyll) is concerned in the production of plant-food in the leaves. Animals do not possess chlorophyll (except perhaps in certain low forms); the green of frogs and certain others is due to pigment in skin or feathers. Many of the lower animals have no legs or wings, and the power of motion is limited; many of the lower plants swim freely.

49. THE MIRACLE

A friend gave me a particle as dry and brown as a grain of sand. He said it was a seed. He told me that if I would put it in the earth and then watch the place, I should behold a miracle.

Presently a tiny thing appeared, green, with two
leaves. My friend declared it came from the particle I had buried. It did not seem possible. It had no mark or semblance of the globular wrinkled seed; and how had the seed found itself among all those grains of sand?

Upward it grew, adding leaf on leaf, all unlike those that first I saw. Hairy stems struck out here and there. Buds came, unlike the leaves or the stems. Then came flowers in gorgeous color, unlike the leaves in color or form or substance.

There it grew, this miracle from the seed. The earth in the pot was black-brown and formless. The water that I added was colorless and formless. The air in which it grew was invisible. Yet here were upstanding brown-green stems, fragile but strong; wide expanding leaves of green, with scalloped edges, thin and veiny, soft with velvet to the touch; crimson flowers on long stems, more fragrant than the dew, shapely, bearing delicate organs within; and presently there came pods, and in them I saw seeds like the one I had planted. What a succession was here of objects all unlike each other, all coming out of the same earth, the same water, the same air!

A seed that my friend planted made stems and leaves and flowers and pods as different from mine as a cat is different from a dog. I wondered how these things could be. I have asked many wise persons, but none of them can tell me.

50. THE ROOT, AND WHAT IT DOES

The root attaches the plant in the earth and grips it fast: we speak of the root-hold. The root branches into
many parts, having no such order of arrangement as do the stems. The fibrils enter the minutest places between the particles of soil, taking from them their films of water and some of their materials.

The materials enter the plant in solution in the soil water. The water enters the root by the process known as osmosis, of which the pupil learns in the study of physics. This process is the passing of liquids of different densities through a membrane. There is also a mysterious force, called root-pressure, driving the water through the tissues.

The membrane, in the case of roots, is mostly in the root-hairs, which are very minute lengthened cells near the ends of the tiniest roots. The root-hair is really a minute tube. It soon dies, and new ones arise on the younger growing parts of the rootlets.

The root-hairs may seem like a delicate white mold on roots of radish seedlings that are sprouted between folds of cloth or blotting paper. If a young plant is carefully pulled from the earth, many particles of soil are likely to adhere to the root, held mostly by the root-hairs. The hairs are laid against these soil particles, feeding.

The soil provides what has been called the pasturage of the roots. If the particles are fine, the roots have more surface on which to act; the pasturage is increased. Good tilth has direct relation to the work of the root-hairs.

The roots need air. One reason why undrained wet soils yield poor crops is because the roots are smothered. Roots also excrete or give off certain substances that aid in dissolving the mineral matter in the soil particles.
51. **The Materials from the Air**

The greater part of the bulk of the plant is derived from the CO₂ of the air, even though this gas comprises very much less than 1 per cent of the atmosphere.

The gas enters the plant through openings or stomata, so small that they are not seen by the naked eye. They are mostly on the under surface of leaves. These breathing-pores may be as many as 100,000 to the square inch of leaf surface.

Inside the leaves or green growing shoots, with the chlorophyll and under the influence of the energy of sunlight, the CO₂ is met by the upward moving current of H₂O, and the food compounds are organized. Nitrogen brought in the soil water is added to the forming compounds: protoplasm, the living cell substance, is formed.

The first material is starch or something very like it. The woody structure of plants, cellulose, is very like starch (C₆H₁₀O₅) in composition. Starch cannot be made in darkness from CO₂ and H₂O, and plants do not produce green shoots in dark places (note the potato sprouts in the cellar); they very soon lose the green when buried, which is illustrated in the blanching of celery.

52. **Movement of Materials in the Plant**

The starch or other food is changed by digestion and carried to parts of the plant, where it is used in the building of tissue, or is stored for future use. Some of it goes back to the very roots that took in the soil water, to be applied in growth. The
mineral materials in solution in the soil water become incorporated in the compounds that the plant makes. Some of the compounds are very complex.

The soil water moves upward mostly in the young wood or sap-wood; the manufactured food materials move downwards in the young bark next the wood. The fluids in the plant, whatever their content, are often spoken of as "the sap." The elaboration of food takes place in daylight, but growth mostly at night.

When the plant is burned, the mineral materials remain behind as ash, containing such substances as lime, potash, phosphorus; and these ashes we may apply to the land as fertilizer. The ash comprises perhaps only 1 or 2 per cent of the total weight of the plant. The materials derived from the air and the free water go off as gas when the plant is burned, — the O, C, H, N. If the plant were burned in a tight receptacle or pit, however, much charcoal would be left; this is C, which did not burn because there was insufficient O.

The water taken in by the roots is itself a source of food to the plant, and it is also the carrier of other materials. Much of it escapes into the air through the stomata, in a process of evaporation, which, in this case, is called transpiration.

For every pound of dry matter composing the plant, probably 15 to 20 pounds of water must pass through it. An herb six feet high may give off a quart of water a day, and a large tree as much as 150 gallons. It is important that the soil hold sufficient moisture to supply this need. When plants wilt, more water is transpired than is taken in. If the roots are so chilled that they cannot absorb, the plant wilts and may die.
53. **The Fungoids**

The process we have described makes the plants independent, able to secure and organize their own food from earthy and gaseous materials. Other plants, however, have no roots to forage in the earth and no green matter to enable them to use the CO₂ of the air. They live on material that has been organized by other plants. They are dependent.

Sometimes they grow on a living plant or animal (which is then called the host), extracting their food from the cells. They are then called parasites. Many of them have thread-like or web-like parts that enter the tissue of the host, in leaf, root, stem, fruit, injuring that tissue and disturbing the regular life process. They produce disease.

The great class of fungi (singular, fungus) subsists on the living or dead tissue of animals or plants. Some of the fungi are large and fleshy, as the mushrooms, toadstools, and puffballs; others are woody, as the shelf-fungi one finds on old logs and trees; others are very minute, and among these are the important plant-disease fungi, as the mildews, rusts, and some of the blights.

Great losses are occasioned by the plant diseases, as the wheat-rust, corn-smut, grape-mildew, potato-blight, apple-scab, bean-spot, sweet-potato-rot. Once it was thought that these blasts are due to some mysterious influence in the atmosphere. Now we know that they are the work of minute plants, each perfect of its kind and living its own round of life as completely as does a peach tree or a cotton plant.
They propagate by spores, which are cells, mostly microscopic. These plants have no leaves and no flowers.

Among the dependent plants are the bacteria. They are numberless, in individuals. They live in the liquids or juices of animals and plants, and in water, and absorb food over the entire body. These "germs" are the cause of many diseases of plants and animals. They are largely concerned in the breaking down and decay of animal and plant tissues, returning the materials to the soil and the air, and making it possible for succeeding plants and animals and for men to live on the earth.

The fungous diseases are mostly held in check, when leaves, shoots, and fruits are affected, by applying to the parts such materials as are injurious to the fungi. These materials are fungicides. Bordeaux mixture is one of the best known. Usually the fungicides are placed in water and applied in the form of a spray. In bulletins and books are given formulæ for the principal fungicides. See page 128.

Bacterial diseases are not controlled by sprays, as the organisms are inside the tissue of the host. The affected parts are to be cut off and burned.

The spread of all plant diseases is checked by burning
all the diseased leaves, fruits, and stalks, and keeping the premises clean so that the organisms do not have hosts on which to breed.

54. THE FLOWER-PERIOD AND THE FLOWER

When growth is well advanced the flowers appear.

Some plants endure only one year from seed to seed and death; these are annuals. The length of life is comprised within a single growing season; pigweeds, marigolds, corn, oats, buckwheat, rice, are examples.

Other plants live two years, biennials, and the bloom usually appears the second season, as in teasel and mullein.

Other plants are perennials, living three or many years, as the shrubs and trees, and also many of the herbs, as docks, peony, and alfalfa. In perennials, flowers may appear the first year from seed, but this is unusual. In shrubs and trees they may not come until the plant is many years old. The gardener forces the bloom earlier, on many of his plants, by keeping them in small pots and providing all the conditions for rapid maturity.

The complete flower has two sets of organs,—the leafy parts, and the so-called essential organs in the
interior. The outer leafy parts comprise calyx and corolla, the parts of the calyx being sepals, and of the corolla, petals. The corolla is commonly the colored showy part, and often very irregular in shape. The picture distinguishes the parts.

The essential organs comprise the stamens, and in the center of the flower the pistil (often more than one). The pistil will make the seed-pod or the fruit. It bears the ovules inside; these ripen into seeds. The stamens supply the pollen, borne in the anthers, at the top.

55. Pollination

The ovules cannot mature into seeds without the action of the pollen. The grains of pollen are lodged on the roughened or sticky summit of the pistil, known as the stigma, and the action of fertilization takes place.

The transfer of the pollen from anther to stigma is pollination. Usually there is provision for cross-fertilization, the pollen of one flower fertilizing another flower. Stronger seeds usually result from such crossing. Pollination is only the transfer of pollen from the anther to the stigma. Fecundation (the making of the plant fecund or fertile) results from the action of the pollen after it falls on the stigma; it is also called fertilization.

In some plants the pistils and stamens are in different flowers. A notable case is Indian corn, the pistils being the "silks" in the ear, and the stamens in the tassel. In pumpkins, squashes, cucumbers, and melons, the pistillate or fertile flowers are far
down among the foliage in the axils of the leaves; one can see the little squash or melon below the corolla. The staminate or sterile flowers are usually more conspicuous, often being raised on long stems; they soon perish. In some plants, as willow, poplar, hop, the two kinds of flowers are on different plants; in these cases both plants must be close together or seeds will not form.

The pollen is carried mostly by insects and the wind. A person may wish to cross two plants for the purpose of combining more or less of the good qualities of both in the offspring. In this case it is not sufficient merely to transfer the pollen to the stigma, for other pollen may lodge there and the cross may not be what was expected.

The flower that is chosen to bear the seed is opened in bud, just before it would open naturally, and the stamens are cut off with scissors or tweezers. The flower is then covered with a thin paper or cloth bag. When the stigma is "ripe," as shown by its color and sticky character, pollen from the chosen flower is placed on it, and the bag is again tied on, to remain until the fruit or pod begins to form. The pollen may be carried on the point of a knife; if the anther is not discharging its pollen, it may be opened at maturity and the pollen crushed out.

56. Dispersal of Seeds

If all the seeds were to drop directly from their pods and remain where they fall, there would be little opportunity for them to make plants. Most seeds or fruits are provided with means of dispersal.

They are carried by wings, down, hairs, barbs, burs;
fleshy fruits are eaten by birds and the seeds scattered far and wide; squirrels bury nuts; sheep carry seeds in their fleeces; the cow’s tail is full of burdocks.

The dead tops of certain weeds roll over the country in autumn and winter. Seeds are blown on the snow, and they float down the streams. Some of them retain their vitality for several years, and grow when conditions are right.

57. Germination

A seed is a minute dormant plant. It will awake when it is given proper conditions of warmth, moisture, and air.

A bean is a seed. Open the halves and note the little plant lying at one side. The halves are really leaves, packed with nourishment to support the plantlet until it begins to take supplies from the earth and the air. The seed-leaves are raised above the earth in the process of germination. In the pea these leaves remain underground; the plant does not “come up” in the same way as the bean. Every plant has its own method of germination.

In the bean the entire seed inside the coats is the little plant or embryo. In wheat and Indian corn and many other seeds the embryo is buried in the food storage. In some seeds the embryo is what we call the chit.

If seeds are planted so deep that they cannot have air, or if the soil is too wet, they rot. Yet the seed must have moisture; this it absorbs; the seed swells, and the processes are set going. In contact with finely divided moist earth, which then holds sufficient air, the seed finds conditions
congenial if the temperature is proper. The well prepared seed-bed is essential to a good start.

Germination is complete when the food store is exhausted and the plant has root-hold and is able to maintain itself.

58. Saving the Seed

Good farming rests largely in good seed. Every pains must be exercised to see that the seed is ripe when harvested, that it does not become moldy and is not allowed to heat in piles. Keep it dry and cool, and protect it from mice and rats.

Seed corn is often strung on wires and hung from rafters in the barn. Beans, peas, and similar seeds are usually kept in tight bags or boxes, and the grain in dry mouse-proof bins. It is well to choose the seed in autumn or early winter, and to set it in a safe place in well-tied small strong bags that can be easily handled.

If weevils attack the seeds, they may be killed by pouring a little bisulfide of carbon (CS₂) into the box and immediately closing the box tight. A teaspoonful in an eight-quart box should be sufficient; in large bins five pounds to each 1000 cubic feet. The liquid does not injure the seeds. It soon evaporates, filling the box with gas. It is very inflammable and should be kept away from fire. The box should be kept closed for a day.

59. Testing the Seed

One should know whether the seeds will grow, and also whether they are strong enough to make vigorous pro-
ductive plants. If there is any doubt as to the age or strength of the seeds, they should be tested in late winter so that other seeds may be ordered for the spring planting if necessary. The testing consists in sprouting or partially germinating the seeds. Good farm seeds show at least 90 per cent of strong germination.

With Indian corn it is also important to know which ears are best for seed. Kernels should be tested from all ears saved for seed, about six kernels being taken from the same place on every ear. In general, however, seeds for testing are taken from the bulk in bin or bag, but care should be exercised to choose a fair or representative sample.

There are many forms of seed-testers. The seeds may be laid between folds of canton flannel or blotting paper, the layers being placed in a plate to which water is added, with another plate inverted over it for cover. Keep the layers moist, not soaking wet. The plate tester allows the sprouted seeds to be taken out day by day.

Perhaps a better device is the sawdust box. Two or three inches of clean sawdust that has been soaked with warm water is placed in a box. On the smoothed packed sawdust spread a stout cloth, wet, on which the seeds may be placed or scattered. Cover with another warm wet cloth, over which place a thick cloth sawdust pad, well pressed down. Keep the box at a living-room temperature. When the time has come for examination (six to nine days for corn,
less for radishes and some other things, more for carrots, parsnips, and celery), the pad and upper cloth are removed and the seeds exposed. Determine the percentage of seed that has germinated, and what proportion is most vigorous and apparently strong enough to make good plants. If just one hundred seeds were placed on the cloth, the calculation will be easier. Sometimes the under cloth is ruled off into squares, by pencil, and the seeds from each ear or fruit placed together. Any ear showing a poor or weak kernel should be discarded for seed.

The “rag doll” tester is now popular. It is merely a canton flannel roll of seeds (page 103). A strip of the cloth about 6 in. wide and 30 in. long is laid on the table and the seeds are spread on it. It is then rolled up and tied loosely, and placed in a pail of lukewarm water for about 12 hours. The water is then poured off, and the rag doll is kept in the covered moist pail until the seeds sprout.

Samples of seeds should also be examined for adulteration, such as weed seeds and dirt. This is accomplished by the use of a small hand lens or a good reading-glass. The examiner will be interested to try to identify the kinds of seeds that he finds in an impure sample.

60. Propagation of Plants

Plants propagate mostly by means of seeds. Yet some plants (as Irish potato, sweet potato, sugar-cane, horseradish, banana) seldom or never produce seeds; and nearly all plants can be propagated by means of their shoots or the growing parts.

The simplest form of propagation, aside from seeds, is by division, the underground stem or root being merely cut into parts. In this way rhubarb, peony, and canna are increased. Akin to this is
propagation by suckers or shoots that come up from the ground, as with blackberry, lilac.

In some plants, shoots bend over or lie on the ground and take root at the joints or the tip, making layers. The grape may be propagated in this way; also black raspberry and many ornamental plants. Sometimes the layers are so prostrate and grow so long that they are called "runners"; the strawberry has them. To propagate by layers, the shoot is bent over in the spring and the joints covered with earth. At the close of the season, good shoots should have formed and the layer may be severed on either side.

Shoots or twigs may be severed from the plant and inserted in the earth to grow independently; these are then cuttings.

Either when dormant or when growing, cuttings may be taken. The hardwood or dormant cutting is taken in winter or very early spring from the wood or shoot of the last year's growth. Grapes, currants, willows, are propagated in this way. The cuttings may be set directly into the ground, or, preferably, they may be tied in small bundles and stood upright in moist sand in the cellar so that the bottom ends will callus. They may be kept over winter in this way. Usually the cutting comprises two or more buds. It is planted so that the top bud stands at about the surface of the ground. Cuttings should make a vigorous growth, and in two years the
plants should be large enough to set in their permanent places.

Softwood or greenwood cuttings may be taken from geraniums, fuchsias, roses, and many other plants. They are short (about two joints) and the leaf surface is reduced to prevent transpiration. The pictures show how they are made and planted. At first they are protected from the sun, and the earth is kept uniformly moist. They thrive best if started in clean sand, where they remain till roots are formed and the plants are established.

Sometimes cuttings are inserted in other plants rather than in the ground; they are then grafts. The cleft-graft is the usual method for old trees which it is desired to change to another variety. Grafting of this kind is most frequently employed on old apple trees, but it is equally successful with pears.

One variety is grafted on another variety or stock of the same kind of plant. Dormant cuttings, which are now called cions, are taken from the tree it is desired to perpetuate and are inserted on the two sides of a cleft on the tree it is designed to change,
a limb an inch or two in diameter having been cut off for the purpose. The cions are held firmly in place by the grip of the cleft, a wedge having been inserted in the center of the stub when the cions were inserted. The line between bark and wood should meet in both stock and cion. The end of the stub is tightly waxed. The operation is performed in spring, mostly April in the Northern States.

Sometimes a single bud is inserted underneath the bark on the side of a young shoot, either in early spring or late summer (as seen in the picture), but this operation, known as budding, need not be explained here. It is mostly employed in the nursery-row for the propagation of fruit trees. The tree or stock is raised from seed; when not more than a year or two old, this tree is budded near the ground, the top removed above the bud; and the shoot from the inserted bud becomes the future tree top.
61. The Kinds of Plants and Their Names

We do not know how many kinds of plants are in the world. It is estimated that about 180,000 kinds or species have been named and described. About 60,000 are of the lower or so-called flowerless plants, as ferns, mosses, sea-weeds, fungi, and others. The 120,000 remaining are seed-plants or the so-called flowering plants, in which are included all the regular agricultural crops.

Plants are grouped into Families because of certain resemblances. More than 600 families are now recognized, nearly half of which are seed plants. Rosaceae (Ro-sa'-ce-ee), the rose family, is an example; also Leguminosae, the pea or pulse family; Gramineae, the grass family.

Plants of still closer resemblance are placed in a Genus (plural, genera), which has a definite name. For example, all clovers are of the genus Trifolium; the different kinds or species of clover are distinguished by their special names, as Trifolium repens, white clover; red c., T. pratense (pronounced pra-ten'-se); alsike c., T. hybridum; crimson c., T. incarnatum. This is much like saying that a certain family is Johnson; there are different Johnsons, as Paul, Henry, Mary, Susan.

The genus Trifolium has between 200 and 300 species, mostly native in the north temperate zone. Only a half dozen or so are well known or important to the farmer. Some genera of plants have only one species, as Zea, the Indian corn. The genus Secale (pronounced Se-ca'-le), to which rye belongs, has two species. Genera are, therefore, large or small in the number of species.
The first of the two names of a plant always is the genus. All plants of the same genus, therefore, are closely related. Thus, when one sees broom-corn, kafir, and sorghum, all named Holcus, one knows that they are very much alike although they may look different; but when one sees sugar-cane named Saccharum, one knows that sorghum and cane are very different kinds of plants, although syrup may be made from both. When one sees Irish potato as Solanum tuberosum and sweet potato as Ipomēa Batatas (I-po-me'-a), one knows that they are not closely related even though called potatoes, and one infers that the cultivation may not be similar for the two. When one finds that the common morning-glory is Ipomēa purpurea, one is interested in the relationship with the sweet potato and wonders how it can be.

REVIEW

What are the classes of living things?
Describe some of the differences between animals and plants.
Name some of the lowest forms in each case.
What is the office of the root? How are the materials in the ground taken into the plant? Describe the root-hairs.
How is the food taken from the air? What is chlorophyll? starch?
Is there digestion in plants? Explain.
What is sap? ash? transpiration?
What are dependent and independent plants?
Explain what you mean by host, parasite, fungus. What is a spore?
What are bacteria?
Discuss plant diseases. How are such diseases treated?
Explain the parts of a flower.
Describe the act of pollination.
What is meant by crossing? Why do we sometimes cross plants?
How and why are seeds scattered or dispersed?
What is germination? What is the embryo?
Discuss methods of saving and keeping seeds.
Explain seed-testing.
How do plants propagate?
Explain division, layers, cuttings, grafts.
What can you say about the kinds and families of plants? How are they named?

THOUGHT-QUESTIONS AND INQUIRIES

Germinate radish, wheat, and bean seeds between moist blotters. Note and describe the change that takes place in each kind of seed.

How do such plants as apples, corn, and potatoes obtain their food from the soil? Why is it that tall trees are not easily overturned during violent storms? What happens to the roots of cultivated plants when the soil becomes water-logged? You frequently notice barren spots in cultivated fields; what would be your suggestions regarding the improvement of such places?

Gather a handful of weeds or other succulent growing plants. If postal or other delicate scales are available, weigh the plant material. Place in a warm dry place and leave for several days until the material becomes very dry. Weigh again, and note the difference in the relative weights of the green and dry material. What part of the plant material disappeared in the drying process? Place the dry material in a shovel or in a metal pan and burn. Heat the pan over glowing coals until all of the dark color has disappeared from the ash. What part of the plant disappeared in the burning? What part is left?

Refrain from watering a potted geranium or some other common house plant until it begins to wilt. Water the plant and note what happens.

Make a list of the principal crops grown in your neighborhood. After each plant mention the diseases that commonly attack it. Describe how each plant disease is controlled.

Bring flowers of different kinds to school. Try to find the different parts of each. Note particularly whether the blossoms are staminate or pistillate. Cut open the pistils of some of the flowers and see whether you can find the ovules or forming seeds.

What insect is most useful to man as a pollinizer of cultivated plants? What plants grown at home have to be pollinized by insects? Which are self-fertile?
Make a list of all the common wild plants with which you are acquainted. Tell how the seeds of each are dispersed or scattered. In walking through an old pasture or the woods in late autumn, what seeds are likely to catch to your clothing?

What part of the wheat kernel is used as human food? As food for farm animals? Make a list of the products that are obtained from the corn kernel. Make a list of the seeds that are used, in whole or in part, as human food.

Where are the seeds grown that are sown on your farm? Make a sawdust or sand-box germinator as described on page 103. Test all of the ear seed corn that will be planted on your farm, or on the farm of a neighbor, next spring. If no corn is grown, count out 100 seeds taken from a sample of the most important crop raised on your place, and test their germination between moist blotting papers. Make note of the percentage of the seeds that show strong and weak germination, and those that do not germinate at all.

Make a list of all of the cultivated plants grown on your farm, and after each plant indicate the method of propagation.

Propagate some of the common house plants such as geranium, house ivy, wandering jew, by cuttings, placing the cuttings in a pot or box of moist earth until well rooted. Then repot or transplant into permanent window boxes.

Bring branches of apple or other kind of fruit-tree branches to school. Practice making cleft-grafts until you can make one that is nearly perfect. At the proper season, do some real grafting out of doors. Try grafting a cion from one variety of apple into the branch of another variety of apple.

Make a list of the cultivated and most common wild plants growing on your farm. Try to find out the family to which each belongs, as well as the genus and species. Note how many of the plants belong to the same family and thus are related although apparently quite different in character.
TOPIC 7

THE ANIMAL

All the products of farming are derived from plants and animals. Sometimes the farmer has valuable building-stone on his property, or mineral, but the quarrying and mining of it is not farming. He may utilize the water-power of a creek or a river, but if he were to sell the power to others the business would not be a part of his occupation of farming any more than would the selling of earth that contained ore. The farmer rears plants and animals. The plant factor we have considered; we are now to study the animal.

62. THE MOTHER

One day a new calf lies in the field, or stall. Its legs are long and it seems not to know how to use them. Not old enough to be afraid, yet it is evident that the world is a strange place to it. Only one thing it knows, and that is its mother. And the mother is aware of her calf. She has a new behavior to-day. She is ready to defy the world. A kind of blind instinct impels her to stand by her calf, to care for it, to protect it. Her instinct is no longer for herself alone.

One day a nest of eggs is found in the haystack. Presently there is a brood of chicks, fluffy and tender. The
center of their world is the mother's wings; from this refuge they make their little explorations and run back when strange sounds arise. And the mother has a new interest, the interest to be with her chicks, to cluck them home, to pick for them the tender morsels, to hover them from cold and danger. No matter how big the man, she is ready to raise her feathers and attack him if he molests her family.

Here is the sense of responsibility for another, the duty to protect those of similar blood and birth. Perhaps here is the beginning of that instinct which has been called otherism, which is unselfish, thinking first of another's welfare. The regard for mate and for offspring is a large force in nature. The regard for mother is a large force, modifying the action of self-preservation and self-interest.

63. The Companion

Many animals like company. So true is this that we speak of herds of cattle, droves of horses, flocks of sheep. Young colts and steers bunch themselves together. Cattle pasture mostly in irregular lines, and they lie together at night. It is often easier to drive a flock of sheep than to drive a single animal. It is a common saying that sheep follow a leader. If there is one hog in a wallow, we are to look for two and more. We call the chickens, not one chicken at a time. Geese hiss at us in companies. Turkeys roost together in trees. These companionable habits are to be understood in the handling of the animals. Perhaps diseases are spread because of these habits.

Not all animals seek companions. We see cats wander-
ing over the fields alone. How is it with dogs? Crows fly in flocks. What is the habit of hawks?

64. **The Animal Kingdom**

The domestic animals of the farm are mammals and birds. Yet there are other classes of animals that directly interest the farmer, chief of which are the numberless insects. Fish should receive more attention from the farmer. They are good sources of food. Most farms contain pools or streams or springs from which good fish-ponds could be constructed. In them the food fishes, rather than the game fishes, should be grown. In some parts of the world fishes are bred and reared as regularly as are other animals, as a product. An acre of water may yield more food than an acre of land.

While the farmer should attempt to understand the domestic animals well, he should also know the wild animals of his neighborhood. They are interesting in themselves. The farmer should try to enlist many of them in his service. The animals that destroy crops and poultry should be known to him as to their habits and something of their life-history, such as the woodchuck, ground squirrel, gopher, prairie dog, weasel, skunk. Farmers cannot afford to raise rats and mice. Farming depends on the forces and conditions of nature.

One does not know any kind of animal well until one is familiar with its life-history. This history comprises the various events in the life of the animal from birth to death: how it begins life, how it grows and feeds, how it propagates, how it migrates or hibernates, how old it lives to be, what are its habits.
The number of species or kinds of animals in the world is not yet known. The species of the so-called higher animals are not very numerous. Insects are much more numerous than all other classes put together. The great Linnaeus, the Swedish naturalist with whom begins the modern system of naming plants and animals, had described and named animals, in 1758, to the number of 4236. In 1859, Agassiz and Bronn esti-
mated the total kinds of animals in the world to be 129,530. In 1912, Pratt estimated the number at 522,400. This number is now increased by discoveries and recent studies. The numbers in some of the main classes were then (1912) stated as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>3,500</td>
</tr>
<tr>
<td>Birds</td>
<td>13,000</td>
</tr>
<tr>
<td>Reptiles</td>
<td>3,500</td>
</tr>
<tr>
<td>Fishes</td>
<td>13,000</td>
</tr>
<tr>
<td>Mollusks (shell-fish)</td>
<td>61,000</td>
</tr>
<tr>
<td>Insects</td>
<td>360,000</td>
</tr>
</tbody>
</table>
The number of domesticated animals is very small in comparison with the domesticated plants. There are probably not more than fifty species of all classes, aside from certain pets. The western hemisphere has contributed only two of much importance, the llama and the turkey; and the turkey is only partially domesticated.

65. THE USE OF ANIMALS BY MAN

Man is not able to overcome difficulties and to contend with the forces of nature until he multiplies his power. He multiplies it by the use of a club to attack his enemies, by a spear, a stick with which to dig in the ground, a knife, a hoe, a plow; eventually he multiplies it enormously by great machines driven by water, steam, or electricity.

Some races of men early learned to multiply their power by enslaving animals. They could apply more force and move faster from place to place, transport heavier loads. They invented wheels. In time they conquered the races (as the red men) who did not use animals or wheels.

There are millions of farmers in the world to-day who use neither animals nor machines. They are laborers, accomplishing what lies within the power of their limbs, aided by a few simple tools. To them the animal is a source of food rather than of power. Usually they cannot afford to keep
domestic food animals aside from poultry, but they may supply their needs from fishes, shell-fish, and other aquatic animals. In some countries certain insects and reptiles are eaten by classes of the people.

66. THE FARM LIVE-STOCK

Most of the farm food animals in this country are reared on cheap feed, and often on cheap land, on the materials that cannot be used for human food, or sold to advantage on the market. Good crops usually pay the farmer better than the animals that might be fed on them; and a given quantity of cereal grains will sustain more human beings than will the animals that may be reared on this grain. A few sheep, for example, may be profitable because they clean the fields and consume low-grade products, whereas a large flock for which feed has to be purchased and which demand much housing and care, might be kept on the same farm at a loss.

In short, one of the advantages of keeping live-stock is that it may make use of the cheaper and coarser unmarketable produce of the farm, as cornstalks, straw, the lower grades of hay, and the grain product of lesser value. To the credit of the animals should be reckoned the value of the manure and the fact that they make more or less continuous employment for labor.

Farming is a combination occupation, and all the products must be used in one way or another, and all the equipment must be utilized. A certain number of live-stock is necessary to keep the business balanced, to maintain rotations, and
to provide a continuous farm operation. Most farms contain land that is adapted only to pasture.

The raising of hogs extensively in the corn-belt is a profitable way of utilizing waste and low-grade corn in connection with beef-production, supplemented with pasture and sometimes with skim milk. It would not be profitable to raise hogs if the corn had to be grown for them alone; the corn would be too valuable (the pork would cost too much).

The milk for city markets is produced mostly on farms that have other products to sell; often these products are the more profitable, but the dairy cattle keep the farm going.

Farms may be devoted largely to one kind of live-stock as a specialty, and to the exclusion of the necessary crops; but only high grades of stock or products, and an unusually good market, will allow of such an enterprise. These farms are likely to be unprofitable; it is only when the product is so superior as to constitute a class by itself that it can compete with similar products raised by the cheap feed and cheap labor of the common farms. Breeding-stock is one of the high class products. In general, the farm itself determines the number of animals to be kept.

Animals are reared by man for the following purposes:

1. As pets or companions: cat, dog, pony, canary bird, goldfish.

2. As beasts of burden: horse, mule, donkey, ox, buffalo, camel, llama, elephant.

3. As meat or flesh producers: cattle, sheep, swine, poultry, fish, oysters.
4. As producers of other food products (milk, eggs, honey): cow, goat, poultry, bees.

5. As producers of other than food materials, such as wool, hair, hides, fur, horn, bone, silk, plumes, and feathers, materials for fertilizer. Some animals yield returns in all these subdivisions, as the reindeer; and most animals meet more than one class of needs of their owners. In North America, about 34 per cent of human food is from animals and their products, and about 56 per cent from cereals, vegetables, and fruits. Man could not now sustain himself in comparative comfort without the domestic animals.

### United States

**Population** 91,972,266

**Value of Crops** $5,487,000,000.

**Value of Domestic Animals on Farms** $4,760,000,000.

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21,418,580</td>
</tr>
<tr>
<td>Horse</td>
<td>8,183,776</td>
</tr>
<tr>
<td>4</td>
<td>52,417,961</td>
</tr>
</tbody>
</table>

**Live-Stock in United States**

67. **Extent of Animal Industry**

In 1910 the total value of all domestic animals on farms in the United States was $4,760,000,000; the total value of all the crops in 1909 was $5,487,000,000. The total population in the United States proper in 1910 was 91,972,266. The total number of domestic animals in different classes in 1910 was as follows:
Cattle ........................................ 61,803,866
Horses, mules, etc. .......................... 24,148,580
Swine ........................................... 58,185,676
Sheep ........................................... 52,447,861

The average value to the farm of total live-stock in 1910 was $774.00, and to the acre $5.60, showing marked increases over 1900. The value of crops to the farm in 1909 was $862, and to the acre $16.30. It will be seen that animals and crops are somewhat alike in value, with the crops in the lead.

In Canada the value of the live-stock in 1911 was $381,915,505. The number of horses was 2,598,958; all horned cattle, 5,526,083; sheep, 2,174,300; swine, 3,634,778; poultry, 31,793,261. These figures may be studied in comparison with those on pages 8, 14.

68. THE NOURISHMENT OF THE ANIMAL

Solid and liquid materials are taken by the animal through the mouth; these constitute the nourishment. Gases are inhaled through the lungs and take part in the working processes. The solid foods are "organized"; that is, they have been built up or compounded, first and last, by plants.
We have learned much in recent years about the uses of the different foods in the animal system, and this subject we shall discuss in a later part of the book (Topic 22). The four-footed animals have practically the same organs as man, performing the same functions. We may trace very briefly the process of nutrition.

The solid foods are first crushed by the teeth. They are masticated. The jaws are controlled by strong and powerful muscles. The carnivorous animals (those that eat flesh) tear and chop and cut their food, the jaws moving up and down. In the herbivorous animals (those that live on vegetable matter, as cattle, sheep, goats, horses), the jaws move sidewise as well as up and down, and the food is ground; usually the material is chewed on one side of the mouth till the muscles are tired, and then shifted to the other side.

In the mouth saliva is added to the food, beginning the process of digestion by causing certain changes in the material. In a full-grown ox the secretion of saliva is more than one hundred pounds in twenty-four hours, and in the horse about eighty-four pounds.

In the stomach and intestines the digestion is completed, the nutritive elements being reduced to such liquid condition that they can be distributed through the body to repair wastes and build new tissues; the remainder is discarded as waste. In the processes of digestion certain injurious elements are developed, and some of these are changed by the liver and passed off in the urine and perspiration; the liver similarly disposes of some of the products of wear and tear of the muscles. The liver also secretes bile, which is discharged into the intestines, aiding in the processes of digestion.
The blood is the carrier and the purifier. It distributes building material to all parts of the body, and removes the waste. The kidneys are filters, removing the injurious and worn materials from the blood and disposing of them in the urine. The blood is pumped through the arteries by the heart and it returns through the veins.

The pulse is the throbbing of an artery, indicating the heart action. By putting the ends of the fingers over a main artery that is close to the skin, one may feel the pulse. In the horse the pulse is usually felt on the lower jawbone, the operator standing on the left side of the animal; in the ox or cow, the pulse may be taken on the right jaw, the operator standing on the left side and reaching over the neck; in the sheep and dog it is usually taken on the inside of the hind leg. A full, strong, regular pulse indicates a good heart and a condition of health. The pulse of the horse is 36 to 40 beats a second; of the ox or cow, 45 to 50; sheep and pig, 70 to 80; dog, 90 to 100. It is more rapid in young animals and also under excitement.

The temperature of the body is associated with the activity of the tissues and the circulation of the blood, although it is regulated by perspiration and other factors. In the horse it is about 100° F.; ox, about 101 to 102°; sheep and pig, 103°; dog variable, about 101°; poultry, 107° to 108°.

Breathing (respiration) delivers O to the blood; it discharges the CO that is released in the wear and tear. The air is taken in by the lungs, through the nostrils and windpipe; in the air-sacs of the lungs the O passes to the blood and the CO from it. The
number of respirations (rapidity of breathing) in the horse is 8 to 10 to the minute; ox or cow, 12 to 15; sheep, 12 to 20; pig, 10 to 15; dog, 15 to 20.

69. Hygiene and Care

The domestic animals, having the same general make-up as man, are affected by the conditions that affect him. Because they withstand filth, darkness, and abuse does not mean that they thrive because of these conditions, but that they live in spite of them, being perhaps more hardy. Nutritious food, pure water, fresh air, sunlight, clean bodies and clean quarters, exercise, protection from sources of contagion, are as essential for good live-stock as for human beings. Sanitary stables and yards and clean animals are not only attractive in themselves, but they insure clean products. One cannot produce clean milk in filthy dingy stables any more than clean foods in slovenly factories or kitchens.

The farmer owes it to his animals that they shall be healthy and comfortable. He also increases the yield and the power for work thereby. We now know, also, that the domestic animals have a close relation to the public health in the spread of diseases to man.

Stables and folds are now built to be warm and yet to have good ventilation, to be light, easily cleaned, provided with water, and with facilities for handling food and bedding. Old stables are

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Modern Dairy Stable. — The cows are in two lines, facing a central walk or thoroughfare.
remodeled to secure these conditions and facilities. Stabled animals are groomed. The first signs of disease are detected. Animals are quarantined when recently arrived in a section, if they have disease or have been exposed to infection, or if they come from a suspected region; this protects the other animals.

70. **The Judging of Animals**

Persons may not agree on what is a good animal or what is an indifferent one. The custom has recently arisen, therefore, of agreeing to certain marks or conformations that should be taken into account in judging or estimating an animal.

Each mark or "point" is given a certain percentage in a perfect scale of 100, and the animal to be judged is scored on every point. Thus, a perfect score for the shape of the chest might be 6; the given animal might be scored only 4 or 5, if the chest is deficient; the shape of the rump might be 6; of the quarters, 4; the character and color of the coat, 8; the form of head, 2. At fairs and other exhibitions animals are now commonly judged by score-card, and many of the breed associations have adopted scales of points. Judging an animal by a score-card is a good class exercise.

Score-card judging considers the outward form, or the conformation, of the animal. These forms may also indicate the capabilities of the animal. Yet the "performance record" is the real test of the animal, — what it can do, how much product it can yield, how much food it requires to produce a given result. The making of these records requires considerable time, and a careful test of the animal.
71. Wild Birds

Nearly all the common native birds are active helpers of the farmer in destroying insects. They should be protected and encouraged. The most active enemies of birds are usually English sparrows, squirrels, cats, egg-collectors, boys with guns and slingshots. Cats should be kept at home, the same as dogs or pigs, and they should be watched very closely. They are very sly in killing young birds and may not be detected. All bird-killing cats should be destroyed. A bell on the cat warns old birds, but not young ones.

In severe winter weather the birds should be fed. Suet or split bones attached to trees attract them. In summer, nesting-places should be provided. Feeding the birds Those birds that naturally nest in holes in trees usually take readily to bird-houses. Abundant shrubbery and a few good trees attract the birds. Drinking places should be made. Birds soon learn where they are welcome and safe.

Nesting-boxes should be protected from cats as well as be attractive to the birds. The following directions show one method (Cora A. Smith): "A most satisfactory cat-proof box for a bluebird can be made of weather-stained boards, if the following precautions are taken: the hole should be well near the top with no perch near; the roof should slope from the back toward the front and should project about three inches. If the box is deep, the young bluebirds find it difficult to leave the house until they are strong and able to care for themselves, and this is a great advantage. The roof prevents rain from beating in and keeps the cats out. From whatever direction the cat may attempt to reach the hole, the projecting roof stands in the way of reaching the nest. Twelve by six by six inches are good dimensions for such a house. It should be placed eight to fifteen feet above the ground."
Chickadees and house-wrens enter a hole $\frac{1}{4}$ inches across, but an English sparrow cannot enter. Houses intended for bluebirds and martins may be closed until the birds arrive, so that the sparrows cannot build in them first.

72. Insects

The loss of crop from insects is enormous, and much of it can be prevented. Every farm should have means for combating insects, in the form of various kinds of sprayers. If the crop is liable to attack it should be watched closely in order to meet the insects when they first appear.

The insect goes through certain changes. The first state is the egg. Often the eggs are in large clusters and can be collected easily, as those of the tent caterpillar and the tussock and gypsy moths.

From the egg hatches the larva, which may be a grub or a caterpillar. In this stage most injurious insects work the greatest damage, and the remedies should be applied with vigor. The slugs of the potato-beetle are the larvae. The larvae are sometimes called "worms," but the true worms (as the earthworm or angleworm) are very different animals, and do not go through the same transformations as insects.

The third state is the pupa, in which the insect is dormant or inactive, usually wrapped in a cocoon. The cocoons of many species are easily gathered. It is from the thread of the silkworm cocoon that silk is derived. From the pupa comes the mature insect, or imago, as fly, hornet, beetle, butterfly and moth.
In some insects the transformation is incomplete; for example, there is not a distinct larval stage in the true bugs like the leaf-hoppers and chinch-bugs.

In their food-taking habits insects are of three classes,—those that bite, chew, or eat the plant, those that puncture the plant and suck the juices, and those that lap their food.

Of the biting insects are the beetles, such as potato-beetle and rose-chafer, and all the caterpillars. Of the sucking insects are all plant-lice, all scale insects, and the true bugs with beaks, such as tarnished plant-bug and stink-bug. Of the lapping insects the flies are examples. The materials or substances used for killing insects are known as insecticides.

The chewing and lapping insects may be killed by poisonous materials, which they may eat or lick up, as arsenic and paris green. The sucking kinds are killed by substances that injure the insect externally, as lime-sulfur and kerosene emulsion.

The remedies for insects should be learned from the most recent bulletins. The following formulas, however, are standard:

*Arsenate of lead* can be applied in a stronger mixture without injuring the foliage than can other arsenical poisons. It is therefore much used against beetles and other insects that are hard to poison. It is bought in the form of a paste or a powder. The paste should be mixed thoroughly with a small amount of water before placing in the sprayer; otherwise the nozzles will clog. The powder may be applied dry or mixed with water. Arsenate of lead may be safely used with bordeaux or lime-sulfur. It is used in strengths varying from 4 to 10 pounds to the 100 gallons, depending on the kind of insect to be killed. Of course, the material is very poisonous.
Kerosene emulsion is composed of $\frac{1}{2}$ pound of hard, soft, or whale-oil soap, 1 gallon of water, and 2 gallons of kerosene. The soap is dissolved in hot water; this is then removed from the fire, and while it is still hot the kerosene is added. The liquid should be pumped back into itself for five or ten minutes or until it becomes a creamy mass. If properly made the oil will not separate on cooling.

For use on dormant trees, the emulsion should be diluted with 5 to 7 parts of water; for killing plant-lice on foliage, with 10 to 15 parts of water. Crude oil emulsion is made in the same way by substituting crude oil in place of kerosene. The strength of oil emulsions is frequently indicated by the percentage of oil in the diluted liquid, as follows:

For a 10-per-cent emulsion, 17 gallons of water is added to 3 gallons of stock emulsion.

For a 15-per-cent emulsion, $10\frac{1}{3}$ gallons of water is added to 3 gallons of stock emulsion.

For a 20-per-cent emulsion, 7 gallons of water is added to 3 gallons of stock emulsion.

For a 25-per-cent emulsion, 5 gallons of water is added to 3 gallons of stock emulsion.

Lime-sulfur is one of the best insecticides for scale. It is also a good fungicide. A standard preparation may be purchased; or it may be made by this formula: 90-per-cent pure lime, 40 pounds; sulfur, 80 pounds; water, 50 gallons. Moisten the sulfur into a paste; slake the lime in 10 gallons hot water; add water to make 50 gallons, and boil for an hour. Take off the clear liquid and keep as a stock solution; dilute with water as needed when used.

REVIEW

Whence come all the products the farmer raises?
What do you mean by the "animal kingdom"? Name the main classes of animals. How numerous are they in species?
What does "life-history" mean to you?
How are animals used by man?
Name the kinds of farm live-stock. What is the place or office of live-stock in agriculture?
For what purposes are animals reared by man?
How extensive is the live-stock industry in the United States and Canada?
How does the animal obtain its food? What is the nature of this food?
What is mastication? What is the office of saliva?
Where is digestion completed? Name some of the offices of the liver.
What is the office of the blood?
What is the pulse? How felt?
Name the blood heat (temperature) of some of the animals.
Describe breathing (respiration).
What can you say about keeping animals healthy?
What do you understand by sanitation? Describe a sanitary stable.
Explain what you mean by the judging of animals. By score-card.
Discuss wild birds in relation to farming.
Discuss insects as they affect farming.
What are the changes or transformations through which insects go?
How do insects take their food? How are they destroyed?

THOUGHT-PROBLEMS AND INQUIRIES

Relate an incident you have observed or experienced among domesticated or wild animals in which the mother fought to protect her offspring.
Make a list of all the wild and tame animals with which you are acquainted, classifying them according to whether they are gregarious (companionable) or solitary in their habits.
Give the main life-history of some animal you know.
Which of the wild animals common to your section are beneficial and which are injurious to agriculture?
What are the most profitable animals on your farm? Why?
Make a cardboard mount, 18" × 24" in size, displaying samples or pictures of all the useful articles that are produced by cattle. There may be some difficulty in devising ways to preserve and mount such things as milk, butter, and cheese, but this problem may be solved by the use of small air-tight bottles, and the like.
What does it cost in your neighborhood to raise a dairy heifer calf until she is two years of age? What is the average cost a pound of raising a 200-lb. hog?

Consult the records of your last school or federal census, and from the information thus obtained, make a list showing the number of dairy cows, beef cattle, horses, swine, and sheep in your county. Also in the State. How do these figures compare with those of the preceding census?

How many kinds of ruminant and cud-chewing animals have you seen? List the wild and domesticated animals that abound on your farm or which are to be found in your section. Classify them according to whether they are herbivorous, carnivorous, or omnivorous in their habits of eating.

Using a score-card as a guide, score your own or some neighbor’s cow barn and cows as to hygiene and care. Make a list of some of the points that bring down the score, and which could be remedied at slight expense.

Using another score-card score one or more of the dairy cows in your own or in some neighboring herd. How do the score-card results compare with the “performance” record of each animal?

Make a list of the birds that have been seen in your neighborhood. Which are transients, i.e., are seen for short periods only in the spring and fall? Which nest in your section? Which are winter residents? What are the principal foods of the birds that nest in your region?

What are the most destructive insects in your region? Describe briefly the life-history of those you know best. How is each pest controlled? Is there any relation between certain stages or habits in the life-history and the method of controlling each insect pest?

CLASS PROBLEM OR PROJECT

Each pupil should make and install at least one bird-house. In the winter months, in those sections where the snow is deep, each pupil should maintain at least one bird-feeding station.
TOPIC 8

THE MARKET

For two purposes the farmer raises his products,—to supply his own needs, and to sell in the market.

There are many kinds of markets. Taken together they are one of the conditions of farm life, and must be considered in all plans. It is not enough that the farmer raise crops and live-stock. He must sell them. He is a business man as well as a producer.

73. THE KINDS OF MARKETS

When we speak of "the market" we may have in mind the place at which the produce is sold, as a given village or factory; or we may mean the general trade condition, as "the market for hay is good." At this time we speak only of the place or of the way of selling.

Usually the market place is the city, village, or railway station at which the farmer does his trading. Formerly he traded farm products for groceries and other supplies, but now he usually sells and buys on a cash basis, and this is best for all concerned.

Even when the places where prices are established are hundreds of miles away, to the farmer the market is the railway station at which he parts with his products. Sometimes the market comes to his door, as when the pick-up wagon of a milk route
stops every day for his milk-cans. Buyers may come for apples or eggs. In most cases, however, the farmer delivers at the dealer’s or at the railway station, and the highway between farm and town becomes almost a part of his business equipment.

74. Location with Reference to Market

The distance of the market and its character may determine the kind of farming. The value of a farm, if one desires to buy or sell it, depends in part on the market to which it has access.

If one raises perishable crops in small amounts, as vegetables or flowers, he should be close to the market in order that he may save time and keep in touch with prices. The coming of the gasoline road-truck shortens the distance, but even then both time and fuel are concerned as well as wear and tear on the machine. If one delivers fresh milk from the farm, he must have a close-by location. General mixed farms, that grow the staple foodstuffs, may be farther away.

The man may come into possession of his farm quite independently of markets; he then tries to adapt his farming to the market conditions in which he finds himself.

75. Direct to Consumer

The prices of the great staples, as cotton and wool, are beyond the control of the single farmer. The values are determined by the general conditions of supply and demand.
Many other products, however, may be sold directly to the consumer for special prices, if the farmer is so situated, either through direct delivery or by express and mail. Many farmers are able to develop direct trade with city residents and hotels. This trade demands a high grade of product and a regular supply. Fruits, vegetables, flowers, and poultry products lend themselves to this kind of marketing. The extra cost of handling such a trade is usually considerable, and the returns may not justify the expense; this is for the farmer to work out with great care.

Personal delivery or retailing of products to families, which may be a kind of peddling, is usually not profitable if one's time is worth very much. One must do a considerable volume of business to pay for frequent trips, and time may be worth more on the farm where every stroke should count toward greater production or increase in value of the property.

The parcel post provides a way of delivering produce directly to the consumer. The government becomes the carrier. Postage stamps are cheaper than horses or motor-cars. In this case the farmer must work up his trade carefully, writing to his customer to find out what he wants and how much and of what quality. The farmer should take pains to make neat and attractive packages, and to deliver the goods fresh and clean.

While the direct-to-consumer trade is to be encouraged, it cannot be practiced by the great mass of farmers. Salesmen who make a study of the business, and who are reliable, must be depended on for the disposal
of the bulk of farm produce. Before shipping to a salesman, inquiry should be made as to his commercial standing.

The salesman is a middleman; he stands between the producer and the consumer. He is an expert in selling, in finding markets, in collecting accounts, and the like. As most farmers cannot put their products into the hands of the consumer, so is the middleman a necessity.

76. THE GRADE AND PACK

The quality and uniformity of the product have much to do with its sale. Many of the standard products, as wheat, are sold on grades. Butter is tested for quality. Vinegar must attain to a certain standard of acidity.

The establishing of grades sets ideals to the grower; in endeavoring to meet the highest grade, he improves his practice. To set ideals in one product is to stimulate ideals in other products and in the management of the farm. Careful grading makes for honesty.

In some products grades are now established by law, as for apples in certain States. It is seldom possible to establish a grade or quality in farm products, however, as accurately as in manufac-

![Good and Poor Packs of Apples](image1)

![A Tray of Cauliflower](image2)
tured goods because there are so many variations beyond the grower's control. These products are not turned out by machinery in a factory.

The grades having been defined, it then remains to sort the product, and in many cases to hand-pack it. The finished package and its contents is called "the pack." Sorting may be by hand or by mechanical devices. Sorters or graders are used for potatoes, apples, oranges, peaches, and other products.

The pack depends on the receptacle, as box or crate, in which the goods are to be sent to market. Great attention is now given to the packing of eggs and many kinds of vegetables and fruits, and the number in a certain receptacle must be exact. The package must be clean, unbroken, and bright, and the finished work must be attractive and honest. The package need not necessarily be fancy, however.
Although the fancy pack may bring increase in price, it does not always pay the extra cost. Whether to pack apples in boxes or barrels becomes a question of expense and income. Much depends on the quality of hand labor and the ease or difficulty of obtaining it. These are questions to be determined every man for himself.

Sometimes a farmer is able to

**The brand**

establish a brand or trademark, maintained by uniform products of high quality, that will greatly aid him with customers. Only the best and most careful farmers can establish reputation by means of a trade-mark or brand. Sometimes the farm is named, and this name may be used as a brand.

### 77. WHEN TO SELL

A book cannot tell the farmer when to sell his products, but it may state a few of the conditions. A higher price later in the season does not necessarily mean a greater income. Nearly all products shrink in storage and in barns. The dry crops, as hay and corn, are not exceptions. The shrinkage in
weight may run as high as 10 or 15 per cent or even more. It is due mostly to the loss of moisture. Potatoes shrink from loss of water and decay, and all fresh products may be injured by frost. Vermin and insects often cause losses.

All these risks must be taken into account in holding for a higher price, as well as fire risk and insurance and the chance that prices may fall rather than rise. If one is not in need of the income at once, the products may be held more readily.

Often the products are held not so much for an increase in price, as to wait for a more leisurely season, allowing the farmer to catch up his fall work. This is true of hay, especially if it is to be baled, and of other non-perishable products.

In discussing the time to sell one must consider
1. the chance of a better market;
2. the risk of holding;
3. the supply of man and horse help;
4. the need of ready money.

Having a good product, well graded and well packed, the farmer may find it to his advantage to advertize it in the periodicals or otherwise; or he may advertize his cattle or other live-stock. Once it was thought that only the "business man," — the merchant — should advertize; but the farmer is now a business man and he may employ all the legitimate methods of business. The farmer may be a merchant, as well as a producer.

78. Coöperative Marketing

The people of any community may unite their efforts for the purpose of making a better or more uniform
product and of developing more satisfactory marketing facilities. Usually an association is formed and incorporated under the laws of the State or Province so that it is responsible and qualified to engage in commercial transactions. This is spoken of as coöperation. It means working together for a common purpose.

Some of the commonest forms of coöperation are in the handling and selling of milk (as by means of creameries), in grain elevators, and in poultry associations. Such bodies, when well managed, have good effect in teaching people how to work together and in standardizing the product. Usually a careful grading and packing system is part of the coöperative enterprise. Storage houses are sometimes owned by such associations.

A true coöperative association is an enterprise in which all the stockholders or coöperators take part in the management and who share in the risks and profits. The association hires a manager and the necessary employees, who commonly work for wages, but the shareholders partake in the business.

Certain transactions usually spoken of as coöperation, are really only co-action: the persons merely agree to buy together, to sell, or otherwise to act together for the purpose of getting better terms. The technical name is "collective bargaining." When several persons join to buy fertilizers, spraying materials, seeds, feed, securing the advantage of wholesale price, they are exercising a co-acting relationship; they may not be coöperating in the maintenance, risks, and gains of an organized undertaking.
Both coöperation and co-action are to be encouraged in rural communities. The direct results are nearly always very important, and the indirect gains in bringing the people together are likely to be seen in many other community undertakings.

79. Keeping Books

One should not trust to memory in money transactions. Disputes and losses are likely to occur. There may be no sufficient evidence in a court of law unless there are records made at the time of the transactions. The elaborate systems of double-entry and commercial bookkeeping are not necessary on the farm. A daybook is usually sufficient, with a page or more devoted to each of the persons or firms with whom business is usually transacted.

Books for this purpose may be had at stationery stores. They are ruled for debits on the left-hand page and credits on the right-hand page. The debits are the man's obligations, as cash paid out, crops sold. The credits are amounts coming in, for which the farmer has exchanged products or labor. The columns should be footed frequently, so that one may see how the accounts stand.

Small running accounts are now often kept in the form of sales-slips given by merchants from whom one buys or by dealers to whom one sells on account. These constitute records. If the business runs large it is better to copy these items into a daybook, retaining the slips until all the accounts are settled.
80. Cost-Accounting

If one would know whether the farm pays a profit, one must know what the products cost. One must know what crops or animals pay best; what fields are most profitable; when it paid best to market certain commodities; whether the farm is increasing or decreasing in earning power. This means a constant investigation or close oversight of the business, and the keeping of records.

Cost-accounting begins with an inventory of everything on the farm. It is usually made in writing when there is most spare time and when the unsold produce is least. Values should be attached to each item, as of supplies and products on hand, live-stock, tools, machines, lumber, posts, fence wire, cash.

If there are several columns on a page, new values may be entered from year to year; new tools and supplies not named at first may be added at the end. Receipts and expenses, yields and values, work expended, manure and fertilizer applied, rent of land, are to be entered as the year proceeds.

Sometimes persons keep records of individual cows, to determine which ones are most profitable. Associations may be formed for the purpose of testing the cows of the members, all the animals being tested alike.

The cost-account enables the farmer to know how his business is running from year to year, discovers the leaks, suggests improvements. The farm bureau agent often aids the farmers in cost-accounting. Valuable
information for the community may be obtained in this way.

**REVIEW**

Explain what you mean by "the market."
What do you understand by "the producer"?
How are farms located with reference to market?
What are perishable products?
How are products sold directly to the consumer?
What is parcel post?
What is meant by "direct to consumer"?
Who is the middleman?
Explain what is meant by grade; by pack.
Does it always pay the farmer to grade and pack his produce?
What is meant by a fancy pack?
What is a brand?
Can you say anything about the time to sell farm produce?
Explain coöperation; co-action.
How may "books" be kept on the farm?
What is cost-accounting? How important is it?

**THOUGHT-QUESTIONS AND INQUIRIES**

Where is the market center for the farmers in your region?
Determine how many miles the different farmers are obliged to drive to and from the market every trip.

What buyers come to the farms in your neighborhood? How extensively do your neighbors sell to them?

What produce in your community is sold directly to the consumer? Do you think it has paid in your region?

What grades are established by law for the produce raised in your community? How many of the farmers grade and pack by a standard?

Does anybody of your acquaintance sell his commodities under a name or brand?

Are there any storage houses, elevators, creameries, and the like, in your community? Are there any coöperative societies?

Do the neighbors buy and sell together to any extent? What commodities?

Is there any cost-accounting in your neighborhood?
Are there cow-testing associations? What is their purpose?
SPECIAL PROBLEMS

Make an outline map of your township or natural region. On this map locate the R. D. route; also the market center and anything in the way of public marketing facilities, as creameries, milk routes, elevators, storehouses, cotton gins, evaporators, cider mills, stockyards, slaughterhouses, packing-houses.

As a piece of school work, the pupils may make inventories of their farms or of their live-stock, with the help of parents and others.
TOPIC 9

THE COMMUNITY

Persons associate with each other. They unite their efforts to build roads, churches, schoolhouses, to hold fairs, to establish business, to found societies, to uphold the laws. Within a certain region they develop the habit of acting together, developing a life in common. This small region of similar interests, with all the people and the affairs, is called a community. Farming is much more than a business or an occupation.

The life of the community is comprised of many affairs and activities, as we shall now discover. We are here to speak of the farming or rural community.

8i. THE COMMUNITY HAS MANY TRADES AND PROFESSIONS

In our rural community the leading trade or occupation is farming. Yet the farmer does not live for himself alone. There is need of the carpenter, mason, painter, tinner, blacksmith, harness-maker, wagon-maker, well-digger. Within reach there must be physicians, veterinarians, dentists, ministers. There must be school-teachers.

There are also men and women who work out. One man has a threshing-machine or saw-mill, another a
ditching-machine, another a hay-press, another a truck for picking up the milk or other produce.

The community divides its work, each person becoming more or less skilled in his specialty. No person could be competent in all these activities, nor could he find time to practice in any number of them even if he were capable. One person serves another, saving the time of the community.

82. THE COMMUNITY CENTER

Usually all these activities relate themselves to some one place in the community. Mostly this center is the market-place, generally a railway station. It is to this place that the people must drive. There may be stores and shops. Persons meet each other.

In many cases, however, the market-place is in a city of considerable size. Then there is likely to be no coming together as in a hamlet or a small village. The city is itself a community or even a number of communities, probably with very little farming interest. The real farming community centers in a small settlement, or sometimes it centers at a church or school-house or library or other meeting-place.

There is no proper size to a community. It may be as large as a township, although it is usually less than this. The circle of common interests in occupation, acquaintanceship, and politics may be one mile across or it may be five miles. It may be a school district or more. The community is large enough to have a center or focusing-point. In
this it differs from a neighborhood, which is a small group of persons who are in the habit of neighboring, borrowing from each other, changing work, the children playing together. Its meeting-place, if it has one, is probably in a farmhouse. The neighborhood is not a business unit. It may have no market of its own, no school, no church. The community usually comprises several neighborhoods.

83. The Political Units

The township or other small governmental division is itself divided into parts that depend on votes of the people and taxation, such as election districts, school districts, highway districts, irrigation districts. These units become more or less community groups, one community or group maintaining its district against all others, and carrying the responsibility of its own affairs.

A community of greater or less size undertakes public works, as the laying of a drain or ditch affecting many properties, the straightening of a creek, the improving of a road, building a bridge, ridding a region of mosquitoes, projecting irrigation. Usually the enterprises that involve more money than can be raised by subscription are taken up by more than one community; then the township or the county is asked to act through its officials or by public vote.

The way in which these public movements start and the means by which they are finally put into operation are excellent subjects for study in any school, for its own region.
84. The School Enterprise

The school supported by funds of the people (taxes) is now a regular part of public work. It is expected that every child shall have school facilities without being sent away from home to live. The boy or girl grows up at home, with the protection and training of home, and with the education that the farm can give.

Yet it was not so very long ago that schools were maintained wholly by other means, as by gifts, subscriptions, rate-paying by the parents according to the number of children, religious bodies, private corporations. In a democracy, education must be supported and controlled by all the people as a public necessity.

Formerly only the literary subjects were taught, such as could be learned from books. Then natural science began to find its way into schools, and pupils were led to study physiology, physics and chemistry, zoölogy and botany, geology, as well as geography. Mechanics and handicraft were introduced, often in the form of manual-training. The older subjects profited rather than suffered, for the school was related to the affairs of life.

Now agriculture is being added, with a new range of experiments and interests. The agricultural work is not confined to the schoolroom; some of it is undertaken at home as a school exercise; and thus are the home and the farm united, each contributing its part in public education.

The study of objects as they exist in nature, of animals
and plants as they live and grow, to the end that the pupil may see, understand, and appreciate them, is now a part of good school work; this is nature-study. All good agriculture is founded on nature-study.

All these enlarging activities of the school demand increased funds. The character of the school is a good index of the character of the community.

85. The Club Enterprises

Clubs of many kinds connected with farm and home life and with a membership of young people, have recently arisen in rural communities. These clubs aim to interest the members intelligently in the raising of better crops and live-stock, in the better preparation of food, the better keeping of the house, the more enterprising development of the garden.

The clubs are largely connected with the school, and they work out the formal lessons of school hours, applying them in daily life. They give the pupils something to do on their own account, and they stimulate competition in excellence.

Corn clubs have interested many young folks in growing more corn to the acre and in understanding the reasons. The exhibitions of corn by these clubs and their members have stimulated a new interest in the crop in the public mind. Similar results have been accomplished by potato clubs, garden clubs, poultry clubs, cattle clubs, dairy clubs, canning clubs, bread-making clubs, sewing clubs, and many others. They are developing a new interest in country life for the young.
The management and administration of these clubs calls for state and county overseers. These officers are coming to be of great importance.

86. FARM AND HOME AGENTS

A specially trained officer or agent has now come to be an established factor in most parts of the United States and Canada. His office is to act as a leader in the rural affairs of his region, to collect and dispense information, to bring the people together in their enterprises, and to be of service as the needs of the various communities may require.

Usually the farm agent represents a county, but he will have assistants and coöperators in different parts. More agents will be required as time goes on. He is maintained usually by state and federal funds, supplemented probably by appropriations from the county board of supervisors. Usually he is directly responsible to an organization or society of farmers, the membership fees of which also help to maintain the work. He is the agent of a bureau, this bureau representing the organized operation of all the forces here mentioned.

Women agents are now developed to aid in the household and home-making side, to give definite help in choice and preparation of foods and in general rural welfare work. These women are usually known as home demonstration or home bureau agents.

The agent is always glad of requests for his or her services; the agency is established for this purpose.
87. **Rural Societies**

Societies for mutual improvement are many in the open country. They are often organized to further some special industry, as the breeding of plants or animals, the growing of fruit or flowers or vegetables, or to look after the interests of a particular breed or kind of live-stock.

Other societies are more general in character, representing agriculture as a whole. They may hold fairs or give other kinds of exhibitions.

Some of the societies represent only a few communities or even only one, as a local poultry club or a reading-club, library club, recreation club, grange, telephone society. Such local organizations are to be encouraged, if they are unselfish, as they add to the variety and opportunities of country life.

88. **The Church**

The moral and religious life must be actively safeguarded and nourished. In fact there is no good agriculture until the farmer is honest with his land, his neighbors, his animals, and his church market. The spiritual nature is to be developed as an enrichment of life.

The pastor and the church, the teacher and the school, are together the supports of rural life, becoming more important as living becomes more complex and as we understand our responsibilities more fully.

The church should be liberally supported. A strong church means a strong community. It brings the people
together. It develops the best personal habits and stimulates public service. It leads the people to seek help beyond themselves.

89. The Highway

All these community activities demand good roads over which to move the produce and on which neighbors and friends may travel to the meeting-places. The roads tie the community together.

There are trunk roads connecting great cities and markets, affording communication throughout the land. There must also be well-made side roads as feeders; good highways should lead to the focus of the local market, accommodating all the region. Every farmer should be given the advantage of easy travel, connecting with affairs and with the world.

Road clubs should be organized to discuss highway improvement, to have an eye out for repairs, to take care of the roadsides of the members, to keep highway property clean, to encourage public sentiment, to cooperate with the officials. The maintenance and betterment of highways should not be left wholly to the town and state. Every citizen should feel a personal responsibility for them.

90. Leadership

There is now a general demand for better communities. Many conferences are called to further the work. The idea of "federation" is now strong, by which is meant the coming together of the agencies and forces of agriculture and country life. It is one of the "signs of the times."
It must not be supposed that the responsibility for the welfare of the community is shifted to these many clubs and agencies. There has never been a time when strong individual leaders are so much needed as now in the open country. The multiplication of organizations itself calls for men and women of clear minds, positive convictions, and readiness to serve the public. These persons should be successful in their own lives; but they must have, also, what is called vision, that they may see ahead, looking beyond the small affairs of the moment. All leaders see visions.

"When Joseph of old went down to meet his brothers, they saw him afar off and said, with a sneer: 'Behold, this dreamer cometh!' In all history the practical men have looked with suspicion, if not with scorn, upon the dreamer. I think this is largely the fault of our systems of education, which have mostly taught men to hunt for facts and to be satisfied to regard them as lifeless things — much as they would cordwood or building stone. Yet the great things — which live longest in history — have always been developed by the dreamers and men of vision, because they carried the power to make men think and plan." — H. W. Collingwood.

REVIEW

Explain what you understand by a community. How large or small may it be?
Is the rural community always composed only of farmers?
Explain your idea of a community center.
What is a neighborhood?
What do you understand by political units?
How important is the school in the rural community? Why?
What is nature-study?
Discuss clubs of any kind, particularly boys' and girls' clubs.
Where is the farm-bureau or county agent? What does he do?
Is there a woman agent in your county or district?
How important is the church, and why?
Explain the necessity of good highways.
What can you say about leadership? What is a leader?

THOUGHT-QUESTIONS AND INQUIRIES

How many people make up the community in which you live?
Make a list of the different trades and professions that are to be found in your community. Mention the farmers in your section who serve their neighbors through the ownership of some animal or specialized farm machine, telling what each does.
Describe the community in which you live, telling of the schools, churches, stores, factories, and other activities.
Make a list of the various political officers that are to be found in your community — town or county. Describe the duties of each.
What is the school-tax in your community? How much is this tax to $1000 valuation? How much money does your school get from the state for its support? Mention some of the ways in which your school serves the community.
Make a list of the clubs or other organizations that are to be found in your community and tell of the objects of each.
Who is your county agricultural agent? What is his telephone number and post-office address? In what way does he try to serve the community? Who is your home demonstration agent? What does she do?
What societies or organizations for mutual improvement exist in your community? When do they meet? What do they try to do?
What churches are located in your community? Who are the pastors?
How many miles of improved or hard-surfaced roads are there in your township or county? How many miles of unimproved roads? Tell of some ways in which good roads have helped or will help your farm.

CLASS PROBLEMS

Discuss ways and means whereby your school, as a unit or by breaking up into a number of groups or clubs, can start one or more
enterprises that will be of benefit to the community along social or economic lines.

What new public movements of any kind have been started in your community within a year or so? Any improvement in roads, churches, play-grounds, libraries, reading-clubs, farm bureau, or otherwise?

On a map of the township locate the school-houses, churches, town hall, fairs, demonstration plots, and other public buildings and grounds.

Has your school helped to collect facts for a farm census?
TOPIC 10
CROPPING

When "the crops" are good, the nation prospers. There is work not only for farmers but for railroad men, steamship men, merchants, manufacturers. Money moves freely, and "business is good." The stock market is affected by the crop reports. The crops are more important than the mines or the produce of the sea.

A crop is the yield of a plant, or more often of a plantation or field of plants. Sometimes we speak of the crop of a single plum tree, but usually we think of the produce of the orchard. With the grains we seldom think of the crop or yield of one plant, but of the return by the acre.

A crop may be
- of forage, as hay, straw, and fodder;
- of grain, as wheat, barley, buckwheat, corn, oats, rice;
- of roots or underground parts, as turnips, carrots, mangels, potatoes;
- of fiber, as flax, hemp, cotton;
- of seeds, as beans, peas;
- of some special part used in manufacture, as broom-corn;
- of an extracted product, as syrup from sorghum and cane, sugar from the beet.
III. STRAWBERRY-FARMING. — The matted-row system, with mulch between, in Missouri.
91. The Crop-Scheme

The ability merely to grow a good crop does not make a person a good farmer. He may spend more effort and money on the crop than it is worth.

It may not pay, for example, to grow 350 bushels of potatoes to the acre. It will depend on the extra expense involved in tillage and in fertilizer, and whether the grower neglects other farm work for the sake of growing potatoes. He may have to invest too much capital in tools and teams to make the extra yield profitable.

That is, the farm as a whole, rather than one crop, must pay.

The character of the soil itself may not be the controlling factor in the growing of any crop. For example, it is possible to grow wheat as a money crop only on lands level enough and friable enough to enable the use of light machinery. In many regions well adapted to wheat, the crop is not grown on a large scale because other crops pay better. This is the case in a good part of the corn-belt. Here corn is more profitable; and where corn is grown, hogs are raised. In many parts of the cotton-belt wheat may be grown successfully, but it would not pay to supplant the cotton.

Yet wheat is much grown outside the wheat regions, that is, outside those parts in which it is the main money crop. In these cases the wheat becomes one of the parts in a general plan of mixed husbandry. It is grown not alone for its market value as wheat, but because it is a good crop with which to seed grass or clover, helping to maintain a good rota-
tion. The straw is also valuable as bedding when many animals are kept.

Whether it is advisable to grow any crop, therefore, depends on many factors. We may read that strawberries produce great returns, yet only a few persons can make any profit or derive any satisfaction in growing them. The farmer must grow the crops that are adapted to his kind of business.

We have already learned (Topic 1) that farming is not a single business, but many kinds of occupations and enterprises. All kinds agree, however, in the fact that the yields are products of living growing things (plant and animal) and that they come out of the earth.

92. The Green-Manuring Crops

Part of the cropping scheme is to provide green crops to turn under for manure. As most of the carbon in the plant comes from the air, the soil receives a clear gain of just that much humic material when the plant is plowed under. The mineral matter which the plant has taken from the land is returned again, but in a form easily used by other plants.

Two general groups of crops are used as green-manures:

Non-legumes, as rye, oats, rape, turnips, buckwheat, and all grasses.

Legumes (p. 108), as cowpea, soybean, peanut, vetches, and clovers.

The gain to the soil in using the first group is mostly in organic matter alone, but with the second group there is a gain of nitrogen as well. This gain of nitrogen may often amount to 40 or 50 pounds to the acre.
To be of value as green-manure, a crop should be hardy, quick-growing, and succulent, and produce a heavy growth. It should be turned under while it is still in succulent condition so that decay may take place rapidly. Generally a green-manure crop should be followed by a tilled crop. As the decay generates acids, plenty of lime should be in the soil, either naturally or added for the purpose.

A special kind of green-manuring is provided by the growing of cover-crops, which are those grown late in the season, assuring a covering for winter and being plowed under the following spring. They are employed especially in orchards. Rye makes a good cover-crop; buckwheat is sometimes used; some of the legumes provide more fertility, as crimson clover, cowpea, vetches, peas. It is usually best if the crop lives over winter and makes an early spring growth; rye, clover, winter or hairy vetch do this.

93. Soiling-Crops

Crops are sometimes grown to be fed green, being cut day by day for that purpose, or the animals turned into a certain part of the field which is set off by a movable fence; or the animals may be tied. This practice is employed mostly with milch cows when there is not sufficient fresh pasture, or when a special yield of milk is to be obtained. The practice is known as soiling, and the plants grown for the purpose are called soiling-crops.

Soiling is especially valuable for dairy cows in dry summers. Corn or kafir makes a good soiling-crop. It is sown broadcast or thickly in drills, so that many soft
stalks are secured. Oats-and-peas is often used; also alfalfa, clover, cowpea, and others.

94. **Rotation of Crops**

This brings us to the subject of rotations. A rotation of crops is a regular order of cropping, one kind of crop following another kind.

For example, corn may follow potatoes or spring wheat year after year. This would mean either that all the land is devoted one year to corn and the following year to potatoes; or else that part of the farm grows corn and part potatoes. In the latter case both crops are raised every year, by means of an alternation of fields, the part that grows potatoes one year growing corn the next year.

In practice, rotation and alternation usually go together, for a farmer does not devote his entire farm to a single crop. One-crop farming is very hazardous.

The farmer determines the kind of farming in which he will engage. He will grow a few staple crops, perhaps three or four. He will plan to grow these three or four following each other in order; and to have all crops every year, he will provide as many main fields as there are crops in the rotation. If he has a three-year rotation, for example (as wheat, oats, corn), he will need at least three fields of somewhat equal size so that every year one field will be in wheat, one in oats, one in corn.

Aside from these rotation fields he may have other areas for crops of long duration, as permanent pasture, alfalfa, orchards. Even in these cases he will follow a kind of succession if he lives long
enough, for he will put other crops on the land, for a time at least, after the orchard comes out or when he plows up the alfalfa. There will also be fields, usually smaller, on which he can grow vegetables for the cannery or any special crop that may seem to be desirable or promises to be profitable for the time being.

There are many advantages in rotating the crops. It provides a plan or line of action, to which the farmer may look forward. It enables him to invest his capital wisely, in labor, tools, teams, machinery, storehouses or barns, knowing about what results to expect year after year. He can keep livestock, raising much of the feed for it.

Rotation aids in keeping the land clean and in maintaining its fertility. The pattern rotation has a "cleaning crop" following grass or sowed grain; this is a tilled crop, demanding good preparation of the land and frequent tillage; weeds may then be destroyed. The faults of one crop are corrected by another; so that if one of them is "hard" on the land, the next crop may be "easy." We have learned (p. 16) that farming is a life-work occupation; we now know some of the reasons why.

The rotation should always have at least one tilled or "hoed" crop. Usually it has one leguminous crop, as clover or cowpea. The grass or mown crops are sometimes spoken of as "resting crops," as they are supposed not to be so hard on the land as most of the tilled crops. Rotation keeps insects and plant diseases in check. Good rotations ought to mean clean and productive farms.

A few examples of rotation are here given, merely as illustration (not for recommendation):
4-year course
1. rutabagas, mangels, potatoes, corn, barley, oats, or peas
2. fall-sown wheat, or spring-sown oats or barley, seeded to timothy and clover
3. meadow
4. meadow and pasture

3-year course in cotton-belt
1. corn, cowpeas between
2. oats, with cowpeas
3. cotton

4-course cotton (thin land)
1. corn and cowpeas
2. oats or wheat and cowpeas
3. same
4. cotton

2-course cotton
1. cotton, followed by crimson clover
2. corn and cowpeas

3-course
1. beans or corn
2. wheat
3. clover

5-course
1, 2. corn
3. oats, clover and timothy seeded
4. meadow
5. pasture

6-course
1. wheat
2. clover
3. oats
4. sugar-beets
5. barley
6. peas

7-course
1, 2. corn
3. potatoes
4. oats and peas
5, 6, 7. clover and timothy, hay and pasture

95. The Breeding of Plants

The present kinds of poultry, sheep, swine, horses, and cattle have been developed by careful breeding. The sires and dams have been selected for certain qualities; and the offspring not good enough for parents is not allowed to breed.

We have not practiced similar care in the breeding of plants, yet we now know that they can be as much improved as can animals. We may

(1) increase the yield of any kind of plant, and
(2) sometimes produce new and better varieties.
All our domestic plants have come from wild ones. Sometimes the differences between the cultivated and the wild are so great that we scarcely recognize them as belonging to the same species. This is the case with chrysanthemum, wheat, cabbage. Of some plants the wild forms are yet unknown, as of Indian corn, common bean, sweet potato. All these changes and improvements have come about through a kind of breeding, but it has been mostly a blind effort extending through centuries. Now we begin to see that we can produce rather definite results within a comparatively few years.

The farmer should give as much attention to choice of seed and tubers and trees for planting as to fertilizing and tilling. He should know not only that the seed is "true to name," but that it has a good pedigree. It should have come from well-grown plants that were raised from carefully selected seed. Any farmer can improve his product by seed-selection, thereby obtaining better quality, or a heavier yield, of oats, cotton, rice, potatoes, melons, carnations, and perhaps both improved quality and yield.

The starting point of all breeding is variation. That is, no plant is exactly like any other plant, and we may breed from the one that suits us best. In a field or patch of beans, for example, we find one plant unusually productive. We save seeds from it, and next year we plant them, giving the growing plant the best of care. At the end of the season we choose again from the most productive plants; and we continue the process until all the offspring are uniformly more productive than the field from which the first plant came.
Then we may plant our regular farm fields with the seeds from the productive plants.

This process of continuously choosing the best plants is called selection. If left to itself under ordinary field conditions, the well-bred stock may deteriorate, or at least fall off somewhat in its good qualities. The poor plants, as well as the good ones, will propagate themselves. We must continue to select stock for seed. This means that the farmer must always be a seed-breeder, every year choosing from the best plants or perhaps even growing a small area just for seed.

It is not enough that the farmer have "good seed." The best and plumpest kernels from a bin of wheat may not give the best crop, nor the best single ear from a crib of corn. One should choose seed from the best plant. A poor plant may produce a few very promising seeds or fruits, but these seeds are more likely to reproduce the qualities of their parent as a whole rather than more seeds just like themselves.

Let us suppose that the farmer desires a longer-headed strain of wheat. He goes through his wheat field when the heads are getting ripe and ties a string or tag on all the plants that please him. He saves the seeds from each head or ear separately. Next spring he plants these batches separately, the seeds from each head making one row. At the end of the season he will probably find that some rows are much better than others. That is, some parents did not reproduce themselves accurately. One cannot tell in advance what plants will give the best offspring. From the best heads in the best rows, one selects again; and so on until a good stock is obtained. This is the ear-to-row method of selection; each ear or head has a
row to itself so that its performance may be seen. Similarly, each tuber of potato may be planted separately, the different pieces comprising a row.

As soon as he gets a good long-headed stock, reproducing itself fairly uniformly, the grower may sow his fields or offer the seed for sale. If he sells it, he is entitled to an extra price.

The question of producing new kinds or varieties of plants is a special subject, too complex for discussion here. It involves not only selection but crossing; and one must then know the law of probabilities as to what result he may likely expect. One must follow the generations of crosses (hybrids) with great care and be able to judge them accurately.

Improvement by simple selection, however, is within the power of every farmer; or, if he does not care to make the selections himself, he should buy Good seed-stock selected seed or tubers from those who have taken pains to breed good stock. The crop yield in North America could be vastly increased by the simple process of seed-selection.

96. CULTURAL REQUIREMENTS

We may classify crops by their requirements in cultivation. For example, we might place in one group all those thriving best in sandy soils and in another group those doing best in clay soils; or we might group them as to whether they are inter-tilled or not tilled.

Perhaps the best primary classification is on their climate requirements, whether they are

(1) cool-season and frost-hardy;
(2) warm-season and frost-tender;
(3) intermediate.
Of the cool-season plants we may at once name wheat (particularly winter wheat), rye, turnips, peas, alfalfa, all the common grasses and clovers; as warm-season, all the beans, pumpkins and squashes, melons, Indian corn, buckwheat, cotton, sugar-cane, sweet potato, tobacco; as intermediate, able perhaps to stand light frost when starting, or at least not demanding hot weather at that time, oats, Irish potatoes, flax, mangels.

Knowing whether the plant thrives best in the cool or the warm of the year, the grower has the key to its culture. He will then inquire whether there are any special requirements in soil, whether it is deep-rooting or shallow-rooting, what method of tilling it requires, and what special fertilizer treatment, the distance the plants are to stand from each other, the quantity of seed required to the acre. He will also find out whether it has any serious diseases or insect pests.

**REVIEW**

What is a crop? What is meant by cropping?
Name some of the classes of crops.
What is a crop scheme?
How is one to determine what crops one shall raise?
What is green-manuring? What crops are grown for this purpose? What are legumes?
Define cover-crops. Soiling-crops.
Explain your idea of rotation of crops; of alternation of fields.
How is the kind of rotation to be determined?
Is the entire farm land generally used in the rotating? Explain.
Name the advantages of rotation.
Give examples of rotations.
What is meant by the breeding of plants?
How may plants be improved, aside from better tillage and fertilizing?
How did our common cultivated plants originate?
Explain variation.
What is selection? How practiced?
What is meant by "cultural requirements"?
Classify plants as to these requirements.

THOUGHT-QUESTIONS AND INQUIRIES

Enumerate the crops grown in your (a) county and (b) state in the order of their value. What is the average acre-yield of each crop for your county? for the United States? Consult the census.

Itemize the cost of producing the three most important crops raised in your county. (Value or rent of land, cost of plowing, harrowing, planting, seed, etc.) What are the factors or items that determine the kind of crops raised in your section?

What green-manure or cover-crops are used in your neighborhood? Describe the use or state the reasons for growing such crops. If none are grown, explain why.

If soilig-crops of any kind are grown on the farms of your community, tell how they are utilized.

Describe the crop-rotation plan followed on your own or on some neighbor's farm. What are the reasons for the particular rotation followed?

Describe the practice followed by most of the farmers of your section as regards the selection of the seed they plant each year. What are the good and the bad points of the method followed?

Go into a field at harvest and note carefully the mature plants you find there. Notice particularly the difference in the size, shape, quantity, and quality of the fruit (ear of corn, head of grain, pods of beans, potato tubers, etc.). If possible, harvest the fruits of a score or fifty different plants, keeping the product of each plant separate. Notice the difference in the yield and quality next year.

State how the farmer may improve the quality and increase the yield of (a) wheat, oats, or barley, (b) corn, (c) potatoes, (d) beans.

Describe the ear-to-row method of corn breeding.

Describe the tuber-unit method of potato improvement.

What are the cultural requirements of the money or cash crops grown in your region? What are cool-season crops? Which are warm-season? Which are intermediate?
CLASS: PROBLEM

Each pupil should demonstrate the method of improving the principal field crop grown in his section. Obtain the very best seed obtainable, plant it in a special plat, and select and save the seed or tubers from the five or ten best plants and from the same number of the poorest plants; plant the seed or tubers from each plant in separate rows the following season, and note the tendency or ability of the progeny of each plant to reproduce in kind. If this selection can be continued for several seasons, planting the demonstration plat with the seed from the very best and the poorest of the last season’s selection, marked differences may be noticed. Even the first season the difference in vigor and looks and yields of the plants may be marked enough for school demonstration.
TOPIC 11

GRASS AND FORAGE

Grass may be called the foundation of agriculture in North America, inasmuch as it constitutes the natural covering of the earth in cleared lands. It provides the basis for the rearing of live-stock; and were it not for the live-stock most of the Indian corn and many other products would not be grown.

Any herbage or roots eaten by cattle, either green or cured, is known as forage. Examples of forage plants are all grasses, clovers, cowpea, alfalfa, vetch, root-crops, and the herbage of soybean, maize, and the small cereal grains. Many other plants, not necessary to mention here, are grown for forage.

The area of pasture is very large, for grazing is one of the major practices of agriculture. Grass also produces hay. The hay crop is not all grass, however. Much of it is clover, alfalfa, and other plants.

In 1909 the hay and forage was 15 per cent of the total value of farm crops in the United States, to which is to be added the value of the seed-crop of these plants. In twenty states it was the leading crop in value. In Canada, in 1911, the crop of hay, clover, and alfalfa covered nearly nine millions of the thirty-five millions of acres, or one-fourth of the total crop acreage. Meadows and pastures cover more than half of all the cleared farm land of the United States.
Although grass grows everywhere, yet it produces a profitable return only on good land that is well prepared. All grass land needs careful management. He is a shrewd farmer who knows what his grass land needs. A good grass man is usually a good live-stock man.

97. The Pasture

Although grass may be called a universal vegetation in the United States and Canada, yet the native grasses of the southern states and to a great extent on the prairies and plains are not productive or very useful in highly developed agriculture. It is in cool countries, as a rule, that dense sod forms, and that grasses develop their best qualities for grazing.

Good grazing grasses may be eaten close to the ground and yet renew themselves and cover the earth with a continuous carpet. In regions in which good hay and pasture grasses do not thrive, other kinds of plants must be used for forage, as cow-pea, Japan clover, alfalfa, millets, and (as in California) the cereals which are mown before the grain is ripe and while they make good hay. The blue-grass pastures of Kentucky and adjoining highlands are famous.

Pastures provide the cheapest feed. The great live-stock regions are those of good pasture grasses, largely of june-grass or blue-grass, timothy, buffalo-grass, bermuda-grass, with more or less clover. The pasturage must be supplemented with other feeds, yet it forms the basis of a live-stock industry. Most of the poetry and sentiment of farm life are associated with cattle, sheep, and horses afield. One does not think of a farm without pasture.
Pastures may be permanent or temporary. The permanent pasturage remains year after year on the same ground. Sometimes the land is a hillside or very rocky, and is never plowed; in other cases it may lie in grass five to ten years and then be plowed up for draining, refitting, or other improvement.

Permanent pastures need constant attention, however. The land should be strong, so that it will hold grass well. The fields should not be pastured so close as to injure the grass, or too early in the spring; sheep are specially likely to graze a pasture to death. If the droppings of the animals are not sufficient to maintain fertility, the land may be top-dressed with manure and perhaps with fertilizer; this is usually necessary, particularly in certain parts of the field. Thin places should be reseeded, the land being disked or harrowed with a spike-tooth drag. Wet and boggy places should be drained. Troublesome weeds should be cut; the better the sod, however, the fewer will be the weeds.

Temporary pastures are likely to be part of a rotation. The grass part of the rotation is then two or three years; the first year hay is cut, and then the sod is pastured. Light lands are usually pastured in a rotation. Good rotation pastures commonly produce more feed than permanent pastures, but they are also more expensive.

Temporary pasturage is often provided in orchards, and on meadow land in late summer and fall. Some of the pasturage is soiling, for which corn or rape may be grown (p. 157).
98. The Meadow

Meadows are practically a necessary part of a farm. Probably no single crop is so universal as hay. Barns are devoted largely to hay storage. One does not think of a general-purpose barn without a mow. Hay is a good money crop, easy to keep and to handle; it provides feed for live-stock; it is one of the backbone crops of a rotation.

They are of two kinds,—clear meadows and mixed meadows. The former are of one kind or species of plant, as timothy, barley, clover, alfalfa. The latter are of two or more kinds, growing together, as timothy and clover.

Meadows may be permanent or temporary. The latter are mostly rotation meadows, even though the farm may not be laid out in a definite rotation scheme; that is, they are plowed up and succeeded by another kind of crop.

Permanent meadows are usually on lands not well adapted to rotations. Sometimes the whole property is devoted mostly to meadow, and the man is said to have a "hay farm." These meadows need much the same attention as permanent pastures. They should be kept continuously in prime productive condition, as much as an apple orchard or an asparagus bed.

If permanent meadows begin to "run out,"—to get thin and weedy,—they should be plowed up, cleaned and refitted in corn, potatoes, or other crop, and after a year or two, seeded again. The seeding is usually made with a grain crop, mostly with wheat.
Temporary meadows are sown to crops that come quickly to maturity, as timothy, orchard-grass, redtop, and the clovers. For permanent meadows, the slower-maturing kinds may be used, as june-grass, meadow fescue, hard fescue, meadow foxtail, alfalfa; these do not attain full growth under two or three years.

Although meadow grass will grow under the most indifferent conditions, yet it responds as well as any other crop to good care and manuring. Only good meadows, producing heavy yields, are profitable.

98 a. Requirements of the Meadow

Meadows and pastures require strong land, particularly if they are to be permanent or to remain a few years. The land should have deep and thorough preparation with good underdrainage, as it cannot be corrected or improved by subsequent tillage. It should be clean of weeds, and free from "bad spots." The surface tilth should be fine, to insure a "good catch" in seeding. Grasses and clovers make the best hold when started in the cool of the year, in autumn or spring. If seeded with the grain, an extra attachment is provided on the grain-drill. If sown at other times, the grass or clover seed is broadcasted by hand or by small machines or implements made for the purpose. Mead-

ows and pastures are not intertilled, but are sometimes harrowed in spring with a slender-toothed implement to "liven them up," to encourage tillering, and to afford lodgment for manure or fer-

tilizer.

Timothy meadows require 10 to 15 pounds of seed to the acre; yield should be 1 to 2 tons of cured hay, although 3 and 4 tons may be secured. Timothy and clover together require 6 to 9 pounds of seed of each.

Many meadow mixtures are advised; some of them are as fol-

lows (not here recommended but given only by way of illus-

tration):
For hay and pasture; to be varied by adding meadow foxtail or other grass

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Pounds of Seed to the Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timothy</td>
<td>8 or 9</td>
</tr>
<tr>
<td>Blue-grass (pine-grass)</td>
<td>1</td>
</tr>
<tr>
<td>Orchard-grass</td>
<td>2-3</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>4-5</td>
</tr>
<tr>
<td>White clover</td>
<td>4-5</td>
</tr>
</tbody>
</table>

For permanent pasture

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orchard-grass</td>
<td>4</td>
</tr>
<tr>
<td>Meadow fescue</td>
<td>4</td>
</tr>
<tr>
<td>Tall oat-grass</td>
<td>3</td>
</tr>
<tr>
<td>Timothy</td>
<td>2</td>
</tr>
<tr>
<td>Meadow foxtail</td>
<td>5</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>2</td>
</tr>
<tr>
<td>White clover</td>
<td>2</td>
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</table>

Two year pasture

<table>
<thead>
<tr>
<th>Mixture</th>
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<tbody>
<tr>
<td>Red clover</td>
<td>7</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>4</td>
</tr>
<tr>
<td>Timothy</td>
<td>5</td>
</tr>
<tr>
<td>Orchard-grass</td>
<td>5</td>
</tr>
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</table>

Rotation hay and fall pasture, for heavy land

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Pounds</th>
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</thead>
<tbody>
<tr>
<td>Timothy</td>
<td>11-12</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>4-5</td>
</tr>
<tr>
<td>White clover</td>
<td>4-5</td>
</tr>
</tbody>
</table>

For hay and pasture, moist heavy land

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timothy</td>
<td>8</td>
</tr>
<tr>
<td>Redtop</td>
<td>5</td>
</tr>
<tr>
<td>Red clover</td>
<td>4</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>2</td>
</tr>
</tbody>
</table>
99. Clovers

Clovers are specially valuable because they supply nitrogen (protein) to animals and to the land. They are leguminous plants, bearing tubercles on their roots. Why clover is valuable

They provide hay, furnish pasture, improve the land when the stubble and sod are turned under. Sometimes they are grown specially for green-manure; the entire plant being plowed down. They are specially valuable in rotations, to supply nitrogen; the red clovers also have long tap-roots, that bring up food materials from the under soil.

In the United States, clover is the most important of the forage legumes. Grown alone or with timothy it occupied about 22 millions of acres in 1909; alfalfa occupied about 4½ millions. Its greatest importance is east of the Mississippi River.

The true clovers are of the genus Trifolium (page 108), of which there are more than 200 species, mostly native of the north temperate zone. There are five principal agricultural trifoliums: T. pratense, the common red clover; T. pratense var. perenne, mammoth

The Red Clover

The kinds of clover
red clover; *T. hybridum*, alsike clover; *T. repens*, white clover; *T. incarnatum*, crimson clover. The crimson clover is annual, although it lives over winter in climates not very severe, if sown late in the season. The others are perennial, although red clover usually begins to fail after two or three years. Clover does not make permanent meadow or pasture, except white clover under favorable conditions; alsike thrives four or five years.

Red clover is usually at its best in the second year; thereafter it begins to decline in vigor and yield. It is usually cut twice in the season for hay. The second crop is sometimes allowed to stand for seed; in this case, the plant usually does not survive to yield a hay crop the following season.

99a. Requirements for the Clovers

Rather strong, deep, well-prepared clay loams, with plenty of lime, usually give the best yields of the red clovers. Wet soils should be avoided. The young plants do not withstand drought well. The plant needs open sun and is short-lived in orchards and other shady places. Clover is usually sown with other crops, sometimes in late summer or fall in corn fields but usually with the small grains. In northern regions it is likely to be sown in spring on wheat fields. It does not thrive so well with oats because more shaded, and the oats are likely to take most of the moisture in summer. If fall-grown, the plants should attain sufficient size to withstand winter.

About 8 pounds of seed is required to the acre. The yield should average about 2 tons of cured hay, although 4 tons (and in some regions even more) may be secured; the yield of seed is 3 to 5 bushels to the acre.

Alsike clover thrives in moister land than the red clover; otherwise its culture is practically the same.
100. **Alfalfa**

Within the past twenty-five years, alfalfa, or lucerne, has come to be one of the most important crops for hay. It yields heavily, and its feeding value is high. It is a legume. Its greatest usefulness in the farm plan is in the region from Nebraska and Kansas to California, although it is a very important crop in the central and northeastern states and in parts of Canada.

Alfalfa thrives specially well under irrigation in semi-arid climates, and takes the place of clover in the irrigated regions. Added experience, however, finds it to be adapted to a wide range of conditions. In most parts of the country it is gaining in popularity. In general, alfalfa is to the West what clover is to the East and what cowpea is to the South. These are the three major leguminous forage crops.

Alfalfa is *Medicago sativa*, native in Europe. The genus *Medicago* comprises probably 50 species, native in the Old World. They are closely related to the trifoliums. Several kinds have agricultural value, and a number of them are
weeds, but only alfalfa is well known to North American farmers.

The alfalfa plant is a long-lived perennial. Good stands of alfalfa will last a lifetime. However, it is usually advisable to plow it up after a period of five to eight years, following it with a tilled crop. Sometimes it is a two-year factor in a rotation, although in the colder climates, with short seasons, it is rarely turned under in so brief time.

100 a. Requirements of Alfalfa

The soil must not be acid. The application of lime for alfalfa is therefore a common practice, specially on old lands. It is a very deep-rooted plant, and for best results the land should not have a hard subsoil; the absence of hard-pan subsoils in semi-arid regions is undoubtedly one reason for the success of the crop. The young plants do not compete successfully with weeds, and therefore the land should be thoroughly clean. The seed-bed should be carefully prepared. Every effort should be made to obtain a good seeding, for a field with a poor stand cannot be corrected. If alfalfa or clover has not grown on the area for a few years, the land should be inoculated with soil from successful fields (sown over the field thinly) or by means of the commercial preparations. Well-manured land usually gives the best stand. Seed may be sown in spring or late summer, with drill or broadcast, usually on lands not in other crop; it is a sun-loving plant.

Seed required to the acre, 12 to 20 pounds. In the northern states, alfalfa produces two cuttings, with a yield of cured hay of 3 to 5 tons. In the southern parts it may give five cuttings. In most of the alfalfa region three or four cuttings are secured, with a yield as high as 7 tons and even more. The crop should not be cut until renewal shoots have formed at the crown (surface of the ground), but before they are tall enough to be severed by the mower.
101. **Cowpea**

The cowpea is an annual bean-like plant now grown extensively in the warmer humid parts of the United States as a green-manure, cover-crop, and for hay. The seeds are also good for human food, although not greatly used for that purpose in this country. It is either bushlike in growth, like a bush bean, or more or less vinelike, although not a true climber. The plant is specially valuable to renew worn or washed lands in the South, and as a factor in short-course cotton rotations.

![The Cowpea in Pod](image)

It is probably native in the warmer parts of Asia. It is one of the sixty or more members of the genus *Vigna*, one of the Leguminosae. There is some confusion as to its proper botanical name, but it is usually known as *Vigna sinensis* (meaning Chinese vigna). Its cultivation in the United States has received much attention within recent years.
101 a. Requirements of the Cowpea

The plant is frost-tender. It grows rapidly, covering the ground and smothering weeds. It does not require liming or inoculation. It thrives even on light poor soils; and it will stand still in a dry time and then renew its growth. It does not thrive in wet soils. The hay is difficult to secure because the leaves fall and the plants break. To obviate this defect, it is often grown with millet, soybean or sorghum when hay is desired. Sometimes the crab grass comes up with it in sufficient abundance to aid in the curing.

Cowpea may be sown broadcast, when 1 to 1 1/2 bushels of seed is required to the acre; or drilled in rows to allow of horse tillage, when 1/2 to 3/4 bushel is sufficient. The yield of cured cowpea hay is 2 to 3 tons to the acre; the yield of seed or grain is 10 to 30 bushels.

REVIEW

How important is grass?
What is forage? Give examples of forage crops.
What is a pasture? Name good pasture plants.
Why are pastures important in farming?
Contrast permanent and temporary pastures.
How are permanent pastures maintained?
How are temporary pastures handled?
What is a meadow? Name good meadow plants.
Explain permanent and temporary meadows and treatment for each.
Recite the requirements for meadow-culture.
What are the clovers? Name some of the kinds.
Give the requirements for clover culture.
What is alfalfa? Why is it so important?
Recite the requirements for alfalfa growing.
What is the cowpea? What is its importance?
Repeat the requirements for cowpea-culture.

THOUGHT-QUESTIONS AND INQUIRIES

What are the most important grasses in your neighborhood?
Collect and mount on cardboard a mature specimen of each
kind of grass raised on your farm. Display these mounted plants in the schoolroom. The best mounted specimen of each kind should form part of the permanent herbarium or equipment of the school.

What native or wild grasses make the best permanent pasture crops in your part of the state? Which are used as temporary pasture crops? To what extent, and in what months, are the pastures depended on to furnish food for farm animals in your region?

What was the total acreage and value of the hay crops in (a) the county, (b) the state, and (c) the United States, according to the last census?

What are the most important hay crops in the county? To what extent (tonnage value) is baled hay exported or imported each year?

Where is the grass seed grown that is sold to the farmers in your part of the state?

Collect and mount a mature specimen of each kind of clover that grows in your section, giving both the common and the scientific names as far as you know them.

What part do clovers and other legumes play in the crop-rotation plans on the best farms in your neighborhood?

Where is the clover and alfalfa seed grown that is used by the farmers in your community? What is the average yield of clover and alfalfa seed to the acre?

Mount for display in the school exhibit a specimen of each type of alfalfa plant that you can obtain.

Obtain a four-ounce sample each of the grass, clover, and alfalfa seed exposed for sale by your seed dealers. Divide into two equal parts. Test one part of each sample for germination. Examine the other part of each sample, making note of the relative number and amount of plump seeds, broken seeds, and foul matter in each sample. Compare your results with those obtained by the seed tester.

What insect pests or plant diseases or parasites, if any, infest the clover and alfalfa crops in your section?

To what extent is the cowpea grown in your state? What is its place in the crop rotation?

Collect and mount a mature specimen of the cowpea for the school collection of forage plants.

CLASS PROBLEM

Let each pupil grow at home a clump 2 ft. square of all the kinds of grasses and clovers, alfalfa, and cowpea recommended for the region. Seeds may be obtained of seedsmen, one packet of each. Or, certain scholars may grow the clovers, others the grasses, and so on.
THE SMALL GRAINS

The cereals are the food grains of the grass family. For purposes of cultivation they are commonly divided into two groups, — the large kinds, which are usually intertilled, as maize, sorghum, and kafirs; and the "small grains," not intertilled in North America, as wheat, rice, oats, barley, rye, the small grain-bearing millets. It is customary to include buck-wheat with the small grains, although it is not a cereal.

Wheat and rice are the great bread-grains. Both of them have been cultivated from earliest times, and their origin is obscure.

Rice probably provides food for more people than any other grain. It is the main support of the densely populated countries of southern and eastern Asia, and is extensively grown elsewhere. It is not grown so extensively in North America. Its genus is Oryza, of which there are about six species in the tropics. O. sativa (the cultivated oryza) is rice, native in tropics of the Old World, but running wild in parts of the western hemisphere. Rice is now extensively grown in many parts of the southern United States and in California, and although the crop must stand in water part of the time, it is nevertheless sown and harvested by machinery, the water being drawn off at certain periods. In Oriental countries the crop is planted and transplanted by hand in water-soaked or submerged land, and harvested by
IV. WHEAT-FARMING. — The harvest in Ohio
hand, after the water is drained off. Rice grows 2 to 3 feet high, and bears its grain in open panicles.

In North America rice is sown broadcast or in drills; 50 to 80 pounds of seed is required to sow an acre; 25 to 40 bushels is the range of the usual yield, although more than 100 bushels have been secured.

102. WHEAT

Wheat is grown for human food, although the grain is good feed for live-stock. The straw is used for bedding, and also as fodder. It is the great food-grain of cool-temperate regions.

Of the three and one-half billions of bushels of wheat of all kinds produced in the world, about one-fourth is grown in North America, one-fifth in Russia, and smaller quantities in India, Argentina, Central and Southern Europe, and Australia. In 1909 (the last census year) more than 42 millions of acres were devoted to wheat in the United States, with a yield of 683 millions of bushels (in 1915 about one billion bushels were produced). About three-fifths of the crop is spring wheat, being grown in Nebraska, Iowa, Minnesota, the Dakotas, and westward. The regions of winter and spring wheat overlap in Iowa, Nebraska, and
other states. In 1911, the acreage of wheat in Canada was more than 11 millions, of which about 90 per cent was spring wheat; the total wheat yield in 1910 was more than 132 millions of bushels.

Wheat belongs to Triticum, a genus of about a dozen species in southern Europe and Asia. The common wheat is *T. aestivum* (summer triticum), comprising both winter and spring wheat and all the forms of bearded, smooth, and club (with short heads thicker at top) wheats. The species from which wheat came is not clearly identified, although a plant recently discovered at Mt. Hermon, Palestine, is possibly the true wild form.

In regions of heavy and dependable snow-fall, winter wheat is mostly grown. It is a hardy race; the plants have the habit of spreading out or tillering at the base when sown in autumn, so that they pass the winter well under the snow. The most injurious conditions for such wheat are bare ground, dryness, and alternate freezing and thawing in winter and early spring.

To avoid such conditions in much of the plains and prairie regions, only spring wheat is grown. In regions of very severe long winters spring wheat is also raised. It is grown and handled in the same way as winter wheat, except sown in early spring rather than in September and October. It is harvested mostly in August in the mid-country rather than in late June or early July. It is more likely to suffer
from dry weather in summer, and the yield does not average as high as for winter wheat.

Wheat requires a continuous growing season from seeding to harvest of 90 to 120 days.

In both winter and spring wheats are varieties with bearded and smooth and club-shaped heads; but in this country nearly all the commercial spring wheat has smooth or awnless heads.

103. Requirements for Wheat Culture

Wheat demands a cool season for starting and making its ground growth. It is sown where it is to stand, an inch deep. It needs a friable loamy soil but not very rich in organic matter, with good surface tilth for its roots are at first shallow; later on, the fine roots may extend three or four feet deep, if the soil is loose enough. Land should be clean and well fitted. Fertilizer or clean manure may be used with wheat or with some other crop in a rotation of which wheat is a part. Weedy and foul land is prepared by summer fallowing, if not in a good cleaning rotation.
The plants tend to tiller or stool,—to throw up extra shoots or stalks from one root; some varieties tiller more than others; sowing should not be too thick. Winter-wheat fields are sometimes gone over with a spike-tooth harrow in spring, before the stand is so large as to be injured, to loosen the soil and to destroy germinating weeds; otherwise there is no tillage for the crop as grown in this country.

The seed may be broadcasted and harrowed in; but nowadays it is mostly sown by machines in rows 4 to 6 inches apart.

The quantity of seed to the acre is $\frac{1}{2}$ to 2 bushels; yield in the United States about 13 bushels to the acre for spring wheat and 15 bushels for winter wheat, although 30 to 50 bushels may be secured.

104. Other Cereals

The requirements for oats, barley, and rye are essentially the same as for wheat. Oats and barley are spring-sown crops in most parts of the country, although oats may be sown in autumn in the southern states; rye is autumn-sown. Oats is grown for horse feed; also for human food, mostly in the form of breakfast dishes. Barley has been raised mostly for malting; also for horse feed. Rye is grown for human food mostly, and the straw is much prized for bedding and other uses.
Oats: seed to sow to the acre, 2 to 3 bushels; yield, 30 to 80 bushels.
Barley: seed to the acre, 2 to 2½ bushels; yield, 20 to 50 bushels.
Rye: 1 to 2 bushels; yield, 15 to 30 bushels.

REVIEW

What are cereals? the small grains?
Give an account of rice.
For what purposes is wheat grown? How extensively is it grown? What is the yield in the United States?
To what genus and family does wheat belong?
What is winter wheat? spring wheat?
Name the requirements for the growing of wheat.
Describe the method of growing it.
How does the culture of oats, barley, and rye differ from that of wheat?

THOUGHT-QUESTIONS AND INQUIRIES

Make a collection of as many different kinds and varieties of cereals as you can obtain. Place the grain samples in small bottles
or vials and label each with its common name. Mount the vials on a piece of heavy cardboard by means of threads or cords. If samples of some of the cereals cannot be obtained locally, perhaps you can get them by writing to a friend or to school children living in regions where such grains are grown.

Give the acreage yield and varieties of wheat grown in your state. What percentage of the total yield of the United States is the yield in the state? What percentage of the total acreage?

Obtain and mount on cardboard, samples of as many different varieties of wheat heads as you can get locally or have sent to you.

Send to a flour manufacturer for the mounted collections of wheat and flour products showing the various stages in the milling of the wheat kernel. One of these mounts for each school or room will be sufficient.

CLASS PROBLEMS

Go to the field at harvest time and after examining carefully several hundred plants, select five that bear the largest and best heads, take to school and compare with those selected by other pupils. Make this selection the basis of a friendly breeding contest next year, each pupil planting the seeds produced by each of his five best plants in a separate row (p. 162). At harvest time, the product of each row should be kept in the straw (unthreshed and in separate bundles). The honorary awards should be given for the greatest yield produced by the progeny of a single plant. The best plants, roots and heads intact, in the best row should be saved for exhibition purposes.

Let the class make a study of wheat or other small grain as grown in the school district. Determine the acreage; kind of soil preferred; place in the rotation; how the land is fitted; when the seed is sown and how much to the acre; varieties; important points in the culture; time of harvest; yield; treatment for insects and diseases. Add any interesting facts you find.
TOPIC 13

THE CORN CROPS

Maize is grown for the grain as food for animals and man; also for the forage value of its herbage. It is the most important single crop in the United States, measured in yields and value. It is a common saying that "corn is king," in North America. In some of its varieties it is grown in every state, although little raised on the Pacific coast.

It is the leading crop of the "corn-belt," the mid-northern region Ohio to Nebraska, comprising the southern parts of the northern tier of states and extending south to about the latitude of the Ohio River. This is the great region of corn and hogs, and also of fat cattle. It comprises mainly the seven states, Ohio, Indiana, Illinois, Iowa, Missouri, Nebraska, Kansas.

The two main purposes for which maize is grown are for grain and for silage. In the form of silage the whole plant is ensiled; that is, it is run through a shredder or cutter so that stalks, leaves, ears and tassels are cut into small parts, and then the material is packed in a silo. The silage is used as a green or fresh winter feed, particularly for dairy cattle. The ensiling of corn is a practice mostly of the dairy regions.

We may say that maize is grown both for grain and for fodder. The fodder is sometimes called stover; this is the stalks and leaves, green or cured, without the ears.
The annual yield of corn in the United States is two and one-half to three billions of bushels, being three-fourths of the maize crop of the world. In the northern dairy states and Ontario the crop is grown largely for its forage value, the entire plant being cut or shredded (as we have seen) and placed in the silo to provide a fresh succulent winter feed for cattle.

The word "corn" is properly used in literature for any one of the bread-grains, particularly for wheat. It means wheat in England. The best name for the plant under discussion is "maize," as the word means nothing else; but "corn" is in universal use in North America for this plant. To distinguish from the Old World plant, it is customary to call it Indian corn. It was cultivated by the Indians. When the Bible speaks of corn, maize is not meant.

The origin of corn is yet unknown. It is supposed to have originated in Mexico, and some authorities think it may at first have been a hybrid of wild grass-like plants. Its botanical name is Zea Mays, the genus Zea containing no other species.

There are many classes or groups of corn, as dent, flint, sugar or sweet, pop, husk or pod (in which each
kernel is inclosed in husks). Samples of all these classes, and also leading named varieties of each, should be preserved in insect-tight glass jars in the school museum.

Other plants requiring much the same care as maize are members of the Sorghum tribe (of the genus Holcus), comprising common sorghum, kafir, durra, The sorghum crops. Kafir and milo. The kafirs and durras are much grown for fodder and grain in the semi-arid regions, as western Kansas to Texas. In all the sorghum crops, the grain is borne in the tassel, at the top of the plant. In maize the tassel bears only the staminate or male flowers, while the ear bears the pistillate flowers. Each "silk" in the ear is a long style, holding the pollen that drops from tassels (p. 99). Maize and all the sorghums belong to the Grass family.

In 1909 the area in the United States devoted to corn was more than 98 millions of acres. The total value of the crop was 1 billion and nearly 500 millions of dollars ($1,439,000,000). One-fifth of all the improved land in the country was devoted to this one crop, and it comprised more than one-fourth of the total value of all crops. In Canada, of the 35 millions of acres in "field crops," upwards of 324,000 acres were devoted to "corn for husking" in 1911.

As stated by the United States Census, "Of the 1,635,153 acres in kafir corn and milo maize in 1909, over 1,000,000
acres were in the two states of Texas and Oklahoma, and nearly 400,000 acres in Kansas. The only other considerable acreages were in New Mexico and California."

105. Requirements of Corn Culture

Indian corn is a warm-season plant, tender even to light frosts throughout its life. It is a sun-loving plant, and it requires continuous warm days and nights for its best development. In regions of cool nights, as in most parts of the northernmost states, it may produce abundant herbage for silage, but a heavy yield of mature grain is not to be expected. The growing season in the corn-belt is 130 to 150 days, extending to 200 days farther south.

The root system is very fibrous and extensive, and penetrates fertile friable soils to a depth of three or four feet, although roots have been traced deeper than this. Roots
are also near the surface, so that shallow tillage is necessary. The soil should contain a good supply of humus; it is customary to apply stable manure to corn in the rotation, or to let it follow a green-manure crop or sod. Indian corn is planted in rows, usually about $3\frac{1}{2}$ feet apart, the kernels being dropped 4 to 10 inches in the row. Sometimes it is check-rowed, to allow of tillage both ways, particularly in weedy or poorly prepared lands. It is tilled two or more times, until midseason.

The average yield of corn (in ears) is about 25 bushels to the acre, although yields of more than 200 bushels are recorded. One hundred bushels to the acre is considered to be a full yield. The yield of cured fodder will run 2 or 3 tons to the acre. About 6 to 8 quarts of shelled corn is required to plant an acre; for silage corn, 8 to 11 quarts; for
sowed corn sometimes as much as 1 bushel. Seeds are planted directly in the field where the crop is to grow.

Sweet or sugar corn is mostly a garden crop, for table use. Plant only after the ground is thoroughly warm, in drills or rows about 3 feet apart, and the kernels 10 to 12 inches apart.

Seed corn should be selected with care and stored in a dry place, as a loft. The ears are often suspended from beams, to protect them from rats and mice.

**REVIEW**

What is Indian corn? family and genus? botanical name? origin?

What about the use of the word "corn"? Consult the dictionary.

Describe the corn-belt. What other products are characteristic of that region?

What is the corn yield (in grain) of the United States? What proportion is it of the world yield?
For what purposes is corn grown? What is the grain? the stover?
Name the crops closely allied to corn.
Give the essential requirements for corn culture.
Describe the growing of a crop of corn.

THOUGHT-QUESTIONS AND INQUIRIES

What was the total acreage and yield of corn grown in (a) your county and (b) your state last year, according to the last Census or the report of your county agricultural agent? What is the average yield to the acre of (a) ear corn and (b) silage corn?
What variety or varieties of corn seem to do best in your section for (a) silage purposes and (b) shelled corn? (This information may be obtained from your county agricultural agent.)
Describe the methods used and give reasons for testing seed corn for germination. How many corn growers in your neighborhood test their seed corn before planting? If you had your choice of shelled corn or ear corn for seed purposes, which would you choose? Why?
Make a list of the different kinds of products obtained from the corn plant.
Tell how and why the habit of growth of the roots of corn governs the method of cultivation.
What are the insects and diseases?

CLASS PROBLEMS

Make a collection of as many different kinds (dent, flint, sweet, pop, and pod) and varieties of ear corn as can be obtained. Mount, label, and display this corn in some prominent place at school.
In late winter or early spring months make arrangements for testing, by either the sand-box or the rag-doll method, at school all the seed corn that will be planted in the district which supports the school. Your county agricultural agent or local high school agricultural instructor will gladly assist you in getting the work started.
Join, or help to organize, a corn-club in your school. Write to the state club leader at your state college of agriculture for suggestions and help. Plan to grow as large a plat of corn as you can manage properly, your aim being to produce the largest crop consistent with the lowest cost of production. Practice field selection of seed and in other ways follow the directions that will be sent to you by the club leader. If your school is in a corn-producing country, you will want to plan for an exhibition in the autumn.
TOPIC 14

THE POTATOES

Two very different plants are known as potato. The leading potato of commerce and of cool climates is *Solanum tuberosum*, native of the temperate Andean region of South America. It is one of the Nightshade family, a group of plants abounding in poisonous members, of which tobacco is one. Persons were once suspicious of the potato because of its relationships, as they later were suspicious of its near relative, the tomato. See p. 109.

*Solanum* is a vast genus, containing many weedy plants. To it the eggplant belongs; also the black nightshade and the *solanums* bittersweet, as well as the Jerusalem cherry of window-gardens and greenhouses. In the tomato, eggplant, and husk-tomato, the berry or fruit is highly developed and comprises the part for which the plant is cultivated. In the potato, the underground stems bear great enlargements; these are the tubers for which we cultivate the plant. The seed-balls of the potato, which correspond to the fruits of the tomato and eggplant and red pepper, are small and inedible, and they are not now often seen.
in potato fields. The seeds from these balls produce new varieties of potatoes.

The other tuber is the sweet potato. It also has interesting relationships, for it is a very close kin of the morning-glory and moonflower. The common morning-glory is *Ipomoea* (*Ipome'a*) *purpurea*; the sweet potato is *I. Batatas*. (Batatas is one of the original forms of the word potato.) The sweet potato plant is a vine bearing purplish flowers like small morning-glories. These flowers are not often produced in this country. The sweet potato is probably native to tropical America, but its origin has not been traced. Some authorities think that it does not occur truly wild, but has developed in the course of centuries from another species.

These two kinds of potatoes are very unlike in their nature, and require different treatments.

106. EXTENT OF THE POTATO CROPS

The Irish, white, or round potato (*Solanum*) was grown on more than 3½ million acres in 1909 in the United States, and nearly ½ million acres in 1911 in Canada. The value in the United States in 1909 was $166,000,000. New York had 10.7 per cent of the total acreage; Michigan, 10 per
cent; the third in acreage was Wisconsin, with 7.9 per cent. The sixteen southern states together, Delaware to Texas, carried only 13 per cent of the total acreage of the country. The Irish potato is mostly a northern crop. In the most southern states it is a winter product.

The potato crop is one of the major agricultural products of the world. It yields more weight of produce to the acre than any other of the staple food crops. The bushels of potatoes produced in the world annually for a recent ten-year period was upwards of 5 billions, of which Germany produced more than 1½ billions, European Russia 1¼ billions, France ½ billion, and the United States something more than ½ billion.

The sweet potato was grown on 641,000 acres in 1909; the value of the crop was $35,429,000. The sixteen southern states carried about 91 per cent of the total acreage. North Carolina and Georgia each had about 13 per cent of the acreage, and Alabama more than 10 per cent.

107. THE IRISH POTATO

The Irish or white potato is grown primarily for human food; it is also useful as feed for live-stock, and is employed extensively in the manufacture of starch and other products. The tuber is the only part of the plant that has commercial value.

While it is primarily a northern crop, the potato is grown in the southern states and Bermuda for shipping north early in the season. The larger part of the early crop is grown in the middle latitudes, and in market-gardens where intensive methods may be practiced. The main-season product is a general farm crop. These
different forms of potato growing are distinct undertakings, although the requirements of the potato plant remain the same in any case.

The Irish potato is essentially a cool-season plant, although frost-tender; it is planted early in the spring, as soon as the ground is settled. As it is planted deep and requires some time to come up, the crop may be put in even when light frosts are yet expected, if the ground is warm and well drained. The best soil is a friable loam, with little clay or tendency to become sticky and hard; it should be "mellow." The plant is propagated by cuttings of the tubers, each cutting or piece containing at least one good "eye" or bud. The cuttings are dropped in a furrow three or four inches deep, in rows usually about three feet apart; the pieces lie ten or twelve inches apart in the row. Clean tillage is given until the tops begin to lop and the tubers begin to grow rapidly. At the last cultivation the earth may be thrown toward the row to "hill up" the plants. For early crop and in soils inclined to be cold, the hilling may be begun earlier in the season, or the plants may be grown on ridges. In general, level culture is best, with a deep well-prepared soil. The "seed" should be of sound perfect tubers, free of scab and rot. If tubers suspected of scab are used, they should be treated before planting, as recommended by the State Experiment Station. Spraying the plants with bordeaux mixture is essential to combat the blight.

From 10 to 15 bushels are required to plant an acre. The average yield in the United States is somewhat less than 100 bushels to the acre, but four to six times this yield is securable.
108. Sweet Potato

The sweet potato plant yields no other product than the large globular or elongated tubers. In northern gardens it is sometimes grown on ridges, in "early soil," for a home supply, but the commercial crop is grown from southern New Jersey southward.

Propagation is mostly by means of "draws" or "slips," which are sprouts removed from the tubers. For this purpose the tubers are placed in a bed (as a hotbed) and covered with loose earth. The slips are removed as they grow and form roots. Two to four crops of slips may be taken from the tuber. The tips of the young vines also make good cuttings, and the late or main crop may be grown from them.

The sweet potato is a warm-season plant. It must have a long season, full exposure to sun, loose warm sandy loam soil deeply prepared. It is frost-tender. It should be provided with a quick-acting manure or fertilizer. The crop is grown under clean tillage until the vines begin to cover the ground. The rows are usually about 3 feet apart and the plants 18 inches asunder in the row.

At these distances, about 9,600 plants are required to the acre. The yield is 100 to 200 bushels to the acre; 400 bushels may be secured.

REVIEW

What are the two kinds of potatoes? Are they closely related?
What is the difference between the two kinds?
Are there differences in foliage?
How extensively is the Irish potato grown? the sweet potato?
For what purposes is the Irish potato raised?
Explain the requirements for the best cultivation of both classes of potatoes.

THOUGHT-QUESTIONS AND INQUIRIES

Which of the potato plants (Irish and sweet) does best in your section? What is the average yield to the acre of each in your state? What is the average total acreage grown in the state?
Describe the cultural methods practiced by the best potato growers in your region.
What varieties of potatoes do best in your soil and climate? Which are the "early" kinds and which are the "late" varieties?
Describe the method practiced by the farmers of your neighborhood in selecting and treating seed potatoes.
Send to the Crops Department of your college of agriculture for a bulletin or circular describing the "tuber-unit" and "mass-selection" methods of improving the yield of the potato crop. Does any potato grower whom you know follow either method?
What insect pests or plant diseases affect the potato crop? Describe the control or remedial measures for each pest or disease.
Why is the potato an important food in war times?
What form of potato tuber is most prized by your neighbors? Bring different kinds to school for comparison.
If you have opportunity, compare flowers of potato, tomato, eggplant, red pepper, and note the resemblance.

CLASS OR HOME PROBLEM

Each pupil should join, or help to organize, a potato growing club in the school or in the community. Write to the club leader at your state college of agriculture for information and help in starting such a club. As potatoes of one kind or another are grown in every part of the country, a potato club ought to be successful.
TOPIC 15
ROOT CROPS

In North American agriculture the term "root crops" is commonly used for such plants as produce fleshy parts underground, excluding the potatoes. These crops are grown for stock-feeding, and also in vegetable gardens for human food. The varieties most prized for livestock are usually the coarse heavy-yielding kinds.

While the sugar-beet is really a root crop, it is usually considered by itself because grown for a very special purpose. The cultivation of it is a large industry in Europe and North America. Once sugar was a luxury, used only by the few. Now it has come to be a common necessity. It is derived from sugar-cane and sugar-beets. But these crops cannot be treated in this book.

109. THE KINDS OF ROOT CROPS

The beet tribe: mangels (sometimes written mangel-wurzel and mangold) for live-stock; garden beets (called beet-root in England) for home use. These and the sugar-beet are forms of a single species, Beta vulgaris, native in Europe; it is one of the
Pigweed family. The genus Beta comprises perhaps a half dozen species, of the Eastern Hemisphere.

**Turnip** (*Brassica Rapa*), in many varieties, mostly with flattish or not elongated usually white-fleshed tubers; grown for stock feed and for human food.

**Rutabaga** (*Brassica campestris*), of many kinds, the tubers usually longer than broad and yellow-fleshed. They are sometimes called Swedish turnips or "Swedes." The turnip and rutabaga are closely related to the mustards, being members of the Cruciferae or Mustard family. They are of the genus *Brassica*, which comprises the cabbage, cauliflower, rape, and kohlrabi. The genus has about 100 species in the Old World.

**Carrot**, long and short, the flesh yellow or whitish; the late large kinds grown for live-stock, others for household use. All forms are of one species, *Daucus Carota*, of the Parsnip family (Umbelliferae). In its wild form it is a bad weed in grass lands, often known as Queen Anne’s Lace. *Daucus* comprises 60 or more species, two or three of which are native in North America. It is mostly an Old World genus.

**Parsnip**, of few varieties, used both in the home and the stall; all kinds require the full season. It is one of the half dozen species of *Pastinaca* (*P. sativa*), of the Umbelliferae; it is run wild as a weed in many places.
Other root crops are radish and salsify (vegetable oyster), grown for household use. The horse-radish is usually classed with the root crops, but it is not a tuber as the others are; and its culture is of a different kind. Kohl-rabi is strictly not one of the root crops, as the tuber is part of the stem above ground; but as its culture and uses are similar, it is often classed with them.

110. The Use of Roots

Roots provide excellent winter feed for dairy cattle and other live-stock because of their succulence. They are juicy and fresh. They also have good feeding-value in nutrients, mostly in the form of carbohydrates, although the protein content is as high as in many grains. The dry-matter is small, however, in proportion to the total weight, which means that much water is handled in these crops. A thousand pounds of mangels or turnips yield about 100 pounds of dry-matter, the remainder being water.

In northern regions, where winters are long and silage corn is uncertain, the roots contribute an important part in feeding, stimulating the flow of milk and the well-being of the stock. Even in other regions they are good supplemental feeds, if the climate and the farm-scheme are such as to allow of their cultivation.

For home use, the roots provide an attractive variety. Every day in the year the table may be supplied with one kind or another. Late in the spring the radishes are ready; these are followed by summer radishes, by early beets and turnips, by carrots;
later by rutabagas, by fall and winter radishes, fall and winter carrots and beets, parsnips, salsify, all of which may be stored till radishes come again; parsnips and salsify are sometimes left in the ground all winter.

Roots should be winter-stored in a temperature near freezing, and the ventilation of the cellar or store room should be good. The air should be moist, else they will shrivel. Furnace-heated cellars are not adapted to such storage. For home use, roots may be kept in barrels of moist sand; broken and bruised tubers should not be stored.

III. REQUIREMENTS FOR ROOT CROPS

While the root crops are of many kinds, they agree in being cool-season plants and requiring a deeply prepared friable soil. Omitting horse-radish, they are propagated by seeds usually sown in drills where the plants are to stand. Most of them are frost-hardy. Some of them do not require a full season, as the common radishes, early beets, and carrots. Rutabagas may be sown in late June to July 1 in the North, and turnips as late as July 25. Salsify and parsnips require the entire season. Winter carrots and beets need a long season of growth to produce large well-matured roots.

In a great many parts of Canada, says a Canadian publication (F. S. Browne, Special Circ. 9, Dominion Expl. Farms), "silage corn can be profitably grown, and, in such sections it is, at present, recognized as the most economical crop to grow as forage for stock. In spite of this, however, field roots, on account of their peculiar value in adding palatability to the ration, are still grown in even the best silage corn sections of the
country. Further, the root crop is a safe venture in many parts of the Dominion where the climatic conditions are such as to render the results with corn just a little too uncertain.

"Field roots are a hoed crop and should preferably follow hay or pasture. The seed should be sown in rows 25 to 30 inches apart. On land free from weeds, that is inclined to dry out, or in districts where rainfall is light, seeding may be done on the flat. Under ordinary conditions, however, it is advisable to sow in shallow drills which have been run up, with the drill plow, and flattened to about one-third their original height with the roller. Hand seeders are usually the most satisfactory, and one with a light roller attached, so that the soil is pressed firmly around the seed, should be used. Mangels, sow as soon as the ground can be conveniently worked in the spring. Turnips may be sown comparatively late; two to three weeks after mangels. Carrots, sow about the same time as mangels, or a little later. With good seed, of strong vitality, the following quantities may be recommended to the acre:—Mangels, 7 to 8 pounds; turnips, 2 to 3 pounds; carrots, 3 to 4 pounds."

REVIEW

What are root crops?
Briefly describe the beet tribe; turnips and rutabagas; carrot; parsnip.
Explain the uses of roots. Where are they mostly grown?
Give your estimate of the importance of roots in the vegetable garden.
Describe how they are stored.
What are the general requirements for root crop cultivation?
Have you ever grown any of the roots in your own garden? Describe the methods you employed.

Describe the differences between turnips, rutabagas, carrots, parsnips, radishes, beets. Are there differences in leaves as well as in roots?

THOUGHT-QUESTIONS AND INQUIRIES

Which of the root crops grow well in your soil and climate? Which are used principally as human food? As stock food?

What is the food value of the root crops grown as stock food in your section? What place do these roots occupy in the balanced ration? (i. e. tell of the relative weight of the roots to the hay and grain).

At your harvest festival or exhibition in your school, see that the different kinds of roots are well represented.
COTTON

COTTON is grown principally for the hair on its seeds; from this fiber all the kinds of cotton cloth are made. Oil is extracted from the seeds, and the cake remaining from this process is used for cattle feed and other purposes. Cotton is the most important fiber-plant in the world.

The cotton region of North America extends from North Carolina (and southern Virginia) to Texas. The so-called "cotton-belt" comprises the ten states North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, Texas; and the less elevated part of Tennessee should be included. This great area is the most important cotton region in the world.

112. WHAT COTTON IS

All forms of cotton are of the genus Gossypium, one of the Mallow or Hollyhock family (Malvaceae). In this
V. COTTON-FARMING. — A field at picking time in North Carolina
family is the hollyhock, marsh mallow, and okra. There are thirty to forty species of gossypium, herbs and shrubs, native to many parts of the world. The species of cotton grown in North America is of two species, the upland cotton, *Gossypium hirsutum* (meaning hirsute or hairy gossypium) which is an herb; and the sea-island cotton (*G. barbadense*, Barbadoes) which is more inclined to be a woody plant. These two species are probably native to the western hemisphere. In some of its forms cotton has been cultivated from ancient times.

The hair or fiber on the cotton seed is called the lint. All the lint on a seed taken together is known as the staple. Although the hairs are short, it is easy to spin them together because there is a natural twist in them. The lint is very slender, as many as 1200 or more of them being required to make an inch wide when laid side by side.

The cotton seeds are contained in a pod or boll. The boll bursts at maturity, exposing the white cotton. Close-jointed and stocky plants, not excessively overgrown, usually produce the greatest number of bolls.
113. KINDS OF COTTON

The cotton grower in the United States may recognize at least three principal types or groups of cotton:

1. The upland, common or short-staple, in which the lint is about 1 in. long.
2. Long-staple upland, in which the lint is 1\(\frac{1}{8}\) to 1\(\frac{1}{2}\) inches long.
3. Sea-island cotton (so called because it is raised mostly on the seacoast islands, or near the coast), with still longer lint.

While the common cotton brings less price to the pound than the other types, yet the yield is so much greater that it is more profitable. The length of the staple may be increased by careful plant-breeding. There are many varieties of the common cotton, as also of the other types.

114. VALUE OF COTTON

In 1909 more than 32 millions of acres were planted to cotton in the United States. The value of the crop was more than 700 millions of dollars, which was much greater than the value of all the hard and soft coal mined. It was more than ten times the estimated value of the wool produced in that year. The value of cotton seed was estimated at more than 120 millions of dollars, which is much greater than the value of the tobacco crop.
American cotton and cotton goods are shipped to all parts of the world. Cotton cloth clothes princes and paupers, and millions of merchants, farmers, laborers, and professional men. Cotton and wool are the greatest sources of clothing, although silk and linen are much used. Cotton is the great money crop of the southern United States. It is one of the leading agricultural products of the world, and the condition of the crop in any year has great influence on the markets.

115. Requirements of the Cotton Plant

Cotton is a warm-country crop, being injured by temperatures even not as low as freezing. Although the cottons are really perennial, they are grown as annuals, and the crop must be made before frost touches the plants. Soil must be such as to yield its fertility quickly, to maintain a continuous rapid growth. The land is fertilized with the crop; but a good short-course rotation, with cowpeas or other legume, is essential to best results. It is a shallow-rooted plant. Seeds are planted where the crop is to grow; rows about 4 feet apart, plants 8 to 24 inches in the row. The crop is tilled frequently, clean cultivation being essential.

About one bushel of seed is required to plant an acre. The average yield is about one-third of a bale to the acre and a good yield is 1 bale (or 500 pounds). Two bales is a heavy yield.

116. How Cotton is Grown

Cotton is a clean-culture crop. Therefore the humus tends to disappear rapidly from land continuously cropped. Rotations
are specially important. The use of fertilizers is also advisable, as the material gives the plants a start, hastens maturity, and increases yields. The land should be thoroughly prepared, so that the soil will be well pulverized and the seed-bed in prime condition. Seeding is sometimes performed by hand, but now nearly always by means of drills. As well-bred seed is expensive, care should be taken not to waste it by planting too heavily. The cotton-planting season begins in the North (North Carolina) about the middle of April or the first of May, in Florida and Louisiana about the first of April, and in parts of Texas somewhat earlier. It is important that seeding be delayed till the weather is warm and settled.

Tillage may be at first with a light harrow or weeder with teeth slanting backward, and run over the surface before the plants are up and perhaps again after they are up and well established but yet too small to be broken. The usual tillage is by the use of a sweep-plow or cultivator between the rows, at intervals frequent enough to keep down the weeds and maintain a good soil-mulch. After the first row-tillage, the plants are thinned by chopping out with the hoe. One or two plants are left in a place or “hill,” at distances of about a foot and a half apart (12-24 inches).

The cotton is picked by hand, and this work is one of the heavy items of expense in the growing of the crop. The lint is removed by the process of ginning. A gin is a mill or machine through which the cotton is run, to separate the fiber and the seed. Gins are established all through the cotton-belt to serve the planters of the region.

Many troubles overtake the cotton-planter, of which one of the worst is the Mexican boll-weevil. The larva eats in the young boll or bud. The remedy is in the nature of methods for circumventing the insect. This consists in getting the crop off early, in cleaning up the plantation to destroy hibernating places, burning the old stalks and fall plowing, in keeping the premises clean of breeding-places throughout the season, and by wide spacing of the plants.

**REVIEW**

What is cotton? What does the plant yield?
Where is the cotton-belt?
To what family and genus does the cotton belong?
Where is the cotton fiber borne? What do you understand by the lint and the staple? by the boll?
Name the types or groups of cotton.
What is the importance of the cotton crop?
Discuss the requirements of the cotton plant.

THOUGHT-QUESTIONS AND PROBLEMS

From the Census determine which states produce the most cotton.
If you live in a cotton-growing state, look up and report the yield by counties.
Whether you live in a cotton region or not, obtain bolls of cotton and examine the fiber. Try to roll the lint together in the fingers. Perhaps you can correspond with schools in the cotton-belt, exchanging some of your products for theirs.
If in a cotton region, name the varieties mostly grown. Compare the length of staple in the different kinds.
What are the favorite cotton soils?
What machinery is employed in your region in the growing of cotton?
Do the cotton growers in your country practice rotation? Explain.
Describe a cotton gin.
Where is the cotton of your region marketed?

CLASS PROBLEM

Obtain for the school museum the market grades of cotton. There are six or seven recognized grades. As cotton is sold by samples from the bales, an examination of standard grades should be a profitable class exercise.
Collect, also, the different by-products of cotton, as seed, oil, oil-cake, meal, hulls, and the materials used in cookery. Some of the kinds of cotton cloth may be collected.
If in a cotton region, join or organize a cotton club.
TOPIC 17

TIMBER

Timber is a crop as much as wheat or sugar-cane. It grows from the land, and it responds to management and good care.

As there may be good or poor stand of corn or millet, so may there be a good or poor stand of timber. There are weed trees, of no value to the owner, that interfere with the growth of other trees. There may be open spaces, yielding nothing.

A forest is a company of trees. These trees grow together, producing conditions of shade, moisture and soil texture found nowhere else. Many trees are required to make a good woodlot, comprising ten acres or more for best results. The small farm forest is usually called a woodlot.

A grove is not a forest or a woodlot. Planting shade trees does not constitute forestry, nor the growing of trees along avenues or city streets or in parks. A forest is a world by itself, large or small, with its own climate, its undergrowth, its springs and creeks, its bird life and insect inhabitants.

117. Importance of Forests

The farmer's interest in the woodlot is of two kinds: as a source of wood, posts, and timber; as an attractive

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part of the property. Every general farm in the timber region is supposed to have its "woods." These woods are characteristic of the landscape in the Northeastern States and Canada.

In New York, the forest products of farms in 1909 were valued at more than 10 millions of dollars, which was more than the value of butter-fat sold. In Ohio, the value of these products was about $5\frac{3}{4}$ millions, which was more than twice the value of mules on farms. In Pennsylvania, the farm forest products were worth nearly 8 million dollars, which was more than the poultry raised, as reported, in 1909. The total value of forest products of farms in the United States in 1909 was more than 195 millions of dollars, being 3.6 per cent of the value of all crops. This is much more than the value of potatoes in the same year.

The kinds of farm forest products are indicated by the Census enumeration: "all firewood, fencing material, logs, railroad ties, telegraph and telephone poles, materials for barrels, bark, naval stores," and others.

A good woodlot adds to the selling value of a farm. It usually also contributes to the home value.

In timber states the farm forests are usually natural woods maintained continuously and yielding their harvests year by year. In the prairie states and in the plains, the woodlots are usually planted about or near the buildings, where they serve as protections against the sun and wind. They may be planted, however, on rough or relatively waste grounds, utilizing such places to advantage. It does not pay, as a rule, to raise forests on land that is well adapted to the staple farm crops.
118. Public Values of Forests

Thus far we have been speaking of the farm forest or woodlot. There are also vast tracts of public forests, specially in the West and on the Pacific slope. They are "reservations," which means that they are reserved or kept by government for forest and are not open to settlement. Great areas of forests are also owned by states, as in the Adirondacks of New York. About one-fourth of the timber land in the United States is owned by state and nation. Cities sometimes own forests, to control water supplies.

Forests exercise great influence on the life of the nation, aside from the yield of timber. They usually occupy mountains and remote lands from which streams derive much of their water. The forest cover prevents floods on the rivers by holding back the rainfall and snowfall and allowing the water to find its way to the streams gradually. Rain falling on a roof runs off at once; on bare steep land, only a small part seeps into the earth, the remainder running off rapidly and injuring the land by washing. On grass-bound slopes, the run-off does less damage. In a forest, the rainfall is broken by the trees, held by roots and leaf-mold, and it finds its way slowly into the creeks. Springs are protected by forests. When the woods are removed, many of the springs dry up. The uniformity of flow from great forested areas has much influence on irrigation. Forests also check the force of drying and destructive winds. The forest is a great natural recreation ground, providing an attractive access to the out-of-doors and to wild life.
119. THE WOODLOT

The farm forest must be thought of as a regular crop, yielding wood, as we think of a meadow yielding hay or an orchard yielding apples. The crop is the woodlot in particular harvested, either by cutting part or all of the woods completely or, as is usual, by taking out the crowded or the mature trees from time to time as needed.

As trees will grow without the aid of man, so we are likely to think that the woodlot needs no care. So does grass grow without aid, and yet we do not obtain a good lawn or a profitable meadow without attention.

Part of the care of the woodland is to protect it against fire, over-grazing, theft, careless cutting. Another part is to remove all worthless trees, as one removes weeds from a cornfield. One is to see that the "stand" is thrifty,—that the trees are close enough together to cover the land and to make tall, straight boles with high crowns or tops. Broken, decayed, deformed, and poor trees are to be removed. Open or vacant spaces should be replanted. Care is to be taken to plant the right species of trees.

The trees should grow rapidly. The rapidity of growth depends on the species: a beech or red cedar grows slowly; a white pine, locust, or basswood grows rapidly. The rate of growth depends on the soil; also on the amount of light, for in overcrowded woodlands the struggle for existence is too severe for rapid growth.

The woodlot is commonly a remnant of the original forest, allowed to remain on the rear of the property or on land not adapted to other uses. When a woodland is newly planted, it should be placed on land of least value agriculturally,
although its location may be extended to break the force of prevailing winds, to guard springs and streams, and perhaps to intercept undesirable views and to improve the landscape. A good road should enter it, which may be used in winter. A sugar-bush may be part of a farm-forest area; and a picnic ground may often be reserved in some part of it. The woodlot provides good winter work, and a means of holding labor throughout the year.

120. MANAGING THE WOODLOT

The cutting of the timber is for two purposes: to improve the forest; to harvest the crop. Improvement-cutting consists in removing undesirable kinds and also thinning so that the remaining trees will thrive better.

The trees should stand so thick that they will naturally drop the lower branches, when these branches are very small, so that the tree will make a long clean trunk. The openings in the forest should not be so great as to encourage grass and bushes. The moist, cool, forest atmosphere is to be retained.

New forests are started by seeds sown naturally or artificially, by planting young trees, and by allowing sprouts to grow from stumps. Some trees (as chestnut and redwood) sprout freely from stumps and soon renew themselves. The sprouts should be thinned to two or three from each root. Stumps of young trees usually produce the best sprouts. Sprout trees generally do not grow to so large size as seedling trees, but they make useful timber for posts, rails, poles, ties, and firewood.
VI. A PLANTED WOODLOT. — Catalpa for fence-posts in Indiana
Seedlings may be allowed to spring up from seeds that drop in the forest or are sown there; but it is often the better practice to plant young trees. Sometimes seeds are sown in little prepared seed-beds, called “seed spots,” where the trees are to grow. Some farmers keep a nursery of timber trees, but usually it is cheaper to buy from nurserymen who make this kind of tree-growing a specialty.

It is customary to plant young trees about 6 feet apart each way, requiring about 1200 trees to the acre. On poor land and with slow-growing species, as some of the evergreens, 5 feet apart is a good distance, so that the trees will shade the ground sooner and smother weeds; this distance requires about 1700 trees to the acre. It is advisable to plant on plowed and well-harrowed land, if possible. Tillage may be continued until the trees master the grass and weeds, and also to lessen the danger of fire.

Planting is usually a spring operation. Trees two or three years old are used, and with strong tools the planting may be performed rapidly. On unplowed land, the earth usually is opened with a mattock, the tree carefully thrust in, and the hole closed with a stamp of the foot. The trees should be kept moist and fresh, and the tops of broad-leaved trees pruned as if they were orchard stock. The leaders of evergreens should not be cut.

**REVIEW**

What is a forest? A woodlot?

How is the farmer interested in forests? What materials does he obtain from them?

How important are the farm forests?
Where do forests occur on the farm?
What are forest reservations? What interest has the public in forests?
How do forests influence floods? soil erosion?
How must the woodlot be protected? What is meant by the “stand”?
How is the crop from the woodlot harvested?
How are new woodlots started?
At what distance are the young trees planted? When and how are they planted?

THOUGHT-QUESTIONS AND INQUIRIES

What is the total area covered by forests in your state? In your county? The annual value of forest products in each?
What are the principal kinds of forest trees in your region? Describe the products that are obtained from the forests.
How many farms in your neighborhood have woodlots? If there are any planted woodlots, describe how they are planted and the kinds of trees.
Which is better, to have the great forest areas owned and managed by the state and the nation or by private individuals?
How many kinds of forest trees do you know? Which ones are the “hard woods”? Which the conifers? Can you tell the different kinds of trees by the wood?
Send to the forestry department of your state college of agriculture or university for free publications on forestry and the management of the farm woodlot. Read these bulletins carefully as a part of this lesson on timber. What recommendations or suggestions are given in these bulletins on the planting and management of the farm woodlot?

CLASS PROBLEM

The school cabinet or museum should contain pressed and mounted specimens of the leaves and flowers of the common forest trees; also samples of bark and wood. Here is a good home problem in which the pupils may coöperate.
What kinds of woods are used in the construction of your school-house? Where do you think they came from?
That great part of agriculture having to do with the growing of fruits, garden vegetables, flowers, and ornamental plants, is known as horticulture. It gives little attention to grass as a fundamental crop, or to grain, or to the rearing of live-stock. All the range of gardening, including the making of parks and home grounds, comes within the definition of horticulture, as does also most of the growing of nursery stock.

Much of the horticulture is very intensive. The greatest product is obtained from a small area of land. The most intensive agriculture is the art of the florist, who grows many of his plants in pots. So carefully must his soil be prepared that he mixes it to suit and then sifts it to remove all lumps and stones and sticks. He puts clinkers or bits of broken materials in the bottom to provide drainage; and the pot also has a hole in the bottom.
He often applies liquid manure or other fertilizer. He is keen to see the first sign of disease or insect injury. In this pot he may grow a plant several feet tall, so tall that the pot will hardly hold it up. If it were possible to apply these methods to the fields, the yield of farms would be enormously increased.

121. THE DIVISIONS OF HORTICULTURE

The raising of fruits is known as fruit-growing or pomology. In this division of the subject is included the growing of such crops as apple, pear, quince; plum, apricot, peach, almond, cherry; orange, lemon, grapefruit; fig, mulberry, olive; nuts of many kinds; grape, gooseberry, and currant; raspberry and blackberry; strawberry; and many others.

The raising of vegetables is vegetable-gardening or olericulture. Here is included the growing of cabbages and cauliflower; turnip and rutabaga; lettuce; melons; pumpkin and squash; sweet corn; pea and bean; onion; sweet herbs; and others.

The raising of flowers is called floriculture. It has to do with roses, carnations, chrysanthemums, sweet peas, violets and pansies, hollyhocks, primroses, and great numbers of other plants both out of doors and in the greenhouse.

When the area is relatively small and the cultivation is intensive, the work is known as gardening. In gardens many kinds of fruits and vegetables and flowers may be grown.

The garden should contain not only plants for human food, but those designed to improve the looks of the
place. To improve the appearance, the plants must be properly arranged. A room is not attractive when the furniture is scattered, even though every piece of furniture is good in itself. So a yard or property is not attractive when plants are scattered or are placed without reference to walks, boundaries, buildings, and to each other. A flower-bed in the center of the home lawn does not improve the place, even though it is a good flower-bed.

We may divide horticulture again into the growing of produce for home use and for the market. The marketing of such produce has now come to be a very large enterprise. Even the amount of supplies raised on home gardens for sale is larger than we know.

122. THE HOME GARDEN

Every home-maker should aim to have a garden. It should be as much a part of a home as is a garage or a lawn.

A good garden provides work and plans for all members of the family. The children can do garden work. It introduces them to many interesting kinds of plants, as one might be introduced to interesting people. One learns how to grow plants, how to manage soils, fertilizers, tools, insects, and diseases.
The garden should also provide vegetables and many of the fruits in their season. Persons who buy only from the stores do not know how different are the products taken directly from the ground or the plant, fully mature, and never having withered. It is a great satisfaction to get one's daily supplies from one's own ground.

Particularly should every farmstead comprise a garden. Much of the daily living, in good variety, can be obtained from it. At least one member of the household should be a gardener.

123. The Public-Service Garden

Public properties should look well. This means not only that the buildings and inclosures should be neat and in good repair, but also that the grounds should be attractive.

School-grounds have no right to be shabby, full of weeds, and without arrangement. Church yards, cemeteries, roadsides, creamery grounds, all should show evidences of good care, as if somebody were interested in them.

In cities and towns, vacant lots should be kept clean of weeds, and devoted to useful and interesting vegeta-
tion. Particularly should all public land be looked after. On many of these lands school-gardens could be grown by those needing them.

All these properties come within the care of the gardener. Perhaps vegetables and garden flowers may not be grown on them, but at least the lawn surface may be good and the planting of shrubbery and trees and hardy perennial herbs may show care and skill. The grounds should not be filled with planting. For the most part the central area should be kept open, and the shrubs placed along fences or other boundaries, and perhaps against foundations.

Many school properties are large enough for a school-garden. This is a place in which pupils grow plants as part of their school work. It is laid out in regular small plots, so that the scholars may be assigned to a place in the garden just as one is given a seat in school. Usually it is best to grow both vegetables and flowers in these plots. The work should follow a regular plan.

When there is no space on the school premises, gardens may be made at the homes of the pupils, and reports given to the teacher. This is one of the best home problems.

124. Fruit-Growing

For most fruits somewhat high areas on the farm are best, as such places are likely to have good drainage of both water and frosty air. The land should be well and deeply fitted before the trees or bushes are set. It is impossible to fit the land so well after they are planted; and most fruits occupy the land for many years.
Usually early spring planting of fruit trees is preferred, particularly in cold and dry climates. The trees should be purchased in fall, if possible, when one may have the choice of stock. If not planted at that time, the trees should be heeled-in till spring.

The trees should have at least half their original top growth cut off when planted; sometimes more than this is removed. All broken roots are cut back to fresh surfaces.

The holes in which the trees are planted should be larger than the spread of the roots. See that the earth is pulverized in the bottom. The tree should be set about as deep as it stood in the nursery. Spread out the roots, finger the soft earth among them, shake the tree up and down to settle the earth into all the spaces; then press the earth firmly about the tree with the foot.

Every year fruit trees should be pruned. The operation consists in removing crowding and unnecessary branches, and all those injured or diseased.

One of the most important parts of the pruning is when the trees are set or within the first year or two. At this time the main framework of the future top is determined. Leave only very few main branches, and see that they are not so placed as to form crotches. Three
or four main branches are sufficient. Pruning is usually performed in winter and early spring. Do not leave stubs, and take care that the wounds are clean and smooth.

Before bearing trees can be pruned intelligently, one must know the fruit-buds. These buds usually differ from the leaf-buds in being thicker and less pointed, and often more fuzzy. On some kinds of fruits, as apple and pear, they are borne for the most part on spurs, which are very short branches, usually only an inch or two or three long. On peaches they are borne mostly on either side of the leaf-bud on the last year's growth. Of course, if one removes or injures the fruit-buds, the number of fruits will probably be reduced.

Orchards are usually tilled until midsummer or later, at which time most of the growth has ceased. A clean surface with good soil-mulch is generally to be advised. Crops should not be grown in bearing orchards. In late summer or in autumn a cover-crop may be sown (p. 157) to be plowed under the following spring.

The fruit-grower must know the insects and diseases likely to attack his plantations. He must be prepared for them with spraying machines and insecticides and fungicides. The applications must be made promptly and thoroughly.

Fruit is a choice product, usually of great beauty. Every care should therefore be taken in the harvesting, grading, and marketing. Even the best of fruit not graded and carelessly packed will fail to bring a satisfactory price.

The usual distances apart for fruit plants are about as follows:
<table>
<thead>
<tr>
<th>Fruit</th>
<th>Area (ft.)</th>
<th>Plants per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>$40 \times 40$</td>
<td>27</td>
</tr>
<tr>
<td>Pear</td>
<td>$20 \times 20$</td>
<td>108</td>
</tr>
<tr>
<td>Quince</td>
<td>$16 \times 16$</td>
<td>170</td>
</tr>
<tr>
<td>Peach</td>
<td>$20 \times 20$</td>
<td>108</td>
</tr>
<tr>
<td>Plum</td>
<td>$20 \times 20$</td>
<td>108</td>
</tr>
<tr>
<td>Apricot</td>
<td>$20 \times 20$</td>
<td>108</td>
</tr>
<tr>
<td>Cherry (sour)</td>
<td>$20 \times 20$</td>
<td>108</td>
</tr>
<tr>
<td>Cherry (sweet)</td>
<td>$30 \times 30$</td>
<td>48</td>
</tr>
<tr>
<td>Grape</td>
<td>$6 \times 8$</td>
<td>907</td>
</tr>
<tr>
<td>Currant</td>
<td>$4 \times 6$</td>
<td>1815</td>
</tr>
<tr>
<td>Blackberry</td>
<td>$4 \times 7$</td>
<td>1556</td>
</tr>
<tr>
<td>Raspberry</td>
<td>$3 \times 6$</td>
<td>2420</td>
</tr>
<tr>
<td>Strawberry</td>
<td>$1 \times 3$</td>
<td>14520</td>
</tr>
</tbody>
</table>

125. **Vegetable-Growing**

The best of tillage and fertilizing is required for the growing of vegetables. The crop must be heavy, and a good part of it also must be early.

There is a regular season for wheat and alfalfa and apples; but vegetables may be had earlier by choosing light "quick" soil, by fertilizing with quickly available materials, and by starting the plants early in the house, greenhouse, or hotbed. There are no farm crops in which the skill of the operator counts more.

The choice of land and site is therefore very important. The place should be "early," which means well exposed to the sun, holding no superfluous water, mellow and easy to work, fertile. Inasmuch as many of the vegetables are attacked by soil-borne diseases, it is well to move the garden to a new area every few years.

Much care should be given to the seed, to be sure (1) that it will grow, (2) that it is true to name, (3) that it has been well selected or bred. The germinating power one can test
for oneself; but for the rest one must rely on the seed-merchant or the seed-grower.

As with fruits, so must vegetables be grown with good knowledge of insects and diseases and with ample supply of spraying materials. The State experiment station or college, or county agent, will aid with information.

The planting-table on pages 228 and 229 will be useful. While the dates are for Pennsylvania, yet the comparative times are about the same anywhere. This table is by M. S. McDowell, and published by the Pennsylvania State College of Agriculture.

126. FLOWER-GROWING

The growing of flowers for market is now a very large industry. The Thirteenth Census reports that in 1909 the value of "flowers and plants" was nearly 35 millions of dollars; yet this great value was produced on only about 18,000 acres of land.

Great ranges of greenhouses, some of them so large that the land in them may be plowed by horses, are now erected for the growing of plants in winter, either flowers or vegetables, or both. Thousands of other houses are small, and the most intensive methods are practiced. Therefore the Census says that the acreage statistics "have comparatively little significance."

For home use flowers are grown for two purposes: (1) to raise a crop for gathering; (2) to adorn the premises.

To obtain a good crop of flowers the soil should be good, well prepared, and fertilized. The plants should be in rows so that they can be tilled. Materials should be ready for spraying. It is as necessary to give these plants the proper conditions for growth as it is for corn or sugar-beets.
<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Seed Required</th>
<th>Longevity of Seed. Years</th>
<th>Rows Apart</th>
<th>Plants Apart in Rows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>1 yr. old roots</td>
<td>3-5</td>
<td>36 in.</td>
<td>15-18 in.</td>
</tr>
<tr>
<td>Beans (snap)</td>
<td>1 pint — 100 ft.</td>
<td>2-3</td>
<td>15-24 in.</td>
<td>2- 4 in.</td>
</tr>
<tr>
<td>Beans (pole)</td>
<td>½ pint — 100 ft.</td>
<td>2-3</td>
<td>36 in.</td>
<td>1 2- 3 ft.</td>
</tr>
<tr>
<td>Beans (bush lima)</td>
<td>1 pint — 100 ft.</td>
<td>2</td>
<td>20-30 in.</td>
<td>3- 6 in.</td>
</tr>
<tr>
<td>Beans (pole lima)</td>
<td>1 pint — 150 ft.</td>
<td>2</td>
<td>30-36 in.</td>
<td>1 2- 3 ft.</td>
</tr>
<tr>
<td>Beets</td>
<td>1 oz. — 100 ft.</td>
<td>4-6</td>
<td>12-18 in.</td>
<td>3- 4 in.</td>
</tr>
<tr>
<td>Cabbage (early)</td>
<td>1 oz. — 5000 plants</td>
<td>4-5</td>
<td>20-28 in.</td>
<td>15-18 in.</td>
</tr>
<tr>
<td>Cabbage (late)</td>
<td>1 oz. — 300 ft.</td>
<td>4-5</td>
<td>24-32 in.</td>
<td>18-24 in.</td>
</tr>
<tr>
<td>Carrot</td>
<td>1 oz. — 400 ft.</td>
<td>2-3</td>
<td>12-18 in.</td>
<td>2- 3 in.</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>1 oz. — 5000 plants</td>
<td>4-5</td>
<td>24-30 in.</td>
<td>18-24 in.</td>
</tr>
<tr>
<td>Celery</td>
<td>1 oz. — 10,000 plants</td>
<td>3-5</td>
<td>20-24 in.</td>
<td>4- 6 in.</td>
</tr>
<tr>
<td>Chicory</td>
<td>1 oz. — 300 ft.</td>
<td>5-6</td>
<td>12-18 in.</td>
<td>3- 4 in.</td>
</tr>
<tr>
<td>Corn (sweet)</td>
<td>1 pt. — 300 hills</td>
<td>2</td>
<td>30-36 in.</td>
<td>1 24-30 in.</td>
</tr>
<tr>
<td>Cucumber</td>
<td>1 oz. — 50 hills</td>
<td>5-10</td>
<td>4- 5 ft.</td>
<td>1 2- 4 ft.</td>
</tr>
<tr>
<td>Eggplant</td>
<td>1 oz. — 2000 plants</td>
<td>3-5</td>
<td>24 in.</td>
<td>16-24 in.</td>
</tr>
<tr>
<td>Endive</td>
<td>¼ oz. — 100 ft.</td>
<td>3-5</td>
<td>14-18 in.</td>
<td>8-10 in.</td>
</tr>
<tr>
<td>Horseradish</td>
<td>Root cuttings</td>
<td></td>
<td>30 in.</td>
<td>12-15 in.</td>
</tr>
<tr>
<td>Kale</td>
<td>1 oz. — 300 ft.</td>
<td>4-5</td>
<td>15-24 in.</td>
<td>6- 8 in.</td>
</tr>
<tr>
<td>Kohlrabi</td>
<td>1 oz. — 300 ft.</td>
<td>4-5</td>
<td>15-24 in.</td>
<td>6- 8 in.</td>
</tr>
<tr>
<td>Leek</td>
<td>1 oz. — 150 ft.</td>
<td>1</td>
<td>12-18 in.</td>
<td>3- 6 in.</td>
</tr>
<tr>
<td>Lettuce</td>
<td>1 oz. — 400 ft.</td>
<td>3-5</td>
<td>12-15 in.</td>
<td>8-10 in.</td>
</tr>
<tr>
<td>Musk melon</td>
<td>1 oz. — 50 hills</td>
<td>5-10</td>
<td>4- 5 ft.</td>
<td>1 4- 5 in.</td>
</tr>
<tr>
<td>Onions (green)</td>
<td>1 qt. sets — 40 ft.</td>
<td></td>
<td>12-18 in.</td>
<td>1 in.</td>
</tr>
<tr>
<td>Onions (late)</td>
<td>1 oz. seed — 100 ft.</td>
<td>1</td>
<td>12-18 in.</td>
<td>1 in.</td>
</tr>
<tr>
<td>Parsley</td>
<td>1 oz. — 200 ft.</td>
<td>2-3</td>
<td>12-18 in.</td>
<td>4- 6 in.</td>
</tr>
<tr>
<td>Parsnip</td>
<td>1 oz. — 200 ft.</td>
<td>1</td>
<td>12-18 in.</td>
<td>3- 4 in.</td>
</tr>
<tr>
<td>Peas</td>
<td>1 qt. — 100 ft.</td>
<td>2-3</td>
<td>16-30 in.</td>
<td>½ in.</td>
</tr>
<tr>
<td>Peppers</td>
<td>1 oz. — 1500 plants</td>
<td>2-3</td>
<td>18-24 in.</td>
<td>12-15 in.</td>
</tr>
<tr>
<td>Radish</td>
<td>1 oz. — 100 ft.</td>
<td>3-4</td>
<td>6-14 in.</td>
<td>1- 2 in.</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>Roots</td>
<td></td>
<td>30 in.</td>
<td>24-30 in.</td>
</tr>
<tr>
<td>Rutabaga</td>
<td>1 oz. — 200 ft.</td>
<td>4-5</td>
<td>15-20 in.</td>
<td>4- 5 in.</td>
</tr>
<tr>
<td>Salsify</td>
<td>1 oz. — 100 ft.</td>
<td>2-3</td>
<td>12-18 in.</td>
<td>2- 3 in.</td>
</tr>
<tr>
<td>Spinach</td>
<td>1 oz. — 100 ft.</td>
<td>2-3</td>
<td>12-15 in.</td>
<td>4- 6 in.</td>
</tr>
<tr>
<td>Spinach (N. Zeal’d)</td>
<td>1 oz. — 50 plants</td>
<td></td>
<td>30-36 in.</td>
<td>12-18 in.</td>
</tr>
<tr>
<td>Squash (summer)</td>
<td>1 oz. — 40 hills</td>
<td>4-8</td>
<td>3- 4 ft.</td>
<td>1 3- 4 ft.</td>
</tr>
<tr>
<td>Squash (winter)</td>
<td>1 oz. — 20 hills</td>
<td>4-8</td>
<td>8-10 ft.</td>
<td>1 8-10 ft.</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>1 oz. — 100 ft.</td>
<td>4-6</td>
<td>15-18 in.</td>
<td>5- 6 in.</td>
</tr>
<tr>
<td>Tomato</td>
<td>1 oz. — 3-4000 plants</td>
<td>4-5</td>
<td>30-36 in.</td>
<td>18-24 in.</td>
</tr>
<tr>
<td>Turnip</td>
<td>1 oz. — 200 ft.</td>
<td>4-5</td>
<td>15-18 in.</td>
<td>3- 4 in.</td>
</tr>
</tbody>
</table>

1 Planted in hills.  
2 Planted to stakes.

<table>
<thead>
<tr>
<th>Depth of Planting, Inches</th>
<th>Hardiness</th>
<th>Date of Planting</th>
<th>Time of Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-12</td>
<td>Very hardy</td>
<td>April</td>
<td>3-4 years</td>
</tr>
<tr>
<td>1-12</td>
<td>Tender</td>
<td>May 10-July 25</td>
<td>40-65 days</td>
</tr>
<tr>
<td>1-12</td>
<td>Tender</td>
<td>May 15-June 15</td>
<td>50-75 days</td>
</tr>
<tr>
<td>1-12</td>
<td>Very tender</td>
<td>May 20-June 10</td>
<td>60-75 days</td>
</tr>
<tr>
<td>1-12</td>
<td>Very tender</td>
<td>May 20-June 1</td>
<td>70-100 days</td>
</tr>
<tr>
<td>1/2-1</td>
<td>Hardy</td>
<td>April 15-July 10</td>
<td>40-70 days</td>
</tr>
<tr>
<td>1/2-1/2</td>
<td>Hardy</td>
<td>February 1-March 15</td>
<td>70-120 days</td>
</tr>
<tr>
<td>1/2-1/2</td>
<td>Hardy</td>
<td>May 1-June 1</td>
<td>90-130 days</td>
</tr>
<tr>
<td>1/2-1/2</td>
<td>Hardy</td>
<td>April 15-July 10</td>
<td>55-90 days</td>
</tr>
<tr>
<td>1/2-1/2</td>
<td>Very tender</td>
<td>May 15</td>
<td>90-130 days</td>
</tr>
<tr>
<td>1/4-1/4</td>
<td>Not hardy — young</td>
<td>March 1; Late, May 1</td>
<td>130-180 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>June 1-15</td>
<td>120-130 days</td>
</tr>
<tr>
<td>1/4-1/2</td>
<td>Tender</td>
<td>May 1-July 1</td>
<td>70-100 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Tender</td>
<td>May 20-June 1</td>
<td>60-80 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15, or July 25</td>
<td>45-90 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very hardy</td>
<td>April 15-May 20</td>
<td>180 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15-August 1</td>
<td>50-75 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15 and August 1</td>
<td>60-75 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15</td>
<td>130-180 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15 and August 1</td>
<td>45-100 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very tender</td>
<td>May 20</td>
<td>90-120 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15</td>
<td>30-40 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15</td>
<td>90-100 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15</td>
<td>60-90 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very hardy</td>
<td>April 15</td>
<td>120-180 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15-May 20</td>
<td>50-80 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very tender</td>
<td>March 15</td>
<td>100-150 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15-June 1</td>
<td>22-40 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very hardy</td>
<td>April</td>
<td>1 year</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>July 1</td>
<td>100-120 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Very hardy</td>
<td>April 15</td>
<td>140-150 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15-May 15 and Aug. 1-10</td>
<td>40-60 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Half tender</td>
<td>April 15</td>
<td>60-80 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Tender</td>
<td>May 20</td>
<td>60-80 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Tender</td>
<td>May 20</td>
<td>90-110 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15</td>
<td>50-60 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Tender</td>
<td>March 1-April 1</td>
<td>100-160 days</td>
</tr>
<tr>
<td>1/4</td>
<td>Hardy</td>
<td>April 15 and August 1-15</td>
<td>60-90 days</td>
</tr>
</tbody>
</table>

Transplanted to permanent place: 3 In hotbed or greenhouse. 4 July 1; 5 July 15; 6 June 1.

In central and southern Pennsylvania there is little danger of frost after May 20.
The flower-garden, therefore, should be placed where flowers will thrive best and yield the fairest crop. The plants should be grown, even for home use, seriously and in good quantity, so that they may be cut freely. The flower-garden should be at one side or in the rear of the residence, where long rows or ample space can be had. It may well be combined with the vegetable-garden.

For decoration of the premises the flowers are to stand without much harvesting. Only such kinds should be grown as will make a good appearance most of the season and not cause the place to look ragged and weedy. Relatively few of the annual flowers are adapted to this purpose. One should not expect to secure the flowers for table, bouquets, and friends from these plantings, but rather from the regular flower-garden.

**REVIEW**

Explain what you understand by horticulture.
How does it contrast with other kinds of agriculture?
Into what parts or subjects is horticulture divided? Name crops in each of the divisions.
What is gardening? Why are home gardens important?
What do you understand by gardens for public service?
What is a school-garden? Its purpose?
What can you say about fruit-growing, as to soil and site, when to plant?
How should a tree be planted? Pruned?
What are fruit-beds?
What is the usual course of tillage in orchards?
What can you say about insects and diseases?
How many apple trees are required to plant an acre? peach trees?
Discuss soils and locations for vegetable-gardening.
VII. Orcharding. — Clean tillage in California
What about the importance of good seed?
State the distance apart and seed required for 100 ft. of row of cabbage, beet, pea, onion, lettuce.
How important is commercial floriculture?
For what purposes are flowers grown on the home premises?
Discuss the requirements of a good flower-garden.

THOUGHT-QUESTIONS AND INQUIRIES

Determine the relative importance of horticulture and general agriculture in your community.
How many farms have good gardens?
What are the crops grown in these gardens?
What are the chief difficulties in the growing of them, as to insects and other troubles?
Why are not more gardens made on the farms?
How extensively are gardens made in the villages or suburbs with which you are acquainted?
Who make all these gardens, the women or the men?
How much do children take part?
Have you, yourself, ever made a garden?
Do you know a school-garden? How successful is it? Describe.
What can you say about the care and planting of the public or semi-public premises in your township?
Are fruits grown to any extent in your state? What kind?
Where?
What are the leading difficulties that fruit-growers experience in raising the crop?
When is the pruning performed?
What attention is given to the grading and packing?
Can you name good varieties of the leading fruits?
Is market-gardening an industry in your region? What kinds?
Are hotbeds or glass houses used to any extent?
Where are the markets? How are the products prepared for market?
What do you observe about the growing of flowers in your neighborhood?

CLASS PROBLEMS

Join a garden club or organize one. Ask the state club leader (at the college of agriculture) for instructions.
GARDEN CONTESTS

(By Extension Department, University of Idaho. Estes P. Taylor)

There are two contests in the Garden Club Work. Contest A requires a square rod in the back yard, and is intended for flowers and a variety of vegetables. Contest B calls for $\frac{1}{10}$ acre or more, and if desired only one vegetable, such as beans or onions, may be grown, instead of several kinds. A seed crop can be raised, the produce can be used or sold fresh, or it may be canned. Choose the crop that you believe will be most profitable, and select the contest best adapted to your ground and conditions.

**Contest A (Garden and Back Yard)**

The back yard (not less than a square rod) should be cleaned up and planted to flowers and vegetables. It must be kept clean and beautiful. Attractive flowers and a well-kept garden are the things desired. At least four kinds of vegetables must be grown.

This contest invites the growing of that host of tender, crisp, nutritious vegetables so necessary to the table. Combined with the kitchen garden, the boys and girls are encouraged in the planting of flowers.

**Contest B (Home Garden and Marketing)**

In Contest B a larger tract of land is required. This garden shall be $\frac{1}{10}$ acre or more, which provides a tract for the boys and girls where such money-making crops as pop corn, sweet corn (fresh, canned, or seed), tomatoes (fresh or canned), onions, peas (fresh, canned, or seed), beans (fresh, canned, or seed), melons, cucumbers, beets, carrots, peppers, parsnips, and other vegetables may be grown.
TOPIC 19

THE ANIMALS — BREEDING

Farm animals play an important part in supplying the needs of man. The most noticeable aids are in providing labor, food, clothing, and in maintaining the fertility of the land.

To the horse belongs much of the credit for our progress. From time unreckoned, his flesh provided our early ancestors with food, and his hide with clothing and shelter. He has borne us in war, and helped to win our liberties. He has carried us messages of victory and sorrow. He has provided us with entertainment at the race, in sport, and at the tournament. And he has plowed our land, sown our grain, and harvested our crops.

Meat, milk, and eggs, the product of cattle, sheep, swine, and poultry, provide us with approximately one-half our food. The average person in the United States eats about 180 pounds of meat a year. The importance of the dairy cow increases as population grows. No other farm animal can produce human food so cheaply, and milk is practically indispensable as an article of human diet, particularly for infants and children. As the economic position of the dairy cow advances, cheese and butter will replace meat, at least in part.
From the sheep's back comes the fiber that provides woolen cloth, and from the cow's hide comes the leather that supplies foot-wear and many other articles. Let the pupil consider the clothes and articles he wears or carries on any day. Even though they are cotton clothes let him trace the origin of buttons, notebooks, combs, shoes, and many other things. We would not know how to live without animals and their products.

127. THE IMPORTANCE OF BETTER ANIMALS

However excellent any invention may be, the inventor or the user wants to improve it. When the florist produces the best crop of roses he has ever seen, he immediately plans to grow a better one. It is the saving quality in the human race that it wants to do better, to make progress.

While some horses are fast enough, some stylish enough, and some large enough, but few, if any, possess these characteristics in the proper proportion. While some cows give sufficient milk, and others give it sufficiently rich in fat, but few, possibly none, possess these attributes in the relation to secure the greatest efficiency or to meet the desires of the dairyman.

As with the main cultivated plants, so with the leading domestic animals, the forms are so modified that it is difficult to connect them with the original species from which they have descended. This modification is the result of a blind kind of breeding on the part of man through long centuries. We are now able, however, to breed animals with much accuracy and to secure many of the results we seek.
While there are many factors in the improvement of farm animals, the experience of successful breeders leads us to suppose that environment, selection, and heredity are the most important. It is by environment that the breeder controls development; by selection that he controls the efficiency; and by heredity that he advances the purity of the animals.

128. The Environment

The conditions in which the animal or organism lives, into which it comes when it is born, are known as the environment. It is the sum of temperature and climate, the range, the feed, the care, the competition with other animals. We speak of environments favorable and unfavorable. With farm animals the environment is largely under the control of the breeder and consists, in the main, (1) of care and management; (2) of training and developing. These two phases of the environment we may now discuss further.

(1) Care and management are very important. To insure improvement, the animal must be well fed. This is especially true of young animals. The individual retarded in youth never reaches that degree of perfection it otherwise would have attained. The growing age is the period of infancy and youth.

That the age of infancy is the age of growth is well illustrated in the rapid gain in the first month. The colt and calf increase their body weight by 100 per cent within this period; the second month by 40 per cent; the third month by 25 per cent; the fourth month by 18 per cent; the fifth by 14 per cent.
The lamb increases its body weight by 175 per cent the first month; 75 per cent the second; 35 per cent the third; 15 per cent the fourth. The pig increases from say 2½ pounds to 12 pounds the first month, or 380 per cent over birth weight; the second month by 120 per cent; the third month by 85 per cent; the fourth by 65 per cent; the fifth by 55 per cent.

At six months of age, well-managed sheep and swine have attained about one-half the normal weight. At one year of age, the horse and cow are about one-half grown. Sheep usually reach maturity at less than two years of age, while horses and cattle continue to grow and develop until about five years old.

The portion or allowance the animal is fed is called the ration. To supply the nutrients needed by the young animal calls for a ration rich in protein and mineral matter. Thus, a ration including wheat bran and linseed-oil meal gives very good results with all classes of young animals. Since growth consists mainly of increase in bone and muscle with but little added fat, those foods favoring fat formation should be used but sparingly, if good breeding-stock is desired.

Proper shelter necessarily differs with the several classes of farm animals as well as with the climate. Thus, the dairy cow requires warm stabling, which may be a detriment to beef animals. Likewise the long winters of New England necessitate better quarters than are required in the southern states. Whatever the conditions, the shelter should be such as to keep the animal in comfort. Exposure to the hot sun, as well as to cold rains and storms, is especially harmful to all classes of farm animals.
(2) Training and development may now be considered. While the greatest improvement cannot be reached without suitable food and shelter, yet training and developing may be even more important in promoting the efficiency of farm animals as breeding-stock.

No matter how pure the heritage, greatest usefulness cannot be attained without proper artificial training. This is well illustrated in training trotters and developing heifers. From birth the colts are fed regularly to the limit of their appetite, to keep them strong. A small track is provided on which they are exercised as soon as they can handle themselves to advantage. This work is continued until old enough to put in harness, when they are hitched and the daily training continued. This continuous work serves to develop speed, style, and action.

The young heifer that is to be retained for breeding is given proper feed from birth that she may be well grown. She is also so managed as to freshen at an early age, as the giving of milk is a kind of habit and the earlier in life she becomes committed to it the better producer she will make. Once giving milk, she is kept in flow as long as possible to develop a persistent milking quality.

129. Selection

Not all farm animals are endowed with the same capabilities for improvement, even under suitable environment. Here selection comes into play, as all animals that fail to develop to the standard are eliminated. The good ones are retained as parents. Thus does selection operate in two
directions, — to eliminate the unfit, to discover and perpetuate the fit.

The purpose of selection is

(1) to modify offspring to suit our purpose;

(2) to prevent, so far as possible, the production of undesirable individuals; and

(3) to encourage the production of those that meet the demands.

Breeding animals should be considered from two points of view in respect to selection, — (1) their individual merit and (2) their performance. These phases of selection we may now consider separately.

(1) Individual merit means that the particular animal should possess the qualities we desire. Animals selected for breeding should be good representatives of the class, breed, and type to which they belong. This means that to be a successful breeder one must be a good judge of animals. Not only should the animals themselves be carefully inspected, but their parents and offspring, if available, should also be critically studied. Especially is this true of the offspring, as they indicate the breeding capacity and give an idea of what to expect further from the given parents.

The animals should be bred at an early age, so that we may learn their breeding capacity as soon as possible. If they should prove to be undesirable individuals, we are able to discard them early and thus save needless expense. They should be mated with animals of known merit.

(2) By performance we mean what the animal has
accomplished. As a basis for estimating the breeding powers of an animal, nothing compares with an accurate record of just what the animal has yielded as a breeder and producer.

In considering such a record, however, it is necessary to have a knowledge of the conditions under which the record was made. Thus an animal with a moderate record made under adverse conditions may be as valuable as one with a good record made under the most favorable conditions. Unless all the possibilities within the individual have been properly developed, intelligent selection is not possible. Without this care, inferior animals may be chosen for breeding and superior individuals may be discarded.

130. HEREDITY

The tendency of offspring to resemble parents is known as heredity. In common usage we have the expression "like begets like," although no animal is exactly like its parents; it would be a physical impossibility to be like both parents. It may be said briefly that environment controls what the animal has, training what it does, and heredity what it is. Heredity is said to denote the "blood."

Not alone from the parents does the offspring inherit its characteristics, but also from the grandparents and even more remote ancestors. According to Galton's law of ancestral heredity, the two parents contribute between them one-half the heritage, the four grandparents one-fourth, the eight great-grandparents between them one-eighth, and so on.
A character reappearing in the new individual, but not known to the parents, is often spoken of as reversion or atavism, depending on the remoteness of the ancestor contributing it. Thus, if a near ancestor possessed the character, the appearance of the character is spoken of as atavism, whereas if the ancestor was farther back, the case is generally known as reversion.

A good example of atavism is the occasional appearance of a red and white Holstein-Friesian calf from black and white parents; of reversion, the appearance of stripes or bars on the shoulders of the colt, a character possessed by the ancestors of the horse.

The capability of the individual to reproduce itself depends largely on the purity of ancestors. If they have been good for several generations, it is reasonably certain that the offspring will be good; likewise if the ancestors have been poor for several generations, it is reasonably certain that the offspring will be poor.

131. Prepotency

By prepotency we mean strong power in any animal to impress its character on the offspring. Thus we say that the animal family, breed, or type is prepotent if it transmits its special characteristics with much certainty.

This power is of much practical importance to the breeder. He naturally likes to breed from animals or families that have the reputation of implanting their own good qualities on their progeny.
132. Variation

While offspring tend to resemble their parents, yet there is ever-present difference. They vary or differ from other animals of the same kind and from their parents. We have found that no two plants are alike.

We always reckon on variability, — the fact that any new animal will have peculiarities of its own. It is at once the hope and despair of the breeder, who seeks to hold fast to what he has gained and at the same time to strive for advancement. The variations are the starting-points of new features, although they may be for the worse as well as for the better.

The breeder tries not to breed from animals that have undesirable qualities. To make best use of variation the breeder must be skilled in judging and know at once what to retain and what to eliminate.

133. Reasons for Variation

The exact cause of variation is little understood, although experience teaches that certain practices can be relied on to give results. Of the factors How differences arise more or less under our control may be mentioned the environment (as the shelter and food supply), and general management. The management and care given his animals by the stock-grower have results beyond the mere welfare of the individual animal.

Another means of producing variation is by crossing; thus the mule, the product of a cross between the donkey and the mare, is unlike either parent. While there is no way of controlling Crossing to produce differences
the product of such a cross, in some respects we can anticipate characters. The crossing of classes, breeds, and types of animals is considered very objectionable and is not practiced by leading breeders, although good results may follow the crossing of families within a breed.

134. Pedigree

As the capacity of the individual to reproduce itself depends largely on the purity of its ancestors, breeders What is meant by pedigree long ago established books of record in which they make a brief history of the animals. Such a record is called a pedigree, and the animal so recorded is a pedigreed or a pure-bred animal. An animal without known or recorded pedigree is a grade.

Thus the pedigree provides us with a general guarantee of the purity of the animal, and the likelihood that the main qualities and features will be perpetuated.

The book in which this record is kept is called a herd-book in the case of cattle, sheep, and swine, and a stud-book in the case of horses.

The pedigree comprises the name of the animal; the number, for convenience in tracing; date of birth; Sire and dam usually the color and markings; name and number of the father or sire, and mother or dam; name and address of both the breeder and owner.

Since most pedigrees, as recorded, show but one generation, they do not provide us with all the desired information. To get Example of a pedigree this information in brief form, we trace out the complete pedigree of the particular animal from all the records. Following is the most common form of writing a pedigree:
Lord Netherland De Kol, 22187 (Holstein bull)

<table>
<thead>
<tr>
<th>Lord Netherland De Kol, 22187</th>
<th>Netherland De Kol's Perfection, 11713</th>
<th>Pietertje 2d's Konigen, 10625</th>
</tr>
</thead>
<tbody>
<tr>
<td>Born Dec. 12, 1894</td>
<td>Netherland De Kol, 10605</td>
<td>Netherland De Kol, 10605</td>
</tr>
<tr>
<td>Bred and owned by</td>
<td>Susie De Kol</td>
<td>De Kol 2d's Netherland, 11584</td>
</tr>
<tr>
<td>E. S. Brill</td>
<td>33688</td>
<td>Daisy De Kol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20201</td>
</tr>
</tbody>
</table>

This illustrates all of Lord Netherland De Kol's ancestors for two generations. In practice this is extended to seven and even ten generations, thus providing detailed knowledge for guidance.

Breed associations are organizations to keep the herd and studbooks, and to manage the business of those interested in the breed. The membership of these associations consists largely of the persons who take part in the development of a particular breed. These associations are considered the official organs of the breeds and have exerted strong influence in the general improvement of the several breeds of farm animals. Each of the more important breed associations has a paid secretary who looks after its affairs. At present the United States Department of Agriculture recognizes nineteen registry associations for horses, two for jacks and jennets, sixteen for cattle, nineteen for sheep, two for goats, and sixteen for swine.

135. STANDARDS OF PERFORMANCE

While the pedigree gives assurance as to purity of breeding, it is silent regarding the performance. It does not tell us what the animal has accomplished.

For many years records have been kept of the speed of trotting and pacing horses, in Wallace's Year-Book. More recently a system of testing the milk and butter-fat of dairy cows has been inaugurated. The results are recorded in the advanced register.
The advanced register may now be considered. Before animals can be admitted to the advanced registry, they must prove their worth by fulfilling certain requirements in an actual test.

The requirement for the major dairy breeds is the yearly production of 250.5 pounds of butter-fat for the two-year-old heifer. For each day the animal is over two years old at the beginning of her year's test, the amount of butter-fat she must produce in a year is fixed by adding 0.1 (one-tenth) of one pound to the 250.5. This ratio applies until the cow is five years old and the requirement amounts to 360 pounds a year, after which there is no addition. The cow that meets this requirement is eligible to the advanced registry. The bulls are admitted on the performance of their daughters. When a bull has four daughters in the register, he is also admitted.

The contents of advanced-register record include the production of the cow both in butter-fat and milk; the number of advanced-register daughters each cow has; the number of sons that are sires of advanced-registry daughters; the number of daughters that are dams of advanced daughters. This information is arranged in convenient form in the register.

To get this information in comprehensive form, let us consider the pedigree of Lord Netherland De Kol, 22187, including his advanced-register record:

\[
\begin{align*}
\text{Lord Netherland De Kol, } & 22187 \\
& (120-31-99) \\
\text{Netherland De Kol's Perfection, } & 17713 \\
& (14-14-23) \\
\text{Susie De Kol, } & 33688 \\
& 475.5 \text{ milk} \\
& 20.245 \text{ fat} \\
& (5-4-8) \\
\text{Pietertje 2d's Koni-gen, } & 10625 \\
& (1-3-0) \\
\text{Netherland De Kol, } & 10605 \\
\text{De Kol 2d's Nether-land, } & 11584 \\
& (22-21-28) \\
\text{Daisy De Kol, } & 20201
\end{align*}
\]

\[1 \text{ Made up from Vol. 24 of Holstein-Friesian Advanced Register.}\]
This means that Lord Netherland De Kol has 120 daughters with advanced registry records; that 31 of his sons have daughters with such records; and that 99 of his daughters are the dams of daughters with advanced registry records; also that his dam, Susie De Kol, has a record of 475.5 pounds of milk and 20.245 pounds of fat in seven days; and that she has five daughters with such records, that four of her sons are sires of daughters with similar records, and that eight of her daughters are dams of daughters with advanced-registry records; and so on for each ancestor.

Such a record shows exactly what has been accomplished. So far as ability to produce performers is concerned, such a record is vastly more important than either individuality or pedigree. Although breeding is subject to the law of chance, yet such records eliminate many factors and enable us to predict the outcome of a given mating with much more exactness than we have been able to do hitherto. This method is directly responsible for the rapid progress in improving dairy cows in recent years.

It will now be seen, therefore, that the breeding of good animals demands both knowledge and keen judgment. We owe great respect to the successful breeders of animals. The modern farm animal is much to be admired.

REVIEW

How important are animals to man? What do they furnish us? Were the domestic animals always as good as they are now? Explain.

What is environment? Explain it as well as you can.

Discuss the importance of care and management in producing better animals.

When is growth most rapid? How important, then, is liberal feeding when the animal is young?

What can you say as to the importance of the ration? and of shelter in the breeding of better animals?

Discuss training and development with reference to the improvement of animals.
Explain selection.
Contrast individual merit and performance.
At what age should animals be bred? Why? What is heredity?
Explain atavism and reversion.
What is meant by the purity of ancestors?
What is a pure-bred animal? grade?
What is prepotency? How important?
Explain what you mean by variation. What relation has it to breeding?
How is variation produced?
Explain how a pedigree is traced.
What are breed associations? How important?
Tell what you mean by standard performance.
What is an advanced registry?
What is the value of such a record?
How are the facts for registry obtained?

THOUGHT-QUESTIONS AND INQUIRIES

Choose a domesticated plant or animal with which you are familiar, and trace its history as far as possible. Tell in what way it has been improved by selection and breeding.
What are some of the favorable and unfavorable factors or conditions that make up your own environment?
Have you seen an animal stunted because of poor care?
What are some of the differences between the factors or influences that make up the environment of a dairy cow and those of cattle on the open range?
What are some of the important things to be remembered in the training and development of a colt? of a dairy heifer?
What are some of the points you would consider when selecting a sire for a dairy herd?
How do you explain the occasional appearance of a "black" sheep in a flock that has been bred for years from a white-wooled ancestry?
If you had a herd of grade dairy cows of average milking capacity, how would you go about improving the herd? Which would be the cheaper sire for your herd in the long run, a grade bull costing $40.00, or a pure-bred bull costing $250.00 or more? Explain.
Try to find two leaves, twigs, flowers, fruits, or animals exactly alike in every particular.

What are crosses? Give examples. Why is it not good husbandry to cross Jerseys with Shorthorns? White Leghorns with Barred Plymouth Rocks?

Are there any breeders' associations (animal or crop-improvement organizations) in your county? If so, give their names and describe their work.

Of what value is a pedigree in the improvement of live-stock? Make a list of the dairymen and farmers in your community or county who own animals that have been admitted to the advanced registry. Get a copy of the pedigree or advanced registry record of such an animal, if possible, and explain the meaning of the various sets of figures under each animal mentioned in the pedigree.

CLASS PROBLEM

Make a map of the school district or township on the blackboard, showing the farm boundaries. Indicate those farms on which pure-bred or registered live-stock is kept, mentioning the kind and number of such animals. Find out whether there is any special means or agency for selling such stock.
TOPIC 20

THE FEEDING OF ANIMALS

An animal left to itself will keep alive and yield offspring, but it is not likely to give a product of great value. To know how to feed animals properly is to know something of the make-up of their bodies and of the materials necessary to keep those bodies in perfect condition. Other material is needed to enable the animals to perform work and to yield products useful to man. These results are all derived from the food, from water, and from the air.

We are not to allow the animal to roam at will all its life and find its food largely by accident. The highly bred animals of the present day could not have been developed without careful feeding. How to feed an animal for the greatest production is a complicated matter. Even when one knows what feeds to use, it may not be possible to obtain them at a reasonable price, and substitutes must be found. We must give very close attention to this topic. No longer do we allow the animal to shift for itself.

136. THE ANIMAL BODY

The bodies of all animals are made up of water and dry-matter.

We think of the animal body as solid, yet 50 per cent of the live weight is water: the body is half water. A turnip seems to be a solid substance, yet 85 per cent of it is water. If a tuber were to
be completely dried in an oven, most of its weight would vanish. What is left is the dry-matter.

The water in the animal tissue has four uses:

1. It enters into all bone and flesh as part of the structure.
2. It carries food from the digestive tract and other parts to be used by the cells.
3. It carries away the wastes of the body through the urine and perspiration.
4. It serves to equalize the temperature of the body.

The dry-matter of the body is composed of many chemical elements, as carbon, hydrogen, oxygen, nitrogen, sulfur, calcium, phosphorus, and eight or ten others in not so large amount. These elements make up the tissues of the bones, flesh, hide, hair, hoofs, and other parts.

The tissues are composed of many combinations of these elements, or chemical compounds. Since it is impossible to follow these compounds through the body, they are put into four groups:

- The mineral compounds, called ash;
- The compounds containing nitrogen, called protein;
- The compounds like sugar, starch, cellulose, and the like, called carbohydrates;
- The fats.

The mineral matter of the body comprises two to five per cent of the live weight. It is mostly in the bones, but some of it is found in all the tissue. This mineral matter comes from the food, the plants having taken it from the earth.
The protein or nitrogen compounds are present particularly in such tissues as lean meat, skin, hoofs, horns, and hair. Of the body products, wool, feathers, the white of eggs, and the curd of milk are rich in proteins. The protein of the body must come from the protein of the food, the nitrogen having been taken from the soil or the air by roots.

The carbohydrates are composed of carbon and the elements of water (C, H, O). The muscular work depends mainly on the supply of carbohydrates in the food. The plant gets its water through the roots and its carbon from the air. An excess of carbohydrates in the food can be turned by the body into fat and stored for future use.

Fat is a storehouse of material to be used for heat and energy, to do the work of the body if the food supply to the animal should fail. The
fat in the body can be made from the fat in the food, from the carbohydrates, and also from the protein. The fat can be used in the cells and furnish everything necessary for the welfare of the body except that it cannot furnish the protein to build up or repair the tissues needing nitrogen. An animal adds to its fat storehouse only when it has an excess supply of food, and it lives on this fat when the supply of food gives out.

137. Demands of the Animal on Its Food

The body of an animal is constantly changing. Old tissues wear out and new parts must be built. The animal is constantly doing two kinds of work: internal, such as breathing and keeping the blood in circulation; and external, such as walking and perhaps drawing a load. To do this, food is used up to produce energy, which is the power to do work.

For the use of man the animal may be required to yield an extra supply of wool, meat, milk, eggs, or other products. These products are simply storage forms of energy. All these results must come from the food, water, and air. That is, the food produces energy, as does coal when it is burned under a boiler, and as gasoline when burned in an automobile.

These requirements may be summed up in the following table:

1. To support life
   - a. To maintain body temperature
   - b. To repair waste tissues
   - c. To form new tissues
   - d. For the muscular activity of the vital processes

2. To reproduce life

Uses of the material and the energy of food
252

3. To yield a product \( \{ \)
   \( a. \) Stored up as fat for flesh
   \( b. \) Secreted, or used in the form of milk or wool

4. To perform labor

Water and oxygen are food. Every one knows the necessity for water. It costs nothing except to collect it or transport it. An abundance of pure fresh water must always be provided. In winter it should not be ice cold, else it will waste the animal heat.

Oxygen is used more than anything else in both food and respiration. It is in a way more important than water. An animal may go a long time without food, a shorter time without water, but it is a matter of minutes before death if the oxygen supply is cut off. Pure air is the freest of all foods. Before considering any other food, the feeder must see that animals are supplied with an abundance of pure air and fresh water.

138. THE NATURE OF THE FOOD

The food of animals is made up of the same elements as the body. The compounds of these elements are put into the same groups, namely ash, protein, carbohydrates, and fat. The food contains more or less water, which is used the same as the water taken directly as drink.

The ash furnishes the mineral matter of the body.

The protein supplies the materials from which the body proteins are made. Any excess protein of the food may be stored as body-fat or be used to furnish heat-energy.
The carbohydrates furnish material to provide energy to perform the body work. An excess of them is built into fat.

The fat makes body-fat, or may be used up like the carbohydrates. One pound of fat will yield two and one-fourth times as much energy as one pound of carbohydrates or protein, when it is used up or "burned."

139. Classes of Foods

Foods supplied to animals fall into two great groups, the roughages and the concentrates.

Roughage comprises foods like hay, silage, and roots, which contain either a great amount of indigestible matter or a large quantity of water. In either case the animal derives a small amount of useful material from them. They are rough or coarse foods.

The concentrates are dry highly digestible foods, such as wheat bran, corn meal, and linseed-oil meal. From small amounts of such foods, an animal derives much material useful to it. They are mostly prepared materials, sometimes manufactured directly, and sometimes the by-products of other manufacture.

The amount of food fed to an animal in twenty-four hours is known as a ration (p. 236).

140. Digestion

The bodies of animals are really tubes. The lining of the mouth, throat, esophagus, stomach, and intestines is a continuation of the outside skin, so modified that a
part of the food can pass through it into the body structure and nourish it.

**Composition of Feeds in Terms of Digestion**

<table>
<thead>
<tr>
<th></th>
<th>Digestible Protein</th>
<th>Digestible Carbohydrates</th>
<th>Digestible Fat</th>
<th>Total Digestible Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Succulent roughages</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn-silage</td>
<td>1.1</td>
<td>15.0</td>
<td>0.7</td>
<td>17.7</td>
</tr>
<tr>
<td>Mangels</td>
<td>0.8</td>
<td>6.4</td>
<td>0.1</td>
<td>7.4</td>
</tr>
<tr>
<td><strong>Dry roughages</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clover hay</td>
<td>7.6</td>
<td>39.3</td>
<td>1.8</td>
<td>50.9</td>
</tr>
<tr>
<td>Timothy hay</td>
<td>3.0</td>
<td>42.8</td>
<td>1.2</td>
<td>48.5</td>
</tr>
<tr>
<td>Alfalfa hay</td>
<td>10.6</td>
<td>39.0</td>
<td>0.9</td>
<td>51.6</td>
</tr>
<tr>
<td>Mixed hay</td>
<td>4.0</td>
<td>39.7</td>
<td>1.1</td>
<td>46.2</td>
</tr>
<tr>
<td>Corn fodder</td>
<td>3.0</td>
<td>47.3</td>
<td>1.5</td>
<td>53.7</td>
</tr>
<tr>
<td><strong>Concentrates—low in protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn-meal</td>
<td>6.9</td>
<td>69.0</td>
<td>3.5</td>
<td>83.8</td>
</tr>
<tr>
<td>Hominy feed</td>
<td>7.0</td>
<td>61.2</td>
<td>7.3</td>
<td>84.6</td>
</tr>
<tr>
<td>Ground oats</td>
<td>9.7</td>
<td>52.1</td>
<td>3.8</td>
<td>70.4</td>
</tr>
<tr>
<td>Ground barley</td>
<td>9.0</td>
<td>66.8</td>
<td>1.6</td>
<td>79.4</td>
</tr>
<tr>
<td>Dried beet pulp</td>
<td>4.6</td>
<td>65.2</td>
<td>0.8</td>
<td>71.6</td>
</tr>
<tr>
<td><strong>Concentrates—medium in protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat-bran</td>
<td>12.5</td>
<td>41.6</td>
<td>3.0</td>
<td>60.9</td>
</tr>
<tr>
<td>Wheat mixed feed</td>
<td>12.9</td>
<td>51.3</td>
<td>4.0</td>
<td>67.0</td>
</tr>
<tr>
<td>Flour middlings</td>
<td>15.7</td>
<td>52.8</td>
<td>4.3</td>
<td>78.2</td>
</tr>
<tr>
<td><strong>Concentrates—high in protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linseed-oil meal</td>
<td>30.2</td>
<td>32.6</td>
<td>6.7</td>
<td>77.9</td>
</tr>
<tr>
<td>Cottonseed meal (prime)</td>
<td>33.4</td>
<td>24.3</td>
<td>7.9</td>
<td>75.5</td>
</tr>
<tr>
<td>Gluten feed</td>
<td>21.6</td>
<td>51.9</td>
<td>3.2</td>
<td>80.7</td>
</tr>
<tr>
<td>Distillers’ dried grains</td>
<td>22.4</td>
<td>40.4</td>
<td>11.6</td>
<td>88.9</td>
</tr>
<tr>
<td>Malt sprouts</td>
<td>20.3</td>
<td>47.4</td>
<td>1.3</td>
<td>70.6</td>
</tr>
<tr>
<td>Brewers’ dried grains</td>
<td>21.5</td>
<td>30.5</td>
<td>6.1</td>
<td>65.7</td>
</tr>
</tbody>
</table>
The process of digestion is the separation of that part of the food useful to the body from that which is waste. The body absorbs what it can use and the waste passes out. Therefore, the first step in the study of foods is to find out how much is digested or used by the animal. See pages 120–123.

The table on the previous page shows the part (in pounds) commonly utilized from one hundred pounds of each of the foods most used in feeding animals:

141. **The Total Digestible Nutrients**

In the table, the percentage is shown of digestible protein, carbohydrates, and fat in 100 pounds of each feed. It has been stated that the body-protein can be made from nothing but protein foods; and that extra protein can furnish energy, or be made into fat. The carbohydrates can furnish energy or be made into fat. The fat of food can furnish energy or be made into body-fat. One pound of fat furnishes as much energy as \( \frac{2}{3} \) pounds of carbohydrates or protein.

Then all that really needs to be known about any feed, so far as its composition is concerned, is how much protein 100 pounds can furnish, and how much is the protein plus the carbohydrates, plus the fat multiplied by \( \frac{2}{3} \):

\[
\text{Protein} + \text{carbohydrates} + (\text{fat} \times \frac{2}{3}).
\]

This gives us the total digestible nutrients; and the amount for each feed is shown in the last column in the table on page 254.

1 Compiled mainly from "Feeds and Feeding," by Henry and Morrison.
For example, in corn silage: 1.1 lb. digestible protein + 15.0 digestible carbohydrates + (0.7 digestible fat × $2\frac{1}{4}$) = 17.7 lb. total digestible nutrients in 100 pounds of silage.

**Examples**

That is, out of 100 pounds of corn silage, a cow can use only 17.7 pounds of digestible material, and she can get only 1.1 pounds of digestible protein to build up or replace body-protein.

A feed is purchased for the total digestible nutrients it contains. Then that feed is the cheapest in which one can buy 100 pounds of total digestible nutrients for the least price.

For example, both gluten feed at $56 a ton and cottonseed meal at $65 are about equally useful in feeding a cow; which should a farmer choose? From the table, gluten feed gives 80.7 pounds of total digestible nutrients in one hundred pounds; multiplied by 20 equals 1614 lb. in one ton. One hundred pounds of total digestible nutrients in gluten feed would cost $56 ÷ 1614 × 100 = $3.47. One hundred pounds of total digestible nutrients in cottonseed meal at $65 costs $65 ÷ 1510 × 100 = $4.30. This shows at a glance that it would not only be cheaper to buy the gluten feed, but the digestible nutrients also would be cheaper.

A table can be made for all the available feeds with their prices in any given locality.

**142. The Nutritive Ratio**

In comparing one feed with another it is sometimes necessary to see at a glance which feed has the most protein compared with the carbohydrates, and the fat multiplied by $2\frac{1}{4}$. This is shown by a ratio between the protein on the one hand and the carbohydrates and fat on the other hand, with the first term representing the protein stated as 1. This is called the nutritive ratio:

1: (carbohydrates + fat × $2\frac{1}{4}$). That is, the ratio or proportion of protein (1) to the sum of carbohydrates and fat multiplied by $2\frac{1}{4}$ is the nutritive ratio.
For example, the ratio of protein to the carbohydrates and fat in corn-meal is \(6.9 : (69 + (3.5 \times 2\frac{1}{4}))\); or \(6.9 : 76.9 = 1 : 11.1\). This shows that in corn-meal to every part of protein there are more than eleven parts of carbohydrates and fat together.

A good rule for computing the nutritive ratio of a feed or ration is: The first term being 1 and representing the protein, the second term equals the carbohydrates plus the fat multiplied by \(2\frac{1}{4}\) divided by the protein. Computed by this rule, the nutritive ratio of wheat-bran is \(1 : 3.9\). Compared with corn-meal, one would know at a glance from the nutritive ratios that wheat-bran is a much better source of protein.

The nutritive ratio of a full ration is computed in the same way. It is important to know the ratio of rations because each group of animals requires a different nutritive ratio; that is, one kind of animal (as cattle) requires more protein in relation to the carbohydrates and fat than another kind.

A nutritive ratio in which the carbohydrates greatly predominate is said to be "wide," as in proportions larger than \(1 : 8\). When the protein is high (not less than \(1 : 5\frac{1}{2}\)), the ratio is "narrow."

143. Feeding Standards

The amount of ration to give the animal varies with the age, the size, and the purpose for which the animal is fed. The first thing one must know is the amount of food required.

Since the available feeds are unlike in different parts of the country or even differ at the same place at various times, it is necessary to state the amount of necessary food in general terms. This statement is made in terms of digestible nutrients. Such a statement is called a "feeding standard." It is a formula, in terms of digestible protein and total digestible

...
nutrients, representing the amount of necessary food for a given animal in twenty-four hours.

The feeding standards in common use are as follows:

### Feeding Standard for Dairy Cows

<table>
<thead>
<tr>
<th></th>
<th>Digestible Protein Lb.</th>
<th>Total Digestible Nutrients Lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For maintenance of 1,000-pound cow</td>
<td>0.700</td>
<td>7.925</td>
</tr>
<tr>
<td>To allowance for maintenance add</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For each pound of 2.5 per cent milk</td>
<td>0.052</td>
<td>0.256</td>
</tr>
<tr>
<td>For each pound of 3.0 per cent milk</td>
<td>0.057</td>
<td>0.286</td>
</tr>
<tr>
<td>For each pound of 3.5 per cent milk</td>
<td>0.061</td>
<td>0.316</td>
</tr>
<tr>
<td>For each pound of 4.0 per cent milk</td>
<td>0.065</td>
<td>0.346</td>
</tr>
<tr>
<td>For each pound of 4.5 per cent milk</td>
<td>0.069</td>
<td>0.376</td>
</tr>
<tr>
<td>For each pound of 5.0 per cent milk</td>
<td>0.073</td>
<td>0.402</td>
</tr>
<tr>
<td>For each pound of 5.5 per cent milk</td>
<td>0.077</td>
<td>0.428</td>
</tr>
<tr>
<td>For each pound of 6.0 per cent milk</td>
<td>0.081</td>
<td>0.454</td>
</tr>
<tr>
<td>For each pound of 6.5 per cent milk</td>
<td>0.085</td>
<td>0.482</td>
</tr>
<tr>
<td>For each pound of 7.0 per cent milk</td>
<td>0.089</td>
<td>0.505</td>
</tr>
</tbody>
</table>

### Feeding Standards for Other Animals to Each 1,000 Pounds Live Weight for 24 Hours

<table>
<thead>
<tr>
<th></th>
<th>Digestible Protein</th>
<th>Total Digestible Nutrients</th>
<th>Nutritive Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>For fattening 2-year-old steers</td>
<td>2.0–2.3</td>
<td>18.0–20.0</td>
<td>1: 7.0 to 7.8</td>
</tr>
<tr>
<td>For fattening lambs</td>
<td>2.5–2.8</td>
<td>20.0–23.0</td>
<td>1: 6.7 to 7.2</td>
</tr>
<tr>
<td>For fattening pigs</td>
<td>4.4–4.9</td>
<td>28.8–31.9</td>
<td>1: 5.5 to 6.2</td>
</tr>
<tr>
<td>For fattening working horses</td>
<td>1.4–1.7</td>
<td>12.8–15.6</td>
<td>1: 7.8 to 8.3</td>
</tr>
</tbody>
</table>

The feeding standard for dairy cows is a little different from that for other animals because the amount of food
needed to maintain the animal and that necessary for the making of the milk must be computed separately. With other four-footed animals there is no product so separate from the body, and therefore the total amount of food is proportional to the live weight, and the part necessary for maintenance does not need to be calculated separately.

144. EXAMPLE OF A RATION FOR A DAIRY COW

A farmer has a herd of cows in milk. The average cow in the herd, let us suppose, weighs 1200 lb. and yields 13 lb. of milk testing 3.5 per cent butter-fat. What is a good ration for the average cow and how will the ration be changed to suit different individuals?

First, the feeding standard must be worked out from the table. Since this cow weighs 1200 lb. she will require for maintenance 1.2 times the amount in the feeding standards for a 1000-lb. cow. The standard calls for .061 lb. digestible protein and .316 lb. total digestible nutrients for 1 lb. of milk testing 3.5 per cent butter-fat. Therefore, 30 lb. of milk would require 30 times these amounts. Adding the two requirements together, the result is the total amount of food required in 24 hours.

The computation is as follows:

<table>
<thead>
<tr>
<th>Food Requirement</th>
<th>Total Digestible Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestible Protein</td>
<td>9.51</td>
</tr>
<tr>
<td>For maintenance 1200 lb.</td>
<td>.84</td>
</tr>
<tr>
<td>For 20 lb. milk, 3.5 per cent butter-fat</td>
<td>1.83</td>
</tr>
<tr>
<td></td>
<td>2.67</td>
</tr>
<tr>
<td></td>
<td>9.48</td>
</tr>
<tr>
<td></td>
<td>18.99</td>
</tr>
</tbody>
</table>

We may now make out the ration. It will be assumed that the farmer has clover hay and corn-silage and that hominy feed, wheat-bran, and cottonseed meal will yield total digestible nutrients the
cheapest, when the cost of 100 lb. of total digestible nutrients is computed in all the foods available.

The necessary amounts to meet the above requirements would be:

<table>
<thead>
<tr>
<th></th>
<th>Digestible Protein</th>
<th>Total Digestible Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 lb. clover hay</td>
<td>.912</td>
<td>6.108</td>
</tr>
<tr>
<td>35 lb. corn silage</td>
<td>.385</td>
<td>6.195</td>
</tr>
<tr>
<td>3 lb. hominy feed</td>
<td>.210</td>
<td>2.538</td>
</tr>
<tr>
<td>3 lb. wheat bran</td>
<td>.375</td>
<td>1.827</td>
</tr>
<tr>
<td>3 lb. cottonseed meal</td>
<td>1.002</td>
<td>2.265</td>
</tr>
<tr>
<td>Total</td>
<td>2.884</td>
<td>18.933</td>
</tr>
</tbody>
</table>

Nutritive ratio = 1 : (18.933 - 2.884) ÷ 2.884 = 1 : 5.6.

The nutritive ratio may now be found. The second term of the nutritive ratio is found by subtracting the protein from the total digestible nutrients and dividing the result by the protein. This is exactly the same process as in the case of a single feed.

Rations for dairy cows require a nutritive ratio between 1 : 4.5 and 1 : 6. These limits are rather wide. The given feeding standard when worked out for most cows calls for a ration with a nutritive ratio of 1 : 6. More protein in the ration than called for by the standard will do no harm when the protein feeds are relatively the cheapest.

We are now to choose the foods for the ration. The roughages on hand will be fed. A succulent or juicy roughage is necessary for dairy cattle. The ration is completed or balanced by means of the purchased concentrates. A cow will eat about 1 lb. of hay and about 3 lb. of silage to 100 lb. of live weight, when fed a reasonable amount of grain. The remainder of the requirement of the feeding standard must be made up with the concentrates.

About 1 lb. of concentrates will be needed for 3 to 3½ lb. of milk. In choosing the concentrates, price is a large factor, but the foods must always be suitable and sufficient high protein food put in to meet the requirement. When high protein foods are cheap, the upper limit is not to put in so much that the nutritive ratio will be
narrower than 1:4.5. As shown by the above ration, from one-third to one-half of the mixture of concentrates must be high protein food. One bulky concentrate must be used, so that the mixture will not weigh more than one pound to the quart. Three or more concentrates should always be put in the mixture.

145. MANURIAL VALUES OF FEEDS

When feeds are purchased, the manurial value should always be considered. The parts that are undigested carry nitrogen, phosphoric acid, and potash, and appear in the manure. These materials are largely available to plants. The wastes of the body carry the same fertilizing constituents and appear in the manure and urine.

In agriculture of the right kind, a farmer must so handle his land that it is always growing better and richer. Therefore, he should know which feeds contain the most fertilizing constituents. Besides the minerals, barnyard manure adds much humus or vegetable matter to the soil.

The fertilizing constituents in the foods mentioned in this chapter are given in the following table (P₂O₅ is phosphoric acid. K₂O is potash):

<table>
<thead>
<tr>
<th>Fertilizing Constituents in Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In 2000 Pounds</strong></td>
</tr>
<tr>
<td>Succulent roughages</td>
</tr>
<tr>
<td>Corn silage</td>
</tr>
<tr>
<td>Mangels</td>
</tr>
<tr>
<td>Dry roughages</td>
</tr>
<tr>
<td>Clover hay</td>
</tr>
<tr>
<td>Timothy hay</td>
</tr>
<tr>
<td>Alfalfa hay</td>
</tr>
<tr>
<td>Mixed hay</td>
</tr>
<tr>
<td>Corn fodder</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Concentrates — low in protein</td>
</tr>
<tr>
<td>Corn meal</td>
</tr>
<tr>
<td>Hominy feed</td>
</tr>
<tr>
<td>Ground oats</td>
</tr>
<tr>
<td>Ground barley</td>
</tr>
<tr>
<td>Dried beet pulp</td>
</tr>
<tr>
<td>Concentrates — medium in protein</td>
</tr>
<tr>
<td>Wheat bran</td>
</tr>
<tr>
<td>Wheat mixed feed</td>
</tr>
<tr>
<td>Flour middlings</td>
</tr>
<tr>
<td>Concentrates — high in protein</td>
</tr>
<tr>
<td>Linseed-oil meal</td>
</tr>
<tr>
<td>Cottonseed meal, prime</td>
</tr>
<tr>
<td>Gluten feed</td>
</tr>
<tr>
<td>Distillers' dried grains</td>
</tr>
<tr>
<td>Malt sprouts</td>
</tr>
<tr>
<td>Brewers’ dried grains</td>
</tr>
</tbody>
</table>

All the fertilizing ingredients in the food, when eaten, must appear in the manure or urine or in some body product unless stored in the body itself. If stored, the animal would be growing or gaining in weight.

Mature animals, other than those fattening, do not gain in weight, so that all the fertilizing constituents in the food must be returned to the manure and urine unless they go into some product, as wool or eggs. A mature horse must return all. A cow returns all except what goes into the milk.
The following table shows the percentages of the fertilizing constituents in the feed voided by animals:

**Proportion in Foods of Nitrogen, Phosphoric Acid, and Potash, Voided by Animal**

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphoric Acid and Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse at work</td>
<td>100.0</td>
</tr>
<tr>
<td>Fattening ox</td>
<td>96.1</td>
</tr>
<tr>
<td>Fattening sheep</td>
<td>95.7</td>
</tr>
<tr>
<td>Fattening pig</td>
<td>85.3</td>
</tr>
<tr>
<td>Milch cow</td>
<td>75.5</td>
</tr>
<tr>
<td>Calf, fed milk</td>
<td>30.7</td>
</tr>
</tbody>
</table>

Therefore, when purchasing a feed, the net outlay is the cost by the ton less the value of the fertilizer returned when the material is fed. The cost of total digestible nutrients should be computed on the basis of the net cost.

The percentages returned, as given, presuppose complete saving and utilizing of the manure and urine. This is not always possible. It is most nearly accomplished when the manure is taken to the field immediately after it is dropped. All urine should be absorbed and the manure spread on the fields as soon as possible. We must also allow for loss in the handling.

As an example, the value of manure resulting from one ton of gluten feed given to a dairy cow may be computed. This feed has been quoted at $5.6 a ton. At the time this paper is written, nitrogen is worth 27 cents a pound, phosphoric acid 7 cents, and potash 35 cents. It is assumed that the manure and urine are so saved that 50 per cent of the nitrogen and 75 per cent of the phosphoric acid and potash are made available to the soil. Then from the table of constituents there would be returned by a milch cow from 2000 lb. of gluten feed, 40.6 lb. of nitrogen, 9.3 lb. of phos-
phoric acid, and 3.5 lb. of potash. This amount of fertilizer at the prices mentioned above is worth $12.84. Deducting from $56.00, the net cost of 2000 lb. of gluten feed is $43.16.

In choosing feed, the fertilizing value should always be worked out and the cost of digestible material computed from the net cost. This will show the lower net cost of high protein feeds in relation to other feeds and, most of all, it will teach the necessity for saving urine and handling manure promptly.

**REVIEW**

Why is it necessary to give so much attention to the feeding of animals?

How is the animal body composed?
What is ash? protein? carbohydrates? fat?
State the use or offices of each.
Why does the animal make such demands on its food?
What is energy?
What can you say about water and oxygen (air) as food?
What are the elements in food?
Name the classes of food.
What is a ration? State what is meant by total digestible nutrients. What are digestible nutrients?
Explain digestion.
What are the total digestible nutrients in corn-silage? in gluten feed? in ground barley?
Explain the nutritive ratio.
When is a nutritive ratio wide, and when narrow?
State what you understand by a feeding standard.
What is meant by the manurial value of feeds?
Why should the farmer give attention to the manurial value as well as to the feeding value?

**THOUGHT-QUESTIONS AND INQUIRIES**

Make a list of the different kinds of food you eat which may be classified as fats, carbohydrates, nitrogen or protein foods.
Why is it necessary that most animals must have plenty of water? How much pure water should a growing boy or girl drink each day? an adult person?

What wild animals with which you are familiar hibernate or remain in a sleepy or quiescent stage during the winter? How can they go for so long a period without food or water?

Make a list of the different kinds of roughage foods used on the farms in your neighborhood. Which is fed to cows? to horses? What is the value or cost a ton of the roughage foods?

Make a list of the concentrates. Which are produced on the farms? Which are purchased from dealers? What is the prevailing cost a ton of the different kinds of concentrates used in your region?

What has been the prevailing price for the past five years? How does the average cost of concentrated dairy feeds compare with the average yearly price of milk in butter for the same period?

Find out the weight of the favorite cow in your own or in a neighbor’s herd as well as the average daily amount of milk and butter-fat she produces. With this information available, determine the total daily amount of digestible protein and total digestible nutrients needed.

Find out the average daily weight of the different foods fed to the dairy cows in your own or in some neighbor’s herd. Determine the amount of digestible protein and the total digestible nutrients in each feed as well as the total amounts of each fed daily.

From the figures obtained in the preceding problem, determine the nutritive ratio of the ration.

How do the rations fed to your dairy cows compare with the standards as outlined in the test?

Determine the value of the fertilizing constituents in some of the foods given your farm animals in accordance with the tables and prices given in the test.

How is the manure handled on your farm? What improvement in method, if any, could be made to save more of the fertilizing constituents of the barn manures produced by your farm animals?

**CLASS PROBLEM**

Find out the total amount of mill-feed or concentrates used in the school district during the year. Determine, if possible, the wholesale as well as the retail prices on each of these feeds. Calculate the saving that could be effected by several farmers cooperating to purchase the feeds in carload (wholesale) lots.
TOPIC 21

HORSES AND MULES

It is sometimes said that the horse will be displaced by the automobile and motor truck. It is true that horses may be needed less on the road, but as work animals they are not supplanted by the gasoline engine.

Horses are used in five general classes of enterprise:
(1) For farm work.
(2) For work in village and city and in the industries.
(3) For military work.
(4) For driving on the road.
(5) For riding.

In speed, the automobile will be used in place of the horse. For drawing heavy loads on the road, the power truck is rapidly coming into use. But on the farm there remain a thousand kinds of work for which no machine would be practicable. The tractor does not take the place of the horse; it performs certain labor more rapidly and effectively than horses, and because of the extra crop makes more work for horses in tilling, harvesting, and hauling. We cannot conceive of an agriculture without the labor of draft animals, unless men themselves assume the burden, tilling very small areas.

Moreover, there is a certain pride in owning a good horse. The farm lad will never forsake his horse. He
X. The Modern Mule Team. — Bringing in a load of hay
learns his habits; he has pride in a good harness, and a light attractive buggy. He appreciates a good draft team, that is well trained to do his bidding. He cannot get the same satisfactions from a machine.

There are over one hundred million horses and more than twenty million mules and donkeys in the world. Of this number about one-fifth of the horses and one-fourth of the mules and donkeys are in the United States. Horses are distributed generally throughout the whole United States. The five leading states in point of numbers are, Iowa, Illinois, Texas, Kansas, and Missouri. The leading horse-producing section is the West North Central States. Not enough horses are raised in the New England, Middle Atlantic, and East North Central States to supply the demand.

146. THE TYPES AND CLASSES OF HORSES

The kinds of horses are many,—large and small, slender and heavy, fast and slow, white and brown, and black. There is no one kind or class of farm horses. The farmer may choose the breed that seems best to suit his purpose. Most farm horses represent no particular breed. They are grades.

The horse is native to the eastern hemisphere.
The wild horses of the far West have come from stock brought by the early explorers. The horse belongs to the genus Equus, being known as *E. caballus*. Equ-us is the Latin word for horse, and several English words are derived from it. Thus, a statue of a person on horseback is called an equestrian statue.

The various breeds of horses may be classified as follows, according to type:

2. Heavy Harness: Hackney, French Coach, German Coach, Cleveland Bay.
5. Ponies.

We may now learn the characteristics of these different types of horses. In doing so we must use the words known to horsemen; there are no other words that so well describe the animals. If the descriptions are not understood, there will be some person in the district who
can explain them to the school, perhaps bringing a horse so that the different parts can be pointed out. The height of a horse is measured in hands (a hand is 4 in.).

The draft horses are known by compactness and massiveness, power rather than speed being desired. They should be sufficiently heavy to enable them to throw the necessary weight into the collar to move a heavy load and at the same time retain their footing. The drafter in good condition should not weigh less than one thousand six hundred pounds.

The heavy harness horse, in any breed, should be closely coupled, symmetrical, and have a high degree of style and finish. His action should be flashy and characterized by high hock- and knee-action.

The light harness horse is long, rangy, lithe, narrow-bodied, and deep. The stride should be long, straight, regular, and rapid. This light kind of horse is used for road driving and for racing under harness. The action may be either a pace or a trot.

The saddle horse, of any breed, should be closely coupled, short in the back, strong in the loin, and be capable of carrying considerable weight. The shoulder should be long and sloping and extend well into the back. The stride should be collected and springy, to insure easy riding.

The market classes of horses are as follows: draft horses, chunks, wagon horses, carriage horses, road horses, and saddle horses. The factors which determine how well horses sell on the market are soundness, conformation, quality, condition, action, age, color, education, and general appearance. Horses
sell best at five to eight years of age. Of whatever class, the horse should be well trained for his work.

147. DESCRIPTIONS OF SOME OF THE BREEDS

The Arabian is the oldest known breed of horses. The Arabs range in height from fourteen to fifteen hands, and weight from 850 to 1000 pounds. In color they are bay, brown, or chestnut, and sometimes gray or black.

The Thoroughbred had its origin in England, and is a descendant of the Arabian. It is a running horse ranging in weight from 900 to 1050 pounds. The usual colors are bay, brown, and chestnut.

The American Saddler was developed in the United States, principally in Kentucky and Tennessee. In height, this breed of saddler is fifteen and one-fourth to fifteen and three-fourths hands, and weighs 950 to 1050 pounds. The colors are black, bay, brown, and chestnut.
The Standardbred originated in the United States. It has been developed for the purpose of business and pleasure, driving and racing. The gait may be either a trot or a pace. The animals stand fifteen and one-fourth to sixteen hands high, and weigh 900 to 1150 pounds. They may be of any color from bay to black.

The Hackney came from England. The breed is noted for its aristocratic bearing, and high trappy knee- and hock-action. The principal use is for park driving. Hackneys range in height from fifteen and one-half to sixteen hands, and weigh 1000 to 1200 pounds. In color they are chestnut, bay, or brown with white markings.

The Percheron exceeds in popularity and in number any other draft horse in the United States. This breed originated in France. The color of the breed is gray or black. The Percheron stands fifteen and one-half to seventeen hands in height, and weighs 1800 to 2300 pounds. The use is principally for heavy hauling.

The Clydesdale originated in Scotland. The prevailing colors are bay, brown, black, or chestnut, with white markings on the face and below the knees and hocks. There is considerable hair on the legs. In height Clydesdales are sixteen to sixteen and one-half hands, and weigh 1800 to 2300 pounds.
The Belgian came from Belgium. The prevailing colors are chestnut, roan, bay, and brown. The animals are in height from sixteen to seventeen hands, and weigh from 1600 to 2300 pounds.

The Shire originated in England. The common colors are bay, black, and brown with white markings on face and legs below knees and hocks. There is considerable hair on the legs. In height the breed is sixteen to seventeen hands, and in weight from 1800 to 2300 pounds.

148. BREEDING OF FARM HORSES

To be most profitable, farm mares should be both good workers and good breeders. If pure-bred stallions are available, pure-bred mares of the same breed will give better returns than grades. The mares should be as uniform in type and action as possible. They should be feminine in appearance and possessed of style, good disposition, and quality. They should be sound, or at least not of faulty conformation.

The stallion should possess the same qualities as the mare except that he should be bold and masculine in his make-up.

Only very well-grown draft mares should be bred at two years of age; others should be allowed to go until at least three years of age before being bred. The period of gestation in mares is 345 days.
The natural time for the mare to foal is in the spring. However, autumn foals may be raised, providing the necessary care and attention can be given. Some mares will breed until twenty-five years of age. However, if they continue to breed until fifteen years old, they may be considered as doing well.

149. Feeding the Work Horse

The draft horse should be fed and watered regularly. The amount of food required will depend on the size of the horse and the severity of the work. Good feeding and good care produce marked results in horses.

The horse is ordinarily given about two and one-half pounds of food daily for every one hundred pounds of weight. From one-third to two-thirds of this amount, depending on the character of the labor, should be grain; and the remaining portion should be good clean hay. The more severe the labor, the larger the proportion of grain to be fed; the lighter the labor, the larger the proportion of hay.

Oats are the best single grain for the horse. However, corn and oats mixed half and half by weight make a very satisfactory grain ration, and the mixture is usually much cheaper than oats alone. Timothy hay is the best roughage for the horse, all things considered. Both clover and alfalfa give satisfactory results, but should be fed in limited amounts.

The work horse should be watered at least five times a day: before and after the morning meal, before and after the midday meal, and before the evening meal. Small quantities of salt should be kept before the horse at all times.
Whenever horses are to remain idle, even if for only a day or two, the grain ration should be reduced.

It is sometimes advisable to turn idle horses into a well-protected lot, and rough them through the winter on hay, straw, or corn-fodder. If straw or corn-fodder is used as roughage, a small quantity of grain must be fed in addition. In case horses are wintered in this way, grain feeding should begin some six weeks before spring work opens, in order to put the animal in condition.

150. Care and Diseases

No animal responds more quickly than the horse to good care. He trains easily. His habits can be controlled by the painstaking horseman. The stable should be light and clean. The horse should be groomed morning and night. The farm boy will learn not to overdrive his horse, or to leave a steaming horse in the draft. He will look out for the animal's comfort, protect him from fright and from injury, see that the harness fits, keep him away from animals that have distemper or glanders. If the owner really likes his horse, the animal is less likely to acquire disease.

The farm youth will also learn how to detect unsoundness, as heaves; and blemishes, such as wind-puffs, side-bones, swollen joints, and the like.

Navel or joint disease affects newly born foals. Seventy-five per cent of the cases occur before the colts are three weeks old. The disease is due to the entrance of pus-forming germs through the stump of the raw navel cord. To prevent the disease, the foal should be born in a clean stall with bright clean bedding.
Immediately after birth, saturate the stump of the navel cord with a solution of powdered corrosive sublimate, two drams in one pint of boiling water to which has been added, after cooling, two drams of tincture of iron. Repeat the application twice a day until the cord shrivels up, drops off, and no raw spots remain. This disinfectant solution is a poison and should be handled accordingly.

Colic may result from whatever suspends or arrests digestion. There are two general causes: a diseased condition of the digestive system, and whatever may render food difficult of digestion. Colic may be due to an excess of gas in the digestive tract, to an excess of partially digested food and fecal matter, and to interferences with the nerve centers of the digestive tract. Colic is always accompanied by pain, which may be very slight or very intense.

The treatment for colic is to give rectal injections of three or four gallons of water at body temperature. A cupful of raw linseed oil, glycerine, or a little hard soap may be added. Give a pint of raw linseed oil to which has been added four tablespoonfuls of turpentine and three tablespoonfuls of laudanum. Chloral hydrate may be used in place of the turpentine and laudanum. A level tablespoonful should be given in a quart of water. If there is no improvement, a second dose of chloral hydrate may be given in about forty minutes, but only one-half tablespoonful.

151. The Mule

The mule is a hybrid or cross between a male donkey (jack) and a female horse (mare). Mules do not breed between themselves.
Mules are valuable work animals, adapted to hard conditions which the horse will not endure. They are patient, strong and tough, hardy, surefooted, little liable to disease. The mule is largely used in the South for driving as well as for heavy continuous work.

Of late years the mule has been much improved by the choice of better parents, particularly by larger jacks. Special breeds of jacks are now used. Large heavy mules are common, having excellent conformation and commanding a high price in the market. They often stand 15 to 16½ hands high and weigh 1100 to 1600 pounds.

REVIEW

Will the automobile displace the horse? Explain.
For what purposes are horses used?
Name the types of horses.
What are the market classes?
Where are the leading horse-producing parts of the United States?
How do horses range in weight? in height?
How can you tell a Thoroughbred? A Clydesdale? A Standardbred?
What can you say about the breeding of horses for farm use?
What are the considerations in the feeding and watering of the horse?
How may idle horses be wintered?
State the need of good care and attention.
What is navel disease? treatment?
Give symptoms and treatment of colic.
What is a mule?

THOUGHT-QUESTIONS AND INQUIRIES

Has the number of horses decreased in your community because of the automobile and motor truck?
What is the average number of horses to the farm in your district?
What are the breeds? How many breeds do you know?
Describe the prevailing method of feeding horses by the farmers of your acquaintance.
Is there a horse market in your vicinity?
If you wanted to buy a horse, where would you go?
What can you say about the blemishes on a horse? How many blemishes do you know?
What is a pacer? trotter?
Are there many mules in your region? Tell how the mule differs from the horse in appearance, build, and hoofs.

CLASS PROBLEMS

With a score-card the class should judge two or three kinds of horses. A horseman or farmer in the district probably will be glad to drive a horse to school and give instruction. Use a measuring-stick, that you may be accurate in the work.

Instrument for Measuring Horses;
four feet long, 18 inches wide (Harper).
Two well-marked types of cattle are known on the farms,—the dairy or milk-producing type, and the beef type. While all cattle are good for beef and the females yield milk, yet some of the breeds are specially adapted to one purpose and some to the other purpose.

It is not to be understood that all cattle are specially developed as milk-producers or beef-producers. Many of them answer both purposes very well, although not excelling in either; these are known as dual-purpose cattle. The Milking Shorthorn is an example.

Many farm animals are of no particular breed, being merely what is called "native stock." They are really not native to North America in the sense of having originated here or being indigenous; but they are come from the common stock of the country, probably the descendants of many early
IX. CATTLE- FEEDING. — A large “self-feeder,” with pigs following the cattle
importations from Europe. The cattle of the country, however, are rapidly taking on the characteristics of breeds, and most herds now are either pure-breds or good grades of the breeds. In this respect they show more progress than the common horse stock on farms.

152. WHERE CATTLE COME FROM

The breeds of cattle are of European origin. Unless the French Canadian can be called a breed, none has originated in North America. In this respect **No American breed** cattle differ from horses, for the Standard-bred, or Trotter, is an American breed. Breeds of cattle have come to be known within the past two hundred years. They have been the result of careful breeding and selection, to meet the needs of the people who developed them.

The beef breeds are of English and Scotch origin, and are probably developed from cattle imported into England at the time of the Norman Conquest. **Native country of breeds** The English are a beef-eating people. The dairy breeds are of Dutch, Channel Islands, and Scotch origin.

The domestic cattle of Europe and North America are supposed to have developed from two or three species now extinct as native wild animals. These ancestors existed on the continent of Europe. **Origin of tame cattle** One of them was the urus, which Cæsar mentions as being abundant in the mountains of what we now know as central Europe. **The domestic cattle are collectively known to zoologists as *Bos taurus*. These are Latin words, bos meaning an ox, bull, or cow, and taurus a bull; they have given us English words, as in bovine and taurine.
The sacred cattle or zebus of India are of a different species, *Bos indicus*. They have been introduced into the West Indies and the southern United States in the hope that they would better withstand the climate and diseases. They have been crossed with common cattle, and one sometimes sees evidences of their influence. They have a hump over the shoulders, a long dewlap, and long drooping ears; they are grayish or tawny in color.

In some countries the true buffalo is reared as a work animal, and also for milk and beef. This is a very different animal from the American bison, which is improperly
called a buffalo. One of the offshoots of the wild cattle of North America was the Texas Longhorn, now practically extinct.

153. Dairy Cattle

A modern dairy cow is a wonderful animal in the product she yields. A good animal of one of the dairy breeds will give from fifteen to more than twenty times her own weight of milk in a year. This is more than her own weight every month. She will yield her own weight in butter-fat within the year. The old-fashioned "scrub" cow no longer has a place in profitable farming. We are to approach the study of the dairy cow with the conviction that she is one of the major factors in modern life, now that great cities must be daily supplied with fresh milk and many milk products. We shall study this question again in Topic 27, when we come to the separate consideration of milk and its products (page 354).

In the United States there are about twenty-two million dairy cows. The five leading dairy states in order of numbers of dairy cows are New York, Wisconsin, Iowa, Minnesota, and Illinois. These five states contain about one-third of all the dairy cows of the United States. According to estimates made by the United States Department of Agriculture in 1917, dairy cattle in the United States had a valuation of over $1,358,400,000.

The census of Canada gives the number of milch cows in 1911 as more than two and one-half million; and all other "horned cattle" were nearly four million. The value of the milch cows was $109,575,000.
The dairy cow is in greatest numbers in those regions in which the population is comparatively dense and land, labor, and feed relatively high priced. It is the most economical of all domestic animals in the production of human food.

The dairy cow has a characteristic form of body. When in full flow of milk she is usually spare, angular, and wedge-shaped, with large capacity of body and udder. The wedge shape is apparent when the animal is seen sidewise, the hind-quarters being broad and deep, with the body narrowing toward the fore-quarters. If seen from above or in front, the wedge shape is also apparent, due to the width of the hind-quarters. She is “bony” rather than fat and round. The milk-veins beneath the body are very large.

154. THE DAIRY BREEDS

The principal dairy breeds are the Jersey, Guernsey, Holstein, and Ayrshire. The Brown Swiss, Dutch Belted, and Milking Shorthorn may be classed as minor dairy breeds.

The Jersey is more widely distributed in the United States than any other breed. This breed had its origin in the Island of Jersey, one of the Channel Islands. The Jersey is a small animal, weighing 800 to 1000 pounds when mature. The color is usually some shade of solid fawn with a black nose, a black tongue, and a black switch or tail. The breed in general produces a smaller quantity
of milk than the other dairy breeds, but the milk is rich in fat, testing on the average about 5.3 per cent butter-fat.

The Guernsey originated on the Island of Guernsey, also one of the Channel Islands. The animal is slightly larger than the Guernsey Jersey, averaging about 1050 pounds. In color it is some shade of fawn and white. The muzzle and tongue should be flesh-colored and the switch white. Guernsey milk is very highly colored and of medium quantity. Guernseys produce more milk than the Jerseys, but the test is slightly lower, being about 4.9 per cent butter-fat.

The Holstein came from Holland. This is the largest of the dairy breeds, a mature cow weighing on the average about 1250 pounds. The color is black and white. With the exception of the Jersey, there are more Holsteins in the United States than any other breed. The Holstein produces a larger quantity of milk than any of the other dairy breeds. The milk is low in color, and the average percentage is about 3.5 butter-fat, although individual animals may test higher in this respect.

The Ayrshire had its origin in Scotland. The color of the breed is some shade of red or brown, and white.
The most characteristic features of the breed are the long, curving, erect horns and square symmetrical udder. The average weight of a cow is about 1050 pounds. The animals have a tendency to smoothness in all parts. The Ayrshire produces a fair quantity of milk, low in color, and testing about 3.8 per cent fat.

155. Management of the Dairy Herd

In the management of the dairy herd, four points are to be kept clearly in view:

(1) Clean, well-lighted stables.
(2) Careful attention to feed.
(3) Thorough grooming of the animals so that they may be clean at all times.
(4) Testing for performance so that the unprofitable animals may be removed.

With the coming of the highly developed dairy cow, a new type of stable has been devised. It is so constructed as to be kept clean, easily ventilated, and free of dust. The floor is cement. Hose-water is at hand. A trough behind the animals provides
drainage. The manure is removed frequently. Only clean bedding is used. The stanchions provide free movement of the animal without allowing her to turn around or to interfere with her neighbor. The cow is always tied, there being several devices for hitching about the neck. For large herds special stables are erected, but the small herd, of a few cows, may be accommodated in a well-built or reconstructed stable in the ordinary barn.

A record of production should be kept of each individual cow in order that the undesirable cows, both from standpoint of yield of milk and as breeders, may be eliminated. When the animal is tested for yield and quality of milk, it may be found that she does not pay for her keep and care. She is called a "boarder." Such cows are to be fattened and sold for beef. Cow-testing associations are now organized (p. 140) for the making of these tests for the neighborhood, a man being employed for the purpose.

Heifers should not have their first calves before they are twenty-four to thirty months old. Jerseys may be bred somewhat earlier than Holsteins. Only a few of the calves are reared to maturity,— as many as the farmer needs to keep his herd full. He retains those that seem to promise well. Very few of the males are wanted. The remainder are sold for veal. It would not pay to try to rear them, for they would require too much milk and other food and demand attention that should be given to the making of the dairy products. If all the calves were reared for beef, we should have a famine in milk and an overplus of meat.
The calf is usually allowed milk from its dam for two or three days. It should always get the first milk of the mother. In two or three days the calf is usually taught to drink milk from a pail. Small quantities of whole milk are fed at first, gradually increasing the amount. When two to four weeks of age a portion of the whole milk is gradually replaced by skim milk, taking about ten days to make the change. Calves should be taught to eat concentrates and good clean roughage, such as clover or alfalfa, as soon as they will do so readily.

Dairy cows produce milk most economically while on pasture. Unless a cow is a high producer it is usually not economy to feed any grain while on pasture.

When not on pasture, summer conditions should be approached as nearly as possible. Cows should be fed an abundance of palatable food, a ration which is carrying sufficient nutriment and which is succulent. Moderate temperatures should be maintained and the cows kept in comfort.

The following general statements may be made on the amount of grain and roughage to feed:

1. Feed all the roughage the cows will eat up clean, at all times.

2. Feed one pound of grain for each three or four pounds of milk produced.

3. Feed all the cows will eat without gaining in weight.

The second rule applies only when roughage, such as alfalfa and clover hay or corn-silage, is fed.

The ideal ration for the dairy cow should be balanced, palatable, laxative, sufficiently bulky, in variety in both
the roughage and concentrate. It should be adapted to the season in which it is fed and be as low in cost as is consistent, without losing sight of the other qualities. The ration

156. **Two Diseases of Cattle**

The two most serious diseases affecting dairy cattle are tuberculosis and contagious abortion. Each of these diseases causes enormous losses. It has been estimated that contagious abortion alone causes an annual loss of upwards of $20,000,000 in the United States.

Tuberculosis is caused by a germ, establishing itself in the lungs and elsewhere. The losses from tuberculosis are due to death, decreased production, and shortened period of usefulness.

The physical appearance of a cow may indicate the presence of tuberculosis, or the tuberculin test may be applied. The tuberculin is injected underneath the skin, a typical rise in temperature thereafter indicating the presence of the disease. This test is to be made only by persons skilled in the operation.

There is no direct cure for tuberculosis. Prevention by means of sanitary measures is most satisfactory. Animals known to be tubercular should be slaughtered and the premises thoroughly cleaned and disinfected. If the herd is to be rid of tuberculosis, all animals should be tested every six months until no reactors are found, after which time the test may be made yearly.

It is possible, although not usually practicable, to develop a healthy herd from a tubercular herd by the "Bang system." This system is the isolation of the
infected animals from the remainder of the herd. All calves born of tuberculous parents are immediately removed and so handled as not to become infected. It is seldom that a calf is infected with tuberculosis at birth.

Contagious abortion results in the death of the undeveloped young. In addition to the loss of the calf, the dam may become sterile. Drugs and remedies have been used for the disease, but it may be safely said that there is no real cure for abortion.

To some extent the disease may be prevented and controlled by a proper system of management and sanitation. The breeding operation of the herd should be under strict control. Great care should be exercised to see that abortion is not brought into the herd by the purchase of infected animals. Calves should be born in clean thoroughly disinfected quarters. All possible precautions should be taken to prevent the spread of the disease.

157. **Beef Cattle**

All cattle eventually make beef, if not condemned for tuberculosis or other disease. The growing of cattle specially for beef, however, is a practice of the mid-continent and the far West. A great part of the beef is produced on the large pasture areas known as ranges, although it may be fattened where grain is grown. The raising of beef animals in inclosed farms of ordinary size is also an important industry, particularly in the corn-belt. The great beef production of Iowa and adjacent states is not a range enterprise.
Estimates for 1917 by the United States Department of Agriculture gave the number of cattle other than milch cattle on farms as about 40,800,000. Statistics of beef cattle gave the number of cattle other than milch cattle on farms as about 40,800,000. These cattle were estimated to have a total value of over $1,465,700,000. The four leading states in point of number of beef cattle are Texas, Nebraska, Iowa, and New Mexico. These four states have about 36 per cent of the total of the United States. More than two-thirds of the beef cattle of the United States are west of the Mississippi River.

The beef industry is rather highly specialized and may in general be divided into three phases:

(1) The care and management of the calf from birth to time of weaning;

(2) The growth of the steer from weaning to an age and maturity sufficient for fattening;

(3) The fattening of the steer.

Some parts of the country raise calves, others grow steers, and still others fatten them. Arizona, New Mexico, and western Texas raise calves which are sold at about one year of age. They are sold to cattlemen on the eastern slope of the Rocky Mountains, particularly in eastern Colorado, Wyoming, and Montana, and North and South Dakota. The cattle are kept in this region for periods of one to two years. If in this time they become fat, they are sent directly to markets on the Missouri River or to Chicago. Should they not become fat, they are sold into the corn-belt as "feeders." Here they are fed three to six months and then marketed.

In Idaho, Washington, Oregon, and California many calves are born, grown, and finished on the same farm.
Beef cattle are divided into three general classes, Butchering, Feeding, and Breeding, depending on the purpose for which they are to be used. To meet the requirements of the butcher a beef animal should be low-set, blocky, rectangular in form, compact of body and broad and smooth in the back and loin. He should have quality and be in good condition of flesh.

158. The Beef Breeds

The principal beef breeds are Shorthorn, Polled Durham, Hereford, Aberdeen Angus, and Galloway.

The Shorthorn had its origin in the northeastern part of England. Animals were first imported into this country about 1783. With respect to color this breed may be red, white, roan, or red-and-white spotted. The horns are small. Bulls of the breed weigh about 2300 and cows about 1800 pounds. The development of the hind-quarters is the strong feature of the breed.

The Hereford is from southwestern England. Animals were first imported to the United States about 1817. The color is red with white face and underline, and white stripe on top of neck extending to top of the shoulder. They have a long curving characteristic horn. Bulls weigh about 2300 and cows 1800 pounds. The Hereford is a hardy breed, and has a particularly smooth well-developed shoulder.
The Aberdeen Angus originated in Scotland. The breed is black and hornless. The animal is smooth-haired and round in body and hind-quarters. Males weigh about 2050 and females about 1550 pounds.

The Galloway is also of Scotch origin. It is black and hornless. The hair is longer and generally coarser than that of the Aberdeen Angus, and in conformation the animal is more square. Males weigh about 1875 pounds and females 1450 pounds.

159. MANAGEMENT OF THE BEEF HERD

In the West, beef cattle are run on ranges in the higher areas in summer. As fall approaches they are moved to lower areas and in some cases graze all winter. Growing the beef

Very little care is given them except that salt is provided occasionally. In the fall the cattle are rounded up and those ready to be sold are separated and sent to market. The cattle fat enough for beef usually weigh between 1000 and 3000 pounds. Those marketed for winter feeders are from 900 to 1100 pounds in weight. Very little hay is fed in winter: about one ton a head is the ordinary allowance.

Calves should ordinarily come as early in the spring as the cows can take care of them. Spring calves should be weaned the following fall. It is well to leave calves with their dams as long as the grass is good. If good pasture is not available, the
calves are corralled and fed all the hay they desire during the winter. Clover and alfalfa hay are the best.

When fall calves are raised, they need not be weaned before ten months of age; they may be weaned on pasture instead of on hay.

Winter feeds for the breeding herd usually consist of pastures, stubble-fields, straw, and hay. One ton of hay to the cow in the winter as a supplement to old grass or straw is the ordinary allowance. Very little corn is grown in the far West, therefore steers are fattened mostly on alfalfa or other hay.

In the corn-belt, fattening is accomplished for the most part on corn and hay. The amount of corn fed daily varies from fifteen to twenty pounds. On alfalfa and clover hay, steers make rapid gains and at low cost. Larger and more economical gains are usually secured if linseed meal, cottonseed meal, or gluten feed is fed supplementary to corn, rather than feeding corn as the sole concentrate.

The "feeders" are not accustomed to eating grain, and therefore should be brought to full feed gradually. From the beginning they may receive all the hay they desire. Two-year-old steers are the kind usually fed. The length of the feeding period ranges from four to six months. Daily gains of one and one-half pounds in winter and two pounds to two and one-half in summer are often obtained. The cheapest gains are made in summer. Under this system of fattening, hogs usually run with the steers and clean up the droppings, thus utilizing all the corn. With whole corn, one to three hogs may follow each steer, while one hog will clean up after two or three steers fed on ground corn.
REVIEW

Name the types of cattle.
What is the “native stock” of the country?
Where did our cattle come from? What is the scientific name?
What is a zebu?
Discuss the nature of the dairy cow.
Where are dairy cattle most numerous?
Describe the general form and appearance of a dairy cow.
What are the dairy breeds? Describe them. Where did they originate?
Give the points in a good dairy barn.
What can you say about the performance of the dairy cow?
Discuss the care of the calf. Why are so many calves sold for veal?
State how dairy cows should be pastured and fed.
What is the nature of tuberculosis? Contagious abortion?
Where are beef cattle grown? Why?
What are the classes of beef cattle?
Name and describe the beef breeds.
How is the beef herd managed?
What can you say about feeding for beef?
Why are pigs such an important product where beef cattle are fattened with grain, but not so on the great ranges?

THOUGHT-QUESTIONS AND INQUIRIES

What is the prevailing type of cattle in your region?
How many breeds do you know?
Can you estimate accurately the weight of an animal?
How are beef animals marketed in your part of the country?
How are the dairy products marketed?
Look up the last census reports on the cattle of your state and county. How do the figures of value compare with the value of other animals and with crops?
Are there cow-testing associations within your knowledge? How carefully do farmers test their cows?
Do the farmers of your acquaintance feed a balanced ration?
What are the principal cattle feeds in your region?
Do your farmers have scales so that they can weigh feed, milk, and also the animals to determine gain in weight?
Can you suggest improvements in the feeding practices? Are there any specially constructed cattle or dairy barns or stables within your knowledge? Describe the one you like best.

CLASS PROBLEMS

If in a dairy section, let the pupils start a movement for a cow-testing association, if one does not already exist.

The pupils should test the cows on their own farms.

If in a beef region, the pupil should feed an animal, beginning as a calf, keeping record of the feed and the gain in weight.

The school may well make a census of the cattle of the district, keeping count of the kinds and ages.

The class may visit any good herds.

Either on a near-by farm or at school, exercises should be held in judging and scoring. In some cases an animal may be led to the school grounds. Score-cards for all the classes of animals may be obtained from the breed associations, and may be found in bulletins and books. Apply to the county agent.
XI. Pig-Feeding. — Forage-racks in the open
TOPIC 23

SWINE

Probably in no animal has the result of domestication been so marked as in the hog. Its origin is considered to have been from the wild hog or boar of Europe and Asia, which is still hunted. The wild boar is a swift and ferocious animal, attacking men and dogs.

The domestic hog is docile; in some of its forms it has lost the powers of locomotion that would enable it to survive in a state of nature. It has developed a remarkable power to lay on flesh, becoming so fat in some cases that its legs will barely support the body and the eyes are nearly buried. It has become a condensed round-barrelled animal, very unlike its rangy fierce ancestor. With these fat hogs one may contrast the razor-backs of the Southern States, which are run-wild forms of early introductions from Europe.

The hog is known to zoologists as *Sus scrofa*. The genus Sus is named from the Latin word of the same form, meaning hog or pig. The word *scrofa* in Latin means a sow. The word swine is a plural or collective noun. One never uses it for a single animal. The word hog is generally used to denote these animals; and pig is used for the young. The male is a boar; the female a sow. A hog a few months old is called a shote.
In farming, the hog is specially valuable because it consumes wastes. It eats a great variety of food greedily, and utilizes it in growth and to lay on fat.

Because the hog is a scavenger and will subsist in the most filthy quarters, it is supposed that these conditions are necessary to its welfare. Yet the hog yields as readily to good care, sanitary quarters, well-chosen food, and cleanliness as do other animals. In fact, the modern swine-husbandry demands careful attention to breeding, management, housing, and feeding. The hog wallows in mud to keep cool, because he does not perspire as do the other farm animals; but by nature he is not a filthy beast.

160. Importance of Swine

The United States has more hogs than any other three nations of the world. About 37 per cent of all the swine in the world are grown in the United States. Iowa, Illinois, Missouri, and Indiana raise a little over one-third of all of the hogs produced in the United States. In general, the area of swine-production follows rather closely the region of corn-production. In value, swine constitute a little more than 8 per cent of the total value of all domestic animals in the United States.

In Canada the number of swine reported in 1911 was more than 3½ millions, with a value of nearly 27 millions of dollars.

The hog is especially valuable in transforming into meat the by-products of the farm. In cattle feed-lots, he consumes corn that the cattle have failed to digest. In dairy districts he utilizes the skim
milk, buttermilk, and whey. He also makes use of table waste and garbage. Outside of the corn-belt, the number of hogs raised to the farm is largely determined by the amount and character of waste products and by-products to be utilized.

Unlike other domestic animals, the hog is grown only for its flesh. Its hide is made into leather, however, but this is a secondary and incidental product.

161. The Kinds of Hogs

With respect to type, hogs may be divided into two distinct classes: the lard type and the bacon type.

The lard type is an American product, adapted particularly to the highest use of the fattening qualities of Indian corn. It is essentially a corn-belt hog. This hog has a thick, deep, compact, smooth body which is symmetrically developed. The hams, back, and shoulders carry the most valuable cuts and, therefore, from the market standpoint, these parts should be strongly developed. High dressing percentage and superior quality in the meat are the two factors that largely determine merit and selling prices.

The bacon type, as compared with the lard type, is longer in the leg and body, less compact, has less thickness and depth of body, and is lighter in the shoul-der, neck, and jowl. The bacon hog should be long from the shoulder to the ham, and possess sufficient depth and thickness of body to indicate good constitution.
Following is a classification of the principal breeds of swine:

- Lard
  - Berkshire
  - Poland-China
  - Duroc-Jersey
  - Chester White
  - Hampshire
  - Cheshire
  - Mulefoot

- Victoria
- Suffolk
- Essex
- Small Yorkshire

- Bacon
- Large Yorkshire
- Tamworth

162. BREEDS OF SWINE

The Berkshire is the oldest of the improved breeds of swine. It had its origin in Berkshire County, England. It was first imported into the United States about 1823. The color is black with white on face, feet, and tip of tail. The face is medium in length and slightly dished. The ears are carried erect. In good breeding condition, mature boars will weigh about 500 pounds and sows 400 pounds. The breed reaches maturity early; the typical animal is a good grazer, prolific, and produces pork of high quality.

The Poland-China had its origin in Butler and Warren Counties, Ohio, in the first half of the last century. The color is black, with white face, feet, and tip of tail. The face is straight and the ears droop over in the top one-third. The body is smoothly and heavily fleshe
typifying the extreme lard type. The Poland-China is early maturing, but is sometimes criticized for carrying too high proportion of fat to lean. Mature males in breeding condition should weigh 500 pounds and females 400 pounds.

The Duroc-Jersey originated in New Jersey and New York. This breed is red in color, the most popular shade being cherry. The Duroc-Jersey face is slightly dished, the snout of medium length, and the ears break over at the top one-third. At maturity a boar should weigh about 600 pounds and a sow 500 pounds. The breed is very prolific, and the sows are in general good milkers and mothers. They are also good grazers. Both the Poland-China and the Duroc-Jersey are the results of the admixture of different types of hogs.

The Chester White originated in Chester County, Pennsylvania, in the early part of the nineteenth century. The color of the breed is white, the face straight or slightly dished, and the ears droop over about one-third the distance from the base. The Chester White reaches maturity early and the flesh is of good quality. Mature boars weigh about 600 pounds and mature sows about 450 pounds. Sows of this breed are strong milkers and good mothers, and also strong breeders.

The Tamworth comes from England. The color is red of varying shades. This breed yields bacon of exceptionally
high quality, the flesh being fine grained and the fat and

Tamworth high quality, the flesh being fine grained and the fat and

lean well mixed. A mature boar should weigh 650 pounds and a sow 600 pounds.

The Large Yorkshire originated in England. The color is white, the face is of medium length and but slightly dished, the ears are erect. Mature boars weigh about 700 and mature sows about 600 pounds. The sows are prolific and good mothers.

163. BREEDING

A pure-bred boar should head the herd. He should be possessed of strong health and vigor, being a good representative of the breed to which he belongs, and having a bold carriage.

The most desirable and profitable type of sow is one capable of being a good mother and that produces large litters of strong vigorous pigs regularly. She should have the conformation and quality of the particular breed.

A young sow should not be bred before eight months of age. The sow carries her young 112 to 115 days. With proper care, feeding, and management the sow may be bred to produce two litters a year without injury. Good mothers should be retained as breeders for five or six years, if possible.

Both sows and boars must be strong and well developed. Ordinary pasturage will not give them the proper development and constitution. They must be fed liberally, as explained further on.
164. Housing

There are two general classes of hog-houses: individual houses or cots, and large houses with separate pens.

The best type to construct depends on the conditions and also the personal desires of the breeder. Hogs are affected by extremes of heat and cold, and the character of their shelter will therefore be influenced by the locality. Light, ventilation, warmth, cleanliness, dryness, and convenience are the most important considerations in the construction of hog-houses.

Cement is used for floors and sometimes for partitions between pens. The construction should allow the free use of the hose or of buckets of water.

Improved wallows should be provided for hot weather. These are made of cement so built that they can be drained or flushed and thereby kept clean.

All hogs should be protected from draughts, as they take cold easily. This is specially true of little pigs. The pens should be so constructed as to receive direct sunlight at some part of the day, so that the beds may be dry, clean-smelling, and warm.

165. Feeding and Management

The brood sow should have food containing sufficient nourishment for the proper growth and development of her litters as well as of herself. She should also be allowed plenty of exercise. If the sows have the run of first-class pasture, such as alfalfa, clover, or rape, much grain will not have to be fed. Brood sows which are to raise two litters a year must be fed more
heavily than those that are bred but once. Corn does not furnish enough bone- and muscle-building material, and therefore should not be fed in large amounts to pregnant sows.

Great care should be taken to see that the brood sow receives sufficient food to maintain a maximum milk supply for her litter. When the young pigs are two or three weeks old they should be given such feeds as skim milk and buttermilk, or tankage may be used mixed with middlings, shorts, or ground oats with the hulls removed. These feeds are a supplement to the mother’s milk.

Spring pigs after weaning, in addition to alfalfa, clover, or rape pasture should be fed about two pounds of concentrates to one hundred pounds of live weight. In winter such pigs should be fed liberally of the finer parts of alfalfa or clover hay supplemented by a reasonable supply of rich concentrates such as corn, barley, skim milk, tankage.

The boar should be given free exercise to maintain him in a healthy condition, and sufficient food to keep him thrifty.

In the last few weeks before slaughter, the pig should be given all the food it will consume. A good ration for this period is ten parts corn to one part tankage. Pastures are very valuable at this time, as they tone up the system and lower the cost of production.

166. Marketing

The tendency for the last few years has been toward a lighter hog carrying less fat. The most desirable weight seems to be about 200 to 250 pounds, although the market demand is at times for heavier hogs.
These weights should be attained at six to twelve months of age, although the hog does not reach maturity until sixteen or more months old. This means rapid growth, resulting from good parentage, excellent care, and proper feeding. The animal must be fat, which indicates that fattening and growth must proceed at the same time. They are fatted in yards or pens in winter, or in summer they are given freedom of good pasture but with supplementary feed.

167. Diseases

Hog cholera is the most serious disease affecting swine. In the year ending March 31, 1917, there were lost in the United States from hog cholera, 2,259,322 hogs, about 4.5 per cent of the total number in the United States. It therefore affects very seriously the profits from swine-production, and every practicable means should be employed to lessen its ravages.

It is a highly contagious disease, caused by a specific germ. It spreads rapidly through a herd and no time should be lost in distinguishing it. Persons, hog cholera birds, horses, and dogs frequently carry the hog cholera germ from an infected area to healthy hogs. Hogs brought in from outside should not be placed with the remainder of the herd until they are known to be free of the disease.

Hogs should not be permitted access to streams which may receive sewage from other hog yards. All hogs that die on the farm should be disposed of by burning, or by burying with quick lime. Hog-houses, lots, and pastures should be located away from streams and public roads. Houses should be exposed to the sunlight and be
so constructed as to be readily cleaned and disinfected. Hog-cholera produces inflammation of the organs. Temperature is high. The skin is blotched. The animal staggers. Sometimes it bleeds at the nose.

The disease may be prevented by treatment with anti-hog-cholera serum. In one method the serum is injected alone; in another method, the serum and a cholera virus are injected at the same time. The first method gives immunity to hog cholera for a period of three to four weeks; by the second method immunity is for life.

Hogs should always be kept free from parasites. There are dips for this purpose. If the wallows are properly constructed and cared for, there will be less infection of this kind.

**REVIEW**

What has been the effect of domestication on the hog? What is its origin?
Discuss the names of these animals.
Why is the hog so important in farming?
Is the hog a dirty animal, as the word is usually understood?
What is the extent and the geography of swine-husbandry in North America?
For what purpose are swine raised?
Describe the Berkshire, Poland-China, Chester White, Tamworth.
State some of the essentials in breeding the hog.
Give your idea of housing conditions for swine.
Why do hogs wallow? Are artificial wallows ever made?
What do you say about the feeding of hogs? pasturing?
Name the marketing demands. How are hogs fattened?
Discuss hog cholera.
What do you say about parasites?
THOUGHT-QUESTIONS AND INQUIRIES

Look up the census for the swine population of your state and county. Are there more recent estimates of the numbers?
What are the breeds? For what kind of market products are they mostly grown?
From what part of the animal is bacon derived? ham? pork chops? lard?
For what purpose is pigskin leather used?
Describe the general method of handling swine in your region. Do they “follow” the cattle? What is the system of feeding and pasturage?
Are there any modern sanitary hog-houses in your vicinity? walls?
Is any attention given to a balanced ration? Or are the hogs merely fed what happens to be on hand or to be left?
How long do your farmers keep their hogs before turning them off to market?
What are the marketing facilities and conditions in your region? Are the animals sold by live weight?
How are live hogs taken from field to field or one place to another? Are they driven, led, or transported?

CLASS PROBLEMS

On a near-by farm a judging contest should be arranged using the score-card.
The class may make a hog census of the school district.
A pig club may be organized. Each pupil or member raises a pig of known parentage, keeping track of feeds, costs, and gains in weight.
TOPIC 24

SHEEP AND GOATS

Once sheep were reared on small farms and housed in barns, much as are other domestic animals; but with the opening of the Great West, sheep-raising took on a new phase, being developed in immense flocks on wild unfenced ranges. The range method is also characteristic of New Zealand, Australia, and other parts of the world.

The sheep is essentially an animal of cheap, half-wild, or rough lands. This is not because the animals do not thrive on the richer better-tilled lands, but because they can be utilized on the other class, leaving the more productive areas to other uses. In the better farming regions sheep are usually only an adjunct to other farming, although they may be very profitable. However, the best sheep are reared only under good feeding and care; and even in the sheep-ranching, the breeding-stock is given very careful consideration.

Sheep are of the genus Ovis; the species is O. aries. The origin of the domestic sheep is in doubt. It probably developed from one or two wild species inhabiting the Eurasian continent. The male sheep is called a buck and the female a ewe. Young sheep are lambs.
168. Geography of Sheep-Husbandry

Of the total sheep of the world, the United States produces about one-twelfth. Russia, Australia, and Argentina each raise about one-eighth of the world's supply. The five leading sheep-growing states are Wyoming, Montana, Ohio, New Mexico, and Idaho. Wyoming and Montana together raise about one-fifth of the total number in the United States.

The Canadian sheep population in 1911 was something over two million head, with a valuation of $10,700,000.

Sheep by nature are adapted to grazing over wide areas and on a variety of herbage. They do better on short fine grasses, but will consume coarse forage to advantage. They will eat considerable brush, and assist in ridding land of weeds. Sheep are specially adapted to grazing on land of comparatively low value, cut-over timber land, waste hillsides, and broken pasture. They also utilize rough feeds, making them over into the marketable products, wool and mutton.

169. Classes of Sheep

Sheep may be classified as wool producers or mutton producers. They may also be grouped on the length of the wool staple. The fine-wooled sheep (which might also be called short-wooled) have wool as short as 2 1/2 inches, and the long-wooled as long as 16 inches.

As to quality of fleece, the common breeds may be classed as follows:
The fine-wool breeds are maintained primarily for the production of wool, with mutton as a secondary consideration. The mutton breeds, on the other hand, are grown with the production of flesh as the primary aim and wool as a secondary object. The mutton breeds include classes two and three.

Like the dairy cow, the fine-wooled breeds are angular in conformation. This type of sheep is less compact and is not as thickly fleshed in the back, loin, and leg of mutton as the mutton sheep. The wool is fine, dense, carries considerable oil, and is closely crimped.

The mutton type is comparable in form to that of the beef animal. It is more blocky, smoother, more thickly fleshed over the back, loin, and leg, and in general is more compact than the fine-wool type. The wool is not as dense nor as fine as that of the others.

The weight of fleece varies greatly. In its natural condition, as it comes from the animal, a fleece will weigh 10 to 20 pounds, sometimes much more, often much less.
170. SOME OF THE BREEDS OF SHEEP

The American Merino was developed from the Spanish Merino. It is a small breed, producing a superior quality of fine, strong wool. Rams weigh 140 to 175 pounds and ewes 90 to 125 pounds. The skin is considerably folded or wrinkled. The fleece covers the entire body except the nose and hoofs. The fleece usually shows a length of two and one-half inches for a year's growth. The rams are horned; the ewes are hornless.

The Rambouillet is the largest of the fine-wool breeds. While most attention has been given to fleece, considerably more size is attained in this breed than in the American Merino. The fleece of the Rambouillet varies considerably in length (about 3 in.) and fineness, but is usually quite dense. The rams have horns; the ewes are hornless. The Rambouillet is a Merino type, originated in France. Rams weigh about 225 to 250 pounds and ewes 150 to 170 pounds.

The Shropshire had its origin in England. The mature ram weighs about 225 pounds and the ewe 155 pounds. The head is wide and short, and the face varies in color from brown to almost black. The legs,
where not wooled, are the same color. In form this breed is very smooth and compact of body. In weight, length, and fineness of wool, the breed ranks high. The breed is well wooled up over the poll and down below the eyes. It has no horns.

The Hampshire also originated in England. This breed is the largest of the middle-wool class. Rams weigh about 250 pounds and ewes 190 pounds. The face and legs are black and the head large with a tendency toward a roman nose. The breed is commonly wooled only over the crown. It is hornless.

The Dorset has face and legs white. Both males and females have horns. Rams weigh about 225 pounds and ewes about 165 pounds. The fleece is more open and coarser than that of the Shropshire. The strong feature of this breed is its early breeding habit combined with good milking qualities. This breed is particularly adapted to the production of winter or "hothouse" lambs. It is an English breed.

The Lincoln is the most compactly built of the long-wool breeds. Rams weigh about 350 pounds and ewes about 275 pounds. The face and legs are white. The wool is of great length (8 in. for one year's growth) and has a characteristic curl at the end. The breed is hornless. It is of English origin.

Tunis sheep are from North Africa. They are employed to some extent in this country for the rearing of winter lambs, as the animals mate
in warm weather. They are a broad-tailed sheep; fleece soft and fine, with a staple about 3 inches long; usually hornless; face and legs brownish or yellowish; ears lopping; weight 120 to 150 pounds.

171. BREEDING

The breeding of sheep presents no special difficulties. The lambs are single, although twins and sometimes triplets occur. A ewe should not be bred when less than one year old. It is best to have the lambs born in early spring.

The period of gestation in ewes is 145 to 150 days. It is desirable that only pure-bred rams be used. Whether the ram should be allowed to run with the breeding flock depends on circumstances.

The most general method followed by farmers is to mate the ewes in September and October, the lambs being born in February and March. These lambs will be ready for market about July first if grain is fed.

Another method is that followed in the production of lambs for spring market. Under this system mating takes place in July and August, the lambs being born in December and January. Breeds such as the Dorset and Tunis, which mate in warm weather, should be used for this purpose.

A third system is that followed in the production of winter or "hothouse" lambs. Mating occurs in April, May, June, and July and lambs are dropped from September to the middle of December. The breeds best suited to the production of "hothouse" lambs are the Dorset, Tunis, and Rambouillet. Ewes of these breeds may be mated with rams
of the medium-wool class. The so-called hothouse lamb is reared and fed in warm quarters in winter, being ready for market as a choice product in the late winter or early spring.

172. FEED AND MANAGEMENT

The ram should be given plenty of exercise and fed in such a way as to keep him in good condition, but not fat. A heavier grain ration is required during the breeding season than at other times. Clover and alfalfa hay are the best roughages for a ram. It is desirable that succulence be supplied, when not on pasture, as roots or silage.

Blue-grass pasture is one of the best for sheep. Forage crops may be used, but more labor, care, and expense are involved. In the summer and autumn no grain need be fed in addition to pasture, except to lambs. While in pasture sheep should be provided with shade, water, and salt.

Winter feeding should be such as to produce strong vigorous lambs and at the same time keep the wool in good condition. Alfalfa or clover hay, straw, or cornstalks are the usual roughages. Clover or alfalfa hay may be the sole ration fed until lambing time approaches. If the roughage consists largely of straw or cornstalks, a nitrogenous concentrate should be fed in addition. It is also desirable to add some succulence to the ration in the form of roots or silage.

Each of the following rations contains approximately the amount of nutrients required for 125-pound to 150-pound ewes:
1 lb. alfalfa or cowpea hay
2 lb. corn silage
½ lb. shelled corn

1 lb. oat straw
2 lb. corn silage
¼ lb. oil meal
½ lb. corn

Profit or loss in sheep husbandry is in a large measure dependent on the size of the lamb crop; therefore the shepherd should be on hand at lambing time to give any assistance necessary either to the lamb or ewe. The ewes should be so fed as to furnish a plentiful supply of milk. Lambs may be safely weaned at twelve to sixteen weeks of age.

Lambs should be docked (tail cut off) when ten to fourteen days of age. This operation adds to the appearance of the lamb, keeps the animal cleaner, and raises the selling price. It should be performed on a bright cool day.

Ordinarily lambs should be ready for market when three to five months of age. Such lambs make the most rapid gain from a given amount of feed and at a less cost to the pound of grain. There is likewise less loss from disease and accident when marketed early. Lambs should be marketed in the spring because higher prices are ordinarily obtained at that time.

Care should be taken not to house sheep too closely. They are very hardy animals if the fleece is kept dry in cold weather, and if the yard is well drained so that the feet are also dry or at least not in mire.

Shearing usually takes place after lambing, in late spring or early summer. It should be undertaken on a
warm day, that the sheep may not take cold. Shearing may be performed by hand or by means of power machines.

The winter feeding of range-bred western sheep is a large industry in parts of the middle and eastern country. In this way the farmer finds use for his roughage and makes employment for winter.

The sheep are marketed, usually in a body, in spring. The farmer has good use for the manure.

173. Parasites and Diseases

Sheep should be dipped to free them from lice, ticks, and other parasites of the skin. This operation may be most easily and thoroughly performed shortly after shearing. Any standard dip solution may be used and every sheep should be treated. A second treatment about twenty-four days after the first is advisable.

Stomach worms often affect lambs, which become pale, thin, and weak. They may die, or continue to live for a long time in poor condition and not make proper growth. There is no satisfactory treatment for this disease. The most feasible method of combating it is by prevention. Rotation of pasture is the practicable means of control. If pastures are so arranged as to permit the flock to be alternated every ten days on two or more fields, the infection with the worm can be partially controlled. The dry-lot method consists in feeding lambs in sheds and yards until they are weaned, when they are put on clean, fresh pasture; this is a means of control.

Sheep are specially subject to internal parasites. They
should be kept on uninfected pastures, with care to see that the water does not come from the direction of infected flocks.

174. Goats

To most Americans the goat is a hardy and vagrant animal of alleys and vacant lots, living on what it can find; yet in many countries it is much prized as a heavy producer of excellent milk. It will thrive under conditions in which cows cannot be kept, particularly in rough and mountainous countries. In some countries goats are reared largely for the pelts, for the making of leather.

The goat is one of the oldest of the domesticated animals, being well known in Bible times. To zoologists the common goat is Capra hircus, but its origin is undetermined. It is supposed to have descended from the wild goat of Persia. The Angora goat, somewhat raised in this country for its fleece as well as for meat, is Capra angorensis. Its origin is also in doubt; not unlikely it has developed from the same wild stock as the common milch goat. The Angora goat derives its name from the vilayet or province of Angora, in Asia Minor.

The milch goat is of several breeds. Among the Spanish-speaking people of Texas and the Southwest the
goat is well known in breeds or types apparently peculiar to the region. The Swiss breeds are perhaps best known.

The animal is very prolific, the young coming commonly in pairs or in threes, and it breeds often. Good care in clean quarters, with sweet hay supplemented by kitchen vegetables and oats, produce excellent results in milk. A few goats will supply a family with milk the year round. There are certain points in their management that should be understood before the raising of them is seriously undertaken. Persons in suburbs and with small holdings are likely to find the goat to be very useful. The hide is valuable as the source of morocco and kid leather.

REVIEW

What part do sheep play in agriculture?
What is the genus? origin?
Name the leading sheep states and regions.
On what kinds of land do they graze?
What are the classes of sheep?
Compare the wool and mutton types.
What is the length of staple?
Name and describe the leading breeds.
What can you say about the breeding of sheep? When are lambs dropped?
Discuss the feeding and pasturage.
What is the docking of lambs?
When are the animals sheared? How? How much do fleeces weigh?
What is meant by “hothouse” lambs?
How are sheep housed?
Why are they often fed far from the place where they are bred?
Name important diseases or parasites.
What do you know about goats?
XII. Sheep-Feeding. — Shropshires fed from racks
THOUGHT-QUESTIONS AND INQUIRIES

To what extent are sheep grown in your state and county?
What conditions determine whether more or less sheep shall be kept?
Are dogs a serious menace? What laws does your state make for the control of dogs, and the payment to the sheep owner for losses by them?
Name the breeds or types of sheep in your region.
What is the market for your sheep?
What is the cost of rearing sheep as compared with that of raising hogs?
Are there any sheep barns or sheds in your part of the county?
Describe.
Describe the meat products and "cuts" of the sheep carcass.
What is tallow?

CLASS PROBLEMS

On a near-by farm, or with a small flock driven to the school grounds, make a judging contest, using the score-card.
Make a census of the sheep in the district, determining the numbers and the breeds, and how many are lambs.
Sheep clubs are sometimes organized. The purpose may be to learn the ways of handling and feeding a few sheep, with costs; or to feed for a time for market (mutton club); or to produce a certain clip of wool (wool club).
TOPIC 25

POULTRY

The largest part of the poultry and poultry products is produced in small or moderate-sized flocks on farms. This condition will probably exist indefinitely, as the proportion of special poultry establishments increases only very gradually.

For this reason, most of the study of poultry should be directed to the improvement of the farm flock. As a country becomes more thickly settled the poultry industry assumes a more prominent relation to other animal production. This is the condition in the United States, where the industry is certain to become more important.

The number of all poultry or fowls on farms in the United States in 1910 was 295,880,190, of which 280,345,133 were chickens, 3,688,708 turkeys, 2,906,525 ducks, 4,431,980 geese, 1,765,031 guinea fowls, 2,730,994 pigeons, 6458 peafowls, 5361 ostriches. More than 5½ million farms had poultry. The total number of farms was 6½ millions; so that poultry was kept and reported on about five-sixths of all the farms in the United States.

The total value of the fowls was $154,663,220, which exceeds the value of the products of the anthracite coal mines, and much exceeds the output of the iron mines. The value of eggs produced in 1909 was $306,689,000, or about twice the value of the
fowls themselves; it exceeded in value the combined output of copper, gold, and other precious metals, and building-stone quarries. Aside from all this is the value of fowls and eggs produced on home lots in villages and cities, which is very large in the aggregate.

The "number of poultry," in Canada in 1911 was 31,793,261, of a total value of $14,653,773. Of the total number 29,773,457 were hens and chickens, the remainder being reported as turkeys, geese, ducks. The number of poultry to 100 acres of improved land in 1911 was 65 1/4, and the average number to the farm was 44. The "average value per bird" was 46 cents.

The raising of poultry in establishments not connected with a farm is a special business. Only in the hands of a skillful poultryman, and with an unusually good market, does such a business pay in competition with the cheaper product from farms. A superior grade of fowl and eggs is possible
by such specialization, and the numbers of fowls may be sufficient to insure a continuous supply so that a particular market may be controlled. The eggs may also be graded into sizes, shapes, and colors for the market, when there is a large number from which to choose; for eggs are not uniform, as the accompanying illustration shows.

175. The Egg and the Fowl

An egg is an inert thing, apparently as lifeless as a stone. A hen sits on it for a time, but there is no external change; then there is a slight sound inside as of escape, the shell is broken, and a living thing comes forth, furry and fluffy, and takes its place in the world. It runs and eats and sleeps; feathers take the place of fur; it is soon able to fly; it lays eggs like the one from which it came; and the wonderful round of life is complete.

If we were to look inside the fertile egg in the process of incubation or hatching, we should find a dense part or germ developing in the yolk, with fibers running out from it through the yolk as stays or guys. Blood-arteries develop after a few days, as part of the hatching process. From the germ the chick develops. The yolk and also the white are food for the growing chick, much as the starch and other stored materials in the seed are food for the young plant.

Before these changes take place, the contents of the egg are prized as human food. If the egg is unfertilized, no male having been in the flock, it will never hatch. In such an egg incubation changes do not take place in warm weather (as they do in fertile eggs even when not under a hen) and the egg does not so soon develop
blood-rings or "spoil." Male birds should be allowed in flocks only when it is desired to produce eggs for hatching. Removal of the males makes no difference in the number or quality of eggs that the hens produce.

Poor eggs are discovered by the process of "candling," which is looking through them to a light. Usually a lamp is placed inside a box, in the side of which at the level of the flame is a hole large enough to hold the egg. If the room is dark, one gets a clearer view of the egg as one looks through it toward the light. A good egg looks perfectly clear, with no rings, or spots, or lines, and the contents are not shrivelled away from the shell.

176. Origins

The common fowl or hen belongs to the genus Gallus, comprising species of birds from far eastern Asia. The hen, *G. domesticus*, is unknown in a truly wild state. Probably it is derived from one or more of the jungle-fowl of India and Malaya, which are most nearly represented in the domestic fowl by the fighting-cock. The domestication of these wild fowls apparently began in remote antiquity. We do not find the hen mentioned in the Bible, however, until the time of Solomon.

The pheasants belong to the same family as the domestic fowl, and are known as gallinaceous birds, although they are not of the genus Gallus.
The guinea-fowl, an African bird, has been reared by man for centuries, yet it is not really domesticated or tamed. It likes to roam far and wide, and to make its nest and rear its young in seclusion. The guinea-fowl is prized for the flesh, and the eggs are sometimes used for cooking. It is a gallinaceous bird, *Numida meleagris*, the second word referring to the speckled character.

The turkey is native to North America, and in many parts of the country the species is still wild. The common turkey is *Meleagris americana*, but it is supposed that the white-marked Mexican turkey (*M. mexicana*) has contributed something to the domesticated races.

Geese are of several species, but the common domestic goose is derived from the European *Anser cinereus* (*cinereus* = ash-colored). The American wild goose (*Branta canadensis*) is sometimes bred under captivity but does not become really domesticated; if left to itself it usually flies away sooner or later.
It is supposed that the common domestic duck is a form of the mallard, *Anas boschas*, which is well known in a wild state and is prized by sportsmen.

177. **Place on the Farm**

Poultry occupies a unique place on the farm. More often than not it is cared for by the grandmother, the wife or the children, and sometimes it is only tolerated by the men. Many farm flocks are allowed to shift for themselves in the warmer months, and are given indifferent quarters and care in winter. Often they must prove themselves profitable before being accorded proper attention, instead of receiving good care so that they may have a chance to become profitable.

Poultry fits well into the farm activities. A hundred or more fowls can be as easily cared for, as a daily chore, as the usual number of horses, cows, sheep, or pigs. The investment on the poultry is much lower, and the returns are usually greater in proportion than from the other live-stock. This is possible partly because fowls pick up waste grain and refuse which has no salable value.

178. **Farm Breeds**

Judging from appearance, any breed of poultry is suitable for the farm. This is not the case, however. There are three general types of fowls: meat, egg, and general-purpose types.
The meat type of bird is large, heavily feathered, clumsy, and slow. It eats ravenously, but is too lazy to forage to advantage; it is an indifferent layer, with a strong tendency to broodiness. The Asiatic breeds (Bramas, Cochins, and Langshans) are the best examples of this type.

The egg type is the opposite of the meat type in general features. It is small, wiry, active, nervous, and close-feathered, too timid to forage far for food, but a high flyer and difficult to keep within fixed bounds. As the name indicates this type is a good layer, especially in spring and summer, and in winter under the most favorable conditions. It makes an unreliable setter and mother. The type is best represented by the Mediterranean class, as Leghorns, Minorcas, Anconas.

The general-purpose type is so named because it combines the best qualities of both the meat and egg breeds. It is medium-sized, fairly active, gentle, heavily feathered, and small-combed. It is neither timid nor lazy, and consequently is a good forager. It rivals and often excels the egg type in production, especially in winter and fall when eggs are highest in price, and is a good setter and
mother. The type is best represented by the American class, the Plymouth Rock, Rhode Island Red, Wyandotte.

Of the three types, the general-purpose is unquestionably the best suited to usual farm conditions. The mixed fowls often found on farms are generally of this type, but lack breeding. Pure-bred stock can be obtained so easily and cheaply, and is so much more productive, all conditions being the same, that it is very poor economy on the farm to be without it.

Specialists in poultry-raising will choose other breeds. The white Leghorn is now very popular as an egg-laying breed.

There are other types of fowls grown by fanciers for exhibition and for their ornamental qualities or as curiosities. Of such are the bantams or dwarfs, Crevecoeurs (black fowls), and the interesting Polish breeds or sub-breeds.

179. HOW TO START

There are three ways of starting a poultry flock:
1. with eggs for hatching;
2. with day-old chicks;
3. with mature stock.
Each method has its advantages. Eggs for hatching or day-old chicks (1 or 2) provide the cheapest way, but they must be hatched by a hen or incubator, and reared perhaps in a brooder. This method means starting in early spring. Purchased eggs may not hatch as well as expected nor do they always produce the type of bird that is wanted.

A brooder is a structure or little building to protect the chicks and keep them warm, taking the place of the mother. Sometimes a little "run" or exercising yard is attached to it.

With mature stock the start can be made at any time of year. Also they show their breed and breeding, and whether they are rugged and strong. From this flock of known merit, eggs are obtained to continue the stock.

180. FEEDING THE FLOCK

The important practices in feeding are regularity, a balanced ration, and proper quantity of food. A fowl appreciates having meals on time as well as does the hired man. A marked variation in the amount or kind of food, and especially in the time of feeding, disarranges the normal production.

A balanced ration is one that contains the proper proportions of different food constituents to produce normal development. These constituents are contained in varying amounts in the different foods. Consequently the food must be combined in correct proportions.
The constituents are protein, which is contained principally in meat and the germ of grain; carbohydrates, in corn and all grains; and ash, found in bone, oyster-shell, grain, and green food.

It is possible to obtain an effective balanced ration with corn or similar grain, meat, cabbage, oyster-shell, and water. Usually, however, it is better to feed a mixture of grains, chiefly corn and wheat, morning and night, and at noon a mash containing ground grain and meat. The Cornell ration and method of feeding, now much used, is as follows:

**Cornell Ration for Laying Hens**

<table>
<thead>
<tr>
<th>Scratch Grain (Formula 200)</th>
<th>Mash Mixture (Formula 201)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 lbs. cracked corn</td>
<td>100 lbs. wheat bran</td>
</tr>
<tr>
<td>200 lbs. barley</td>
<td>100 lbs. wheat middlings</td>
</tr>
<tr>
<td>200 lbs. wheat</td>
<td>100 lbs. corn meal</td>
</tr>
<tr>
<td>100 lbs. heavy oats</td>
<td>100 lbs. ground oats or ground barley</td>
</tr>
<tr>
<td>Fed by hand morning and after-noon in deep straw litter</td>
<td>100 lbs. meat scrap</td>
</tr>
<tr>
<td></td>
<td>3 lbs. salt</td>
</tr>
<tr>
<td></td>
<td>Fed dry in hoppers</td>
</tr>
</tbody>
</table>

Feed according to the appetite of the birds; no definite rule can be given. Feed scantily of grain in the morning and give all the grain they will eat in the afternoon in time to find it before dark. There should be no grain in the litter at noon; when found, it indicates feeding too much in the morning. In general, feed by weight 2–3 parts of grain to 2 parts of mash. When the birds are laying heavily they should consume a larger amount of mash.

A very simple although effective farm ration consists of corn and wheat fed in a deep bed of straw morning and night; and at noon meat in the form of slaughter-house refuse, fresh meat of horse, cow, sheep, pig or game, or green cut bone. Skim-milk...
is also a substitute for meat. Fresh water and oyster-shell should always be present, and cabbage, beets, sprouted oats, or the like fed daily.

Over-feeding is as harmful as under-feeding. A small quantity of grain should be fed in the morning to keep the fowls hungry and active, and a larger quantity at night to satisfy their hunger and meet their needs.

A working formula is 6 to 8 quarts of heavy grain to 100 hens daily, and nearly as much mash. If no mash is fed, more grain must be given accordingly.

Hens require more food when laying heavily than when inactive. They often act hungry when sufficiently fed. The best indication of appetite is the degree of activity. If the fowls scratch deep holes in the litter and are active between feedings, they are making good use of their food, and could probably use more.

181. Housing

The housing is very simple. Three essential conditions cover the problem: plenty of light, warmth in winter, dryness. The size, type, design, and mode of construction are of more value in the eyes of the farmer than in those of the hen.

Light can be obtained with plenty of glass windows, preferably in the south and east sides of the building.

Warmth is assured by tight construction, low roofs preferably packed with straw, and hens in the proportion of one for every $3\frac{1}{4}$ to 4 square feet of floor space.
Dryness is insured by building on high well-drained ground, by having the floor, — whether earth, board, or cement, — well above the outside level, and by proper ventilation.

The ventilation may be provided through a coarse cloth curtain or by any of the usual mechanical devices; but a simple and very satisfactory method is to ventilate by opening the glass windows. This is best accomplished by fastening the windows at the bottom so they may swing inward a few inches at the top; the window opening is boxed in at the sides so that all the incoming air must work upward. In this way there is little danger of a harmful draft reaching the hens. The outward movement of air is slow, and the pens do not lose their warmth.

Under the foregoing conditions there will be no trouble in keeping the hens healthy and contented.

In equipping the pens with nests, roosts, and feed-boxes, the arrangement should be convenient, all parts above the floor so as to give the hens the entire floor space.

Pens should be kept reasonably clean, otherwise they become damp, and breed disease and vermin. A box for coal ashes, road-dust, or plaster should be provided in which the hens may dust themselves. In this way they will rid themselves of body
lice to a large extent. Perches should be treated with a good commercial spray every few months, and oftener in summer, for lice.

182. Mating

Perhaps the most important single operation in connection with poultry-keeping is providing proper mates. This includes the selection of a group of individuals which possess the health, strength, and inherited ability to lay a profitable number of eggs, and to produce young that will be equally capable. Great pains should be taken in selecting the individuals.

Selection for breeding

The best indications in selecting the individuals for breeding are (1) activity; (2) appearance; (3) shape; (4) type. These points may now be considered more fully.

Points in a good breeding fowl

(1) The activity: a strong healthy bird is doing something most of the time, as hunting food, crowing or singing, early to rise and late to perch.

(2) The appearance: the healthy bird has a bright look, comb red, eyes glistening, and plumage sleek.

(3) Shape: the strong bird looks rugged and stocky, has a wide back and deep breast and body.

(4) The type: it is well to select for mating those birds that show the most uniform size and color of the breed; although birds of various colors and sizes may be as profitable individually, they are not so collectively. The uniform product in eggs, in market poultry, or in live birds will command a better price.

With general-purpose breeds one male for every fifteen hens is the usual allotment. There should be fewer hens with each male of heavy or meat breeds.
183. Hatching and Brooding

Natural hatching and brooding are giving place more and more to artificial methods. With a small flock, hens can be used to very good advantage for hatching the eggs and brooding the chicks. Hens understand better than man does, and they can hatch stronger chicks. However, it is doubtful whether, on the whole, the natural method of brooding is any better than the artificial, especially when the flock of chicks is large.

Eggs for setting or for incubation should be fresh and have been kept cool and never subjected to rough handling. If strong chicks are desired, the eggs should be those of strong vigorous parents, and uniform in size and age.

When a hen is being set, she should be thoroughly dusted with lice-powder. A second treatment should be given in ten days. This will rid her body of lice and often remove the cause for leaving the nest before the chicks hatch. This precaution is especially important in hot weather.

A box of fine hay or grass makes an excellent nest. It should be about 15 inches square and 6 inches deep; the bottom is often filled with earth, hollowed out, and well lined with straw or hay. A sitting hen should be allowed to leave her nest to exercise and feed once a day. She will cover 12–15 eggs effectively.

It requires 21 days to hatch hen’s eggs, 28 days to hatch duck, turkey, and guinea eggs, and 30 or more days for goose eggs.

In the evening after all the chicks have hatched, the
hen and her brood should be placed in a small coop or house. If the weather is warm, the coop may be placed on clean ground and moved to a fresh spot every few days. The chicks should be confined in a small yard near the coop for a few days, so that none will stray from the mother and be lost. If the weather is hot the coop should be placed in the shade of a tree; if cool, it should be in the sunshine, preferably on the south side of a building. After two weeks the hen should be given her liberty to roam with the chicks.

If artificial means of hatching and brooding are employed, it is best to follow carefully the directions which come with the incubator and brooder. If good sitting hens are to be had, and not more than 200 chicks are desired, it is usually best not to use an incubator.

The best time to have chicks hatch is in April and early May. Pullets from these chicks will mature early enough to lay in autumn and early winter. It is difficult to get good laying hens to sit in March and April, so the use of an incubator or neighborhood hatchery is very common and practicable.

184. Feeding Chicks

No food should be given the chicks the first day. The chick will feed on the unabsorbed yolk in its body for three days. Then chick-grain and chick-mash should be given.

It is well to feed at first in shallow trays. Chicks should have plenty of food; in fact, it is safe to keep food before them all the time, provided it is fresh and sweet. However, when this is practiced, the chicks kick the food into their bedding.
where it mixes with filth, becomes stale and moldy, and then when eaten produces digestive disorders. Clean food in clean dishes is more important than the kind or quantity of food.

Our grandmothers raised very good chickens on corn meal and bread mixed in sour milk and fed three times daily. It is still possible to raise good chicks in this way. However, if the flock is rather large, it is better to use a good brand of commercial chick-grain and mash, keeping sour milk, water, and sand or fine grit before the chicks all the time.

185. Diseases and Pests

Many ailments and diseases attack poultry. At the same time, there is no animal more capable of withstanding sickness. The danger of strong stock contracting disease in clean fresh-air houses when fed wholesome food is small or even negative. However, it is possible by neglect and improper sanitation to impair the digestion of the most rugged birds, so that disease germs find foothold.

The most common disease of poultry is some form of cold or roup. This is generally brought about by excessive dampness; or it may be due to overfeeding, or filthy water, or litter containing germs which derange the fowl's digestion and weaken the constitution.

The treatment for roup is first to remedy the improper conditions and remove the affected birds. If the bird shows a swollen face or eye, the cost of curing her is usually greater than her value. But if the bird sneezes and shows a slight mucus dis-
charge from the nose, mouth, or eyes, then it is possible to cure her. The easiest and surest method is to plunge the entire head into kerosene, holding it there but a moment. The fowl should then be removed to a comfortable place and receive wholesome food. A slight film of kerosene should be kept on her drinking water for three days. Usually one treatment cures. It is a wise precaution to pour a little kerosene on the drinking water every week or two, especially if the weather turns cold or damp, or if a few of the hens sneeze or cough. Be sure to use enough kerosene so that the hen cannot get water without passing her bill through the thin film of it.

The fowls must be protected from lice. Following are standard directions (Lawry's lice powder):

Spread $2\frac{1}{2}$ lbs. plaster of Paris in a shallow pan or tray. Pour $\frac{1}{4}$ pint of crude carbolic acid into a cup and into this pour $\frac{3}{4}$ pint of gasoline. Pour this mixture over the plaster of Paris and mix thoroughly. Rub through wire window-screen on a piece of paper. Allow it to stand for 1½ to 2 hours until thoroughly dry. Do not place near a stove. Keep powder in a closed can or jar. Apply by means of ordinary sifter, or with fingers. Brush the powder in among the feathers about the vent, fluff, and under the wings. Repeat in about two weeks in extreme cases. Ordinarily this need not be repeated for six months. A small pinch of the powder is sufficient for a fowl.

To avoid tainting the flesh, apply one week before killing. Treat brooding hens at the beginning of the period of incubation and again, lightly, a few days before the hatch.

To destroy red mites, paint or spray the perches, dropping boards and other harboring places with a mixture of one part crude carbolic acid and three parts kerosene oil.
REVIEW

Where is the bulk of the poultry products raised?
How extensive is the poultry business?
What do you mean by poultry? What kinds of animals?
How does the chick live and grow inside the egg?
How are poor eggs discovered?
What place do fowls occupy on the farm?
How readily may fowls be cared for?
What are the classes of farm poultry? Contrast the different types.
Mention some of the good farm breeds.
How may the flock be started?
What is the importance of care in feeding?
Give examples of rotations.
Name the essentials in the proper housing of fowls.
How is ventilation assured?
How should the pens be arranged?
What can you say about the mating to secure best results?
What should be the nature of the parents?
Contrast natural and artificial hatching or incubation.
How should eggs be handled for hatching?
Explain the setting of a hen.
How should chicks be cared for?
What is brooding?
Explain the proper feeding of chicks.
What is to be done for lice? for roup?

THOUGHT-QUESTIONS AND INQUIRIES

What was the number of poultry in (a) the county and (b) in the state according to your last school or federal census? What was the value of the poultry? Of the eggs? Are there more recent estimates or statistics?

Are there any specialized poultry farms in your region? If so, report on the kind and number of fowls, and the methods.

One pupil should bring a fresh egg to school; another a hard boiled egg. Break the fresh egg into a clean saucer; cut the hard boiled egg in two. Examine both eggs very carefully, and see whether you can find all of the parts.
Ask your local merchant or whoever purchases from the producer, about the percentage of bad, dirty, and cracked eggs he finds in his deliveries.

Make an egg-candling device. Obtain from the store or home a bad egg, a stale egg, an egg with a blood clot, and a strictly fresh egg. Examine all closely and note the differences in appearance.

Make a list or a map of the different farms in your district or farm community, and indicate the kind, breed, and number of poultry kept on each one.

What is the average number of eggs produced to the hen on your farm? What is the highest authentic egg record in the United States?

What is your favorite breed of poultry? Why?

Who in your section sells day-old chicks? How far may chicks be sent with safety by mail or express?

Describe the method in feeding the home flock and the nature of the ration. How do the rations vary from season to season?

Describe the methods of housing and yarding of poultry as practiced by a successful poultryman in your community.

What is the Standard of Perfection as it relates to poultry? What breeds and varieties are included in the Standard? Do you think that breeding for "feathers" or fancy points will conflict with the obtaining of utility points or high egg yields? Why?

Describe the methods followed by successful poultrymen in breeding for high egg-production.

Is natural or artificial hatching and brooding practiced generally on the farms in your region? Which method do you prefer? Why? Describe the methods used with your flock.

Describe the chick ration and method of handling chicks recommended by the poultry department of the state college of agriculture. Consult your county agent.

What are the most troublesome ailments and diseases that affect poultry flocks in your county? Describe the preventive and remedial methods that are to be adopted in each instance.

**CLASS PROBLEMS**

Arrange with your parents to take over the care and management of the home flock for an entire year, or secure their permission to keep a flock of your own.

Join, or help to organize, a poultry club in your school. Write to the state club leader at your college of agriculture for literature and suggestions dealing with the poultry club work.

Make a census or enumeration of the fowls in your school district.
TOPIC 26

BEES AND HONEY

The bee is the smallest of the animals usually reared by man. The silkworm and sometimes the cochineal insect are the other insects raised for their commercial products.

The bees are "social insects," which means that they live in great families or colonies and all work together for the welfare of the colony, one class or group performing one duty and others performing other duties. To feed their young and themselves they make a material known as honey.

The honey is made in the organs of the bee from the nectar gathered from the flowers. The bees build a comb of wax, and in the six-sided cells the liquid honey is stored against the time of need. They also collect and store pollen for food.

By placing the colony in a hive and properly managing the insects, more honey is made than the bees need, and this surplus the beekeeper takes. He may even take all the honey, when the breeding season is past, and feed the bees until the next season with sugar (sirup) or the cheaper grades of honey. Usually, however, the good beekeeper leaves enough honey in the hive to supply the needs of the bees.
Like other insects, bees are propagated from eggs. The eggs are laid in the cells of the honeycomb. The young taken together, when in the form of grubs or larvae, is known as the brood.

It may appear that the bees in the hive are alike, but if we look closely we find that there are three kinds:

The queen, which is the mother of all the others in the hive, and the only developed female of the colony;
the drones or male bees, which are stingless;
the thousands of workers (undeveloped females), so called because they do the work of the colony.

All these live together in the hive and not one of them is able to live alone. The queen is not the ruler of the hive; this name was given to the mother bee centuries ago, before the nature of the colony had been studied. We know that she does nothing but lay eggs from which the other bees develop. She is proficient in this, for she sometimes lays as many as 2000 or even more eggs in a single day.
The drones do no work; the lazy person is called a drone because he does no more work than the male bee. The workers do not seem to approve of loafers in the hive, and as soon as the supply of new honey is reduced, the drones are driven from the hive to starve to death.

The workers are well named. They clean the hive, feed the developing brood, build the wax cells of the comb in which the brood (or young) is reared and the honey stored, and, last of all, they gather the honey and pollen on which all the bees of the colony live. They seem busy as we see them flying from the hive, and the more we study them the more their industry is admired. From the time they come from the wax cells as full grown bees until they die, there is no rest for them if there is any work to be done. It is an interesting fact that they work themselves to death, for the more there is to do, the sooner they die. In the busy season of summer, when there is plenty of nectar to gather, the workers live about six weeks, but in the autumn and winter there is usually less work and they may live six months. It is small wonder that they are cited as examples of industry. Of course, they do not appreciate what they are doing as we do, for bees do not have real memories and do not learn from experience, but we admire their zeal.

From the eggs of the queen bee all the members of the hive develop. Whether the progeny shall be queens, drones or workers depends on the way in which the young are fed and reared by the members of the colony. The queen is fertilized once by a drone, and then lays her great store of eggs.
It is as true of bees as of the farm live-stock that the best results are to be secured only by careful breeding. In this case the queen bee only is bred. The profit of the hive may depend on the character of her offspring. The breeding of queen bees is a specialty and the general beekeeper will do well to purchase queens from a reliable source.

There are many kinds of honey-making bees in many parts of the world. They are placed in different genera by entomologists. The common honey-bee is of the genus Apis. Beekeeping is known as apiculture, and the establishment is an apiary. It is usually considered that Apis has only three species, the leading one being *Apis mellifica*, the "honey-making" *apis* or honey-bee. This species inhabits many countries, but probably it is not native in the western hemisphere. There are many races of it, as the Italian, Cyprian, German, Syrian.

187. The Hive

All the bees live together in a hive unless they are living in a hollow tree or cave in the rocks. The artificial hives are usually so made that the beekeeper can help the bees do their work better. Inside the hive are large combs, just like the comb in which we see honey for sale, but larger. Each cell of the comb has six sides and the ends fit together snugly so that there is no waste space.
The beekeeper finds it necessary to give the bees more room at times and he must also learn how they are working, so he makes wooden frames in which the combs are built by the bees. Then he can take out any one or all of the combs, can change combs from one hive to another, and can give the bees the care which they so often need. In the old-fashioned box-hives or log "gums," the combs are not built in frames and so they cannot be handled. This is the reason why it is only the modern beekeeper who finds bees to be profitable.

The best hive has ten frames, each one of which is \(17\frac{5}{8}\) by \(9\frac{1}{8}\) inches in size. This is the standard size of frame in the United States. This movable frame hive was invented by Rev. L. L. Langstroth, and he decided the size of the frame as best suited to the needs of the bees. It is necessary that the hives and frames be accurately made and it is best to buy at least one as a pattern to be followed closely if one makes one's own hives. Most beekeepers buy them from the factories which specialize in supplies for beekeeping.

In the cells of the central combs the young developing brood is reared throughout the year except in winter. The queen goes from cell to cell and deposits a small egg in the bottom of each one. In three days this egg hatches into a white worm-like larva, and this is fed and cared for by the workers. For six days
this young larva is fed large quantities of honey and pollen and it increases to many times its original size and fills the cell. Then the cell is capped over by the workers.

The larva gradually changes into the form of the adult bee and in 21 days from the time the egg was laid the full-grown adult worker bee gnaws its way out of the wax cap. Drones require 24 days to develop, while queens reach the adult stage in 16 days.

i88. The Honey

In other cells above and behind the brood, the workers store the supply of pollen or bee-bread with which the brood is fed, and still higher in the combs is the store of honey which they use as food when no nectar is available.

The pollen comes from the various flowers on which the workers are seen, while the honey is made from nectar, the sweet liquid of the flower. If one watches closely when bees are at work on a flower, he can tell whether they are gathering nectar or pollen, for when they get nectar they stick out the tongue and probe into the bottom of the flower, while in gathering pollen they get it all over their bodies, collect it by brushing on the legs and finally carrying it home to the hive on the back legs in little pellets. The nectar is carried in a special sack inside the bee's abdomen, and when the hive is reached this sweet load is deposited in the cells.

Any one at all familiar with honey knows that there are great differences in the flavors and colors of different kinds. We know that the blossom of the apple is not at all like that of the clover in shape and that there is much difference in the colors of
various flowers. There is also great difference in the color and flavor of the various nectars. The flavor of the nectar is still observed in the finished product, honey.

Thus we have the honey of white clover, which is white in color and of characteristic flavor, while that from buckwheat is dark colored and has a flavor enjoyed only by those who have learned to like it in their youth. The honey from alfalfa is as light as that from clover, when it is produced in the high altitudes of Colorado and Utah, and it soon granulates or “turns to sugar.” Alfalfa honey from the lower altitudes of California, Arizona, and New Mexico is amber in color and has a flavor slightly different from that of the white alfalfa honey. The honeys from wild raspberry, fireweed, basswood, sweet clover, the mesquite of Texas, and the mountain sages of California are white, those from the sourwood of the southern mountains, Spanish needle and tupelo of the southern swamps are amber, while those from the tulip tree (tulip poplar or white-wood) and buckwheat are dark. Sweet clover honey sometimes has a green tint, while some others are nearly red.

The plants named in the preceding paragraphs are the chief sources of honey in the United States, but bees gather nectar from many other plants, and in certain parts of the country considerable quantities are harvested from other sources. A full list of the plants from which bees gather honey that the beekeeper can market would be large, and if we were to include descriptions of all the plants from which bees ever gather nectar or pollen, a special book would be needed for them.
When nectar is brought to the hive it is often merely sweetened water, but the bees evaporate much of this water, leaving the thick honey. They also make other changes in it, for the sugar is changed from being mostly cane-sugar to what is known as invert-sugar. This change is the same as takes place when we eat cane-sugar, so that honey is really pre-digested sugar. It may therefore be eaten by those who cannot digest cane-sugar and it will not harm the digestion as will too much candy.

In making this change in the sugar, the bees give to honey certain characteristics that sugar does not possess. If cakes are made with honey instead of sugar, they will not dry out so rapidly, and for this reason commercial bakers use considerable quantities of honey in making cakes that lie on the shelves for a long time.

It is thus seen that the bee-hive is a chemical laboratory. Nectar would soon ferment if the bees did not drive off the surplus water; and the other changes make it a much better food.

When the nectar is first brought to the hive it is deposited in the cells by the gathering bees. Then other bees fan it with their wings, move it from cell to cell during the process of ripening and finally fill cells with it and seal in the honey with a capping of wax. The honey is now ready for use as food either for the bees or for man.

The process of ripening takes place within a few hours, yet if the honey remains in the hive for a long time it still undergoes change, for it becomes still thicker and richer in flavor. Honey that is well ripened does not ferment and, therefore, will keep
for years without spoiling. After a few years it begins to darken, but the flavor is not injured.

189. Kinds of Honey

Honey is used by man in several forms. The small combs built in wooden frames, called sections, are familiar to us all. These sections are placed in the top of the hive by the beekeeper, the bees build comb in them and then fill this comb with honey and seal it over, when the finished product is removed and ready for the table. This is called comb-honey.

In buying comb-honey we may be sure that it is a product of the bees and is not adulterated, for no one has ever been able to make this delicate comb and to fill it with inferior material. A skilled beekeeper can have his bees produce such even and fine combs that it sometimes seems impossible that they are not machine made, but if they are examined carefully it is seen that no two are exactly alike as would be the case if they were turned out of a mold.

Honey is mostly marketed in liquid form in bottles or cans, having been separated from the comb. This is known as extracted honey, or when it is simply squeezed from the combs by the old-fashioned crude process it is known as strained honey. When extracted the comb remains uninjured and the bees fill the combs again when they are put back in the hive.

When they are well filled, the combs are taken from the hive, the wax capping is removed with a warm knife,
the comb is whirled rapidly in a special machine, known as the honey extractor, and the honey flies out. The combs are then returned to the hive and the bees refill it if there is still nectar coming in.

If the season is over, the beekeeper saves these combs to be used the following year. Since it requires about twenty pounds of honey to make one pound of wax, it will be seen that the extracting of honey is economical in bee energy. The price of the container and the work of bottling usually brings the price of extracted honey in small vessels to about that of comb-honey.

A crude method of removing honey is simply to cut out the comb from the hive, and when it is marketed liquid honey is poured over it to fill the container. This is known as chunk-honey or bulk comb-honey. It is as pure as honey in the other forms, but it is usually produced by unskilled beekeepers, and it cannot be recommended. Usually it is the owner of box-hives, without movable frames, who takes his honey in this form. In beekeeping, as in every other line of agriculture, it pays to follow the best methods.

190. Handling the Bees

The fear of stings keeps many persons from raising bees; yet the beekeeper would not have stingless bees if he could, for he knows that honey would not remain in his hives long unless it were guarded well, if there were many boys about. The beekeeper learns how he may handle his bees so that they do not sting him much; and he becomes accustomed to the stings so that, while they are not pleasant, they
do not cause a swelling on him as they do on the uninitiated. If the operator is calm and quiet in his movements, the bees do not become excited. They sting to protect themselves. By the proper use of smoke blown over the combs after the roof of the hive is removed, the bees may readily be handled.

The beekeeper can do much to help his bees to gather more honey. This skill lies in two directions: (1) the bees must be provided with conditions that will permit the colony to build up to full strength before nectar is abundant; and (2) then they must be kept from dividing their strength by swarming. The oldtime beekeeper boasted of the number of swarms, but this does not increase the output of honey. In all his work, the beekeeper does not attempt to change the instincts of the bees, for they are still wild animals. He merely directs their instincts into lines that will bring him greater profit.

The work of getting the colonies strong in time for the gathering of nectar begins the previous fall. The bees are thoroughly safeguarded from cold and wind. In the Northern States it is necessary to give the bees protection from winter cold. Sometimes in the south nothing more is needed than a sheltered place, inclosed by buildings or high tight fences. If the thermometer is likely to register much below freezing, the hives should be wintered in a specially prepared cellar, or else packed in larger boxes with plenty of shavings or chaff around them. Even though unprotected colonies may live through the winter, they are likely to come out weak in the spring.

The food in winter must be of good quality, for not all
honey is equally useful for this purpose. If a sufficient supply of good honey is not at hand, the bees should be given a sirup made of granulated sugar.

In the spring the bees need not only the protection and the abundant food as in winter, but also plenty of room in which to rear great quantities of brood. Usually this process must be aided by the beekeeper, or the colonies will fail to grow to proper strength. If protection, food, and room for breeding are provided, there is little else that the beekeeper can do to assist the bees, yet it is in this work that most beekeepers fail, and the failure results in loss of half the honey crop.

191. SWARMING

As the season advances and the secretion of nectar begins, new colonies may form by swarming. In this process the old queen and most of the workers leave the hive to form a new colony, leaving behind them the stores of honey and pollen, the brood, and some queen cells from which will emerge young queens.

Of course, there must be some way for the formation of new colonies, but the beekeeper has learned that this results in a great loss of honey, so he tries to prevent swarming and then divides his colonies, if he wishes more, after the honey flow is over for the year. It is not easy to break up this swarming instinct, and the skill of the beekeeper is to be measured by his effort in this direction rather than in his success.

The method is to examine every colony about once a week, and queen cells that contain only eggs or young
larvae are removed. If, however, the swarming preparations have progressed so far that the larvae are of fair size, the only thing the beekeeper can do is to cage the queen so that she cannot lay more eggs and so that she cannot go out with a swarm. After a period of about ten days she is released and usually the danger of swarming will have passed. Of course, all queen cells are removed before and after the caging of the queen.

If the beekeeper prefers, he may make an artificial swarm by removing the brood, with the queen cells attached to the combs, to a new hive, and this is better than to wait until the bees decide to swarm at their convenience, for then they may fly off to the woods and be lost. There are ways by which the beekeeper may reunite the swarm with the old colony and thus have the bees together again for the gathering of honey. Some of these processes are rather complex and should be undertaken only by the experienced beekeeper.

192. Diseases of Bees

Unfortunately there are two serious diseases of the young, called foul-brood. They are caused by bacteria.

American foul-brood causes the larvae to die and decay into a sticky mass which the bees cannot remove from the cells. The only remedy is to remove the combs and allow the bees to build a new set.

European foul-brood is less dangerous since the dead larvae can be removed from the cells, and the combs can still be used for the rearing of brood.

Both diseases cause considerable loss, and every beekeeper should study the symptoms so that they may be
recognized early. Many States have inspectors who gladly assist in eradicating these troubles without cost to the beekeeper.

193. The Value of Beekeeping in North America

Few persons realize the importance of the beekeeping industry. The average honey crop of the United States is about 250,000,000 pounds, yet it is less than 2½ pounds to each person.

While the industry is growing rapidly, beekeeping is doing more for the country than simply to conserve this amount of sweet. Bees gather both nectar and pollen. They have a habit of not visiting two kinds of flowers on one trip. The result is that they bring about cross-pollination, without which many of the fruits will not set seed, and unless the seed is set there will be no fruit.
Many forage crops must also be cross-pollinated. The part the bees unconsciously play in carrying pollen from flower to flower brings a greater gain to the Bees in fruit-agriculture of the country than the entire growing honey crop. In many of the large orchards, bees are brought in for this work without reference to their honey gathering. In greenhouses where cucumbers are grown in winter, colonies of bees are sometimes employed for this purpose.

REVIEW

What are bee colonies?
What is honey?
For what purpose do the bees make honey?
How is it that the beekeeper gets the honey?
What are the kinds of bees in the colony? Define each, and state the office.
How are these different kinds produced?
Why are some persons called drones?
How may bees be improved by breeding?
To what genus and species does the honey-bee belong?
What is a beehive?
What is the movable-frame hive?
What are the frames?
How do bees propagate? What is a queen bee?
How long is required from the egg to the mature worker?

Drone? Queen?
What is bee-bread? Of what use?
What is nectar?
How do bees gather and carry pollen? Nectar?
What are the kinds of honey?
What plants provide most of the honey in the market?
How is honey made from nectar?
What is the comb?
How long will honey keep?
What is comb-honey? Extracted honey? Chunk-honey?
What becomes of the combs after the honey is extracted?
How are bees handled so that they do not sting?
How are the colonies made strong?
What about winter protection?
How are bees fed in winter?
What is swarming? Describe.
What does the beekeeper do about the swarming instinct?
What is foul-brood? Remedies?
What other service do bees render aside from making honey?

THOUGHT-QUESTIONS AND INQUIRIES

Mention some kinds of "social insects" with which you are familiar. How do their habits compare with those of bees? How do honey-bees and bumble-bees differ in habits?

Help to obtain and install an observation hive in the school-room. So arrange the entrance to the hive that the bees may come and go out of doors without getting into the room. Glass sides to the hive will enable you to study the habits of the bees. Find the queen and watch the developing larvae.

What are the principal honey-producing plants in your country?
What is the prevailing price of comb-honey and extracted honey in your local market?

If any members of the class have had experience handling bees, let them demonstrate to the others how it is accomplished. If not, visit some beekeeper and get him to demonstrate the proper methods of handling.

Is there any foul-brood in the vicinity?

What was the total value of the honey crop for \( (a) \) the county and \( (b) \) the state last year, or when the last census was taken?

What crops grown in your region are dependent on bees to a greater or less extent for pollination?

CLASS PROBLEM

If conditions are favorable in the neighborhood for the keeping of bees, and they are not kept at home, plan to keep one or more hives yourself, getting some adult beekeeper to start you off. If
five or six pupils become interested, your state club leader will help you to organize a bee club which will make the work more interesting and possibly give you the chance to win honorary and cash prizes for the excellence of your work.

How many persons in the district keep bees? How many colonies? What breeds or races?

A hive with a glass side provides an interesting object for study.
TOPIC 27

THE DAIRY

Of all the domestic animals, the milk-producing kinds are probably the most indispensable to man. The leading milk-producer is the cow, which is the female of the species ox; other animals prized for the giving of milk are the zebu, buffalo, reindeer, goat, sheep, llama, camel, mare.

Milk is used in its natural state as a fresh food, and also for the manufacture of butter, the different kinds of cheese, ice-cream, and other products.

194. VALUE OF MILK AS HUMAN FOOD

The reason why milk of some kind is so widely used is because mankind has learned that it satisfies hunger and meets the needs of the body, for persons of all ages. The animal provides a daily supply, easily drawn and ready at once for food; and, at the same time the animal also has other uses. Milk is probably the most perfect single food of which we have knowledge.

Cow's milk is superior in food value to market meat when measured in terms of usual current price. A pound of milk (a little less than a pint) has about one-third the energy-value of a pound of good beefsteak, and about half as much protein and about the same amount of mineral elements. One pound of butter contains 3605 units or calories of energy-value, as against 985 calories in one pound of sirloin steak.
One pound of full milk cheese contains 1950 calories. In ash or mineral matter, both products are superior to the beefsteak, and in protein cheese much excels it.

The consumption of milk per capita constantly increases, indicating that the people recognize its value as food.

195. EXTENT OF MILK PRODUCTION

Figures of the Department of Agriculture show in the year 1914 nearly 21,000,000 dairy cattle in the United States. The value of the butter, cheese, and condensed milk from the yield of the dairy cows was almost $365,000,000, or one million dollars a day; and this does not include the value of the milk used for other purposes. Large as these figures are, they do not represent the entire importance of milk production in agriculture, for much manure is produced, and this makes it possible for the farmer to raise larger crops of hay, potatoes, grain, and other food products. There is approximately one dairy cow to every family.

The number of dairy cows on farms in the United States in 1910 was 20,625,432. The total milk production in 1909 was 5,814,000,000 gallons. (1 gallon = 8.6 pounds.) In Canada in 1911 the number of milch cows was 2,595,255, and the total production of milk was 9,806,741,348 pounds. From these figures and the population figures given on pages 14, 15, the per capita production can be calculated.

196. WHAT IS DAIRYING

Dairying is that branch of farming having to do with the production and handling of milk and with the manufacture of its products.
The word "dairy" is used in different senses, sometimes to denote the milk-producing herd and the establishment that goes with it, sometimes to designate the building or place in which the milk and its products are handled.

A creamery is a commercial dairy establishment manufacturing butter; but it usually sells whole-milk (that from which milk-fat has not been removed), or may even make cheese when this product is more profitable than butter.

In the college of agriculture the subject of dairy- ing is often confined to the handling and manufacture of the milk after it leaves the herd, and the production of it, in that case, is left to the animal husbandry department. The dairy establishment is then a factory, combining butter-making, cheese-making, the marketing and testing of milk and its products together with the teaching of the scientific matters relating thereto. That is, the subject deals with milk, not with animals. In this sense it is studied in the present chapter.

Butter-making and cheese-making as home industries are passing out in regions in which there is sufficient milk production to maintain factories. Yet every farm household is called on to handle milk in one form or another.

The handling of whole- or market-milk is one of the
most important parts of the dairy business, supplying the cities and towns with their daily needs. About 112 quarts of milk per annum are consumed in cities of the United States to every person. The winter supply of milk to the cities is very large, and silos have come to be a part of the equipment of the dairy farm in the North to furnish succulent roughage to the cows.

**Milk to Market**

197. Composition in General

The composition of milk is complex, but there are only six substances of interest to the dairyman:

1. water
2. fat
3. casein, more commonly called curd
4. milk sugar
5. albumin
6. ash

These substances are present in all milk, but they vary in amount, the reasons of the variation not being always known. The composition of the milk of a certain cow is not always the same. If she is sick, or becomes angry or excited, the composition of her
milk is likely to change. The composition varies also with the breed. There is wide variation in the first few streams and the last milk drawn from the cow. The first milk is low in fat, while the last contains a high percentage. The composition is also influenced by the length of time the cow has been giving milk. If she has been in lactation a long time, say ten months, the milk will be much higher in fat content than at five or six months.

The average composition of a normal cow's milk is about as follows:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Fat</th>
<th>Casein</th>
<th>Sugar</th>
<th>Albumin</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>87.27 per cent</td>
<td>3.68 per cent</td>
<td>2.88 per cent</td>
<td>5.0 per cent</td>
<td>0.51 per cent</td>
<td>0.72 per cent</td>
</tr>
</tbody>
</table>

The fat, casein, sugar, albumin, and ash comprise the "total solids." The casein, sugar, albumin, and ash are the "solids not fat."

The water in milk is no different from water found elsewhere. It gives milk its liquid condition, and is the carrier of the other materials.

**Other milk**

With these figures may be compared those of the milk of other animals:
198. The Fat in Milk

The fat is one of the most important substances in milk, and at the same time the most variable.

It is present in the form of small globular droplets, so small that a microscope magnifying several hundred times is necessary to see and study them. The fat globules are lighter than the other substances, and when milk is allowed to stand for any length of time the fat rises to the surface.

Fat is important as a direct food, and also in the making of the different products. It is an important part of many dairy products, such as ordinary American cheese, but its chief use in manufacturing is in the making of butter. About 80 per cent to 82 per cent of butter is fat; because of its importance in butter-making, it is often called butter-fat. This fat furnishes heat or energy for the human body, and recent experiments tend to show that it is more valuable for this purpose than most fats of other kinds.

199. The Casein

Casein, commonly called curd when it becomes united into a mass, exists in milk in such fine particles that it cannot be strained out by any ordinary means. Casein contains a large proportion of protein, and for this reason it is one of the most important food substances in milk. It forms a considerable part of most kinds of cheese.

The casein may be thrown down in a solid mass by adding certain substances to milk, such as rennet and pepsin. Very weak acids also cause the casein to come down in a
solid mass. This is what happens when milk sours naturally. The solidified casein is used in manufacture, as in the making of buttons, combs, toilet articles, and the finishing of writing paper.

200. The Milk-Sugar

Milk-sugar, commonly called lactose, is in solution in milk. It differs somewhat from cane-sugar, and will not dissolve as easily. It is used to coat pills and for making of powders in medicine.

The process of obtaining sugar from milk is expensive, and this is probably one of the reasons why it is not more commonly used.

201. Albumin

The albumin is in solution. Like casein, it furnishes protein. It is thrown out of solution by high temperature, and when once it is in solid form it will not go into solution again. Boiled milk has most of its albumin thrown down in solid form.

Albumin may be roughly compared to the white of an egg. It is sometimes made into Italian cheese, which is a valuable food product containing a high percentage of nutritive protein.

202. Ash

The ash is the part left after the milk has been burned. The burning follows, of course, the evaporation of the liquid part. Ash is the mineral substances in the milk, such as salts of calcium, iron, magnesium, phosphorus, and sulfur.
Ash varies the least of any of the substances in milk, and while it is present in small amounts, it is necessary for growing animals in the formation of bone. It comprises one of the important food elements.

203. The Germs in Milk

Every one knows that if milk is allowed to stand at the temperature of the room for a few hours, it will turn sour. In many cases the souring is accompanied by other changes which render the milk unfit for human food.

These changes are caused by the action of bacteria or germs. The organisms are nearly everywhere, as in dirt, dust, on the body of the cow, and also on the utensils, unless great pains is taken to clean them. Some diseases, such as diphtheria, typhoid fever, and tuberculosis, are caused by bacteria (page 91). But not all bacteria are harmful to mankind.

Bacteria must have plenty of moisture to grow well, more or less mineral matter, and usually a temperature of $80^\circ$ F. to $100^\circ$ F. Knowing these facts, it is easy to see that milk is naturally a good medium or "soil" for them.

It is important that all dairy utensils be kept very clean after washing. They should be thoroughly scalded or, better still, subjected to live steam for not less than an hour. The farm practice of setting in the sun after cleaning, is also an aid in sterilizing, but they should at the same time be protected from contamination by dust and dirt. Using a small-top or covered milk pail will also keep out a large number of bacteria.
In spite of all care, a few bacteria will enter, and unless milk is cooled soon after being drawn, and kept cold, these germs will multiply with great rapidity. This would soon cause the milk to spoil. Most bacteria do not grow well at a temperature of 50°F. or below. It is always best, if the milk is to be held for any length of time, to keep it at as low temperature as possible and not freeze it.

Straining milk does not remove the germs, although it catches much of the foreign matter that carries them. Germs pass wherever the milk globules can pass. Straining does not even purify the milk, because much of the uncleanness is soluble. However, straining is a great aid if the proper device is employed. Some of the modern cone-shaped strainers are fitted with absorbent cotton held between layers of gauze, the cotton being removed after every straining. Some strainers use layers of cheese-cloth and other materials. Straining greatly improves the appearance of the milk.

No good dairying is possible without the strictest cleanliness, and this cleanliness consists not alone in the removal of impurities, but in eliminating conditions favorable for the growth of germs.

204. The Cream

Cream may be defined as milk into which a large percentage of fat has been gathered. This large content of fat lessens the proportion of other constituents. Cream may be obtained by allowing the milk to stand quietly for several hours, when the fat rises to the surface and it may be skimmed off.
There is wide variation in the percentage of fat in cream. Most states fix by law the lowest amount of fat it may contain and still be sold as cream. The lowest legal fat limit in the different states varies from 15 per cent to 20 per cent, but only four states have the lowest legal fat limit as high as 20 per cent and only one as low as 15 per cent. The larger number have adopted 18 per cent as the lowest legal fat limit. Since cream contains all of the substances found in milk, it must be cared for in the same way. When held in storage it must be kept cold.

The most common method of obtaining cream is to run milk through a machine called a separator, operating on the principle of centrifugal force. This mechanism contains a cylindrical bowl which revolves at high speed, and as the milk flows through it, the cream is forced to the center and the skim-milk, being heavier, is forced to the outside. As the bowl fills, the cream and the skim-milk flow out through openings provided for them.

The separator has reached a high degree of mechanical perfection. It is manufactured in many different styles and some are operated by hand and some by power, depending on the size of the machine.
Cream is used for many purposes, one of the most common being the making of butter.

Sour cream is mostly used in butter-making, although sweet cream may be employed. For butter-making it is best to use cream containing about 30 per cent to 35 per cent fat. The cream is "ripened" by being held for several hours at the desired temperature for churning, this temperature varying with conditions. In summer 48° F. is good temperature, while in winter it may be necessary to churn as high as 64° F. Such temperatures should be maintained as will allow the process of churning to be completed in about three-quarters of an hour.

The churning causes the particles of fat to stick together in a firm mass, and the butter "comes." The buttermilk is then drawn off, and the butter is washed two or three times in clean water of about the same temperature as the buttermilk. The purpose of washing is to remove all the buttermilk, which if left in the butter would injure its keeping qualities.

After washing, salt is usually added and the product allowed to stand until the salt is dissolved, after which it is evenly worked through the butter. Three-quarters of an ounce to one ounce of salt for every pound of butter is a common rate.

One hundred pounds of fat will produce more than one hundred pounds of butter, and the increase is due to the water, curd, and salt which are mixed with the fat in the process of churning and working. The increase is called "overrun" or "churn-yield";
the amount obtained is variable, depending on the skill of the maker and conditions of manufacture. A skillful butter-maker will frequently make 120 pounds of butter from 100 pounds of fat. When milk is purchased at the creamery on its butter-making test, the creamery-man expects to make most of his profit on the overrun.

Renovated or process butter is that which has been worked over in factories to remove impurities and bad flavors, and to make a more uniform product. Renovated butter

The original product is usually of inferior quality; it comes mostly from home manufacture that has been purchased by small dealers. The manufacture of renovated butter is subject to oversight by government.

206. Cheese

Next to butter, the manufacture of different kinds of cheese is one of the most common uses of milk.

In making ordinary hard American or cheddar cheese, the milk is warmed to about 85° F., and rennet or pepsin is added. The making of cheese

This pepsin causes the milk solids to collect in a mass, which is then cut into small cubes by means of wire knives. The watery part that separates is called whey and the solid cubes are called "curds." The temperature of the entire mass is then raised to about 100° F. to solidify the curds; about one hour is required for the
process, the exact time and temperature depending on the condition of the curds.

When the curds have sufficiently firmed, the whey is drawn off, the curds allowed to mat together, and they are then cut into strips. These strips are piled on top of one another for a time to allow the formation of a certain amount of acid. The strips are then cut into small pieces, by means of a curd-mill, salted, and pressed, making cheese. The metal hoops or the receptacles in which the curds are pressed give to cheese the shape in which we find it in the market.

Many kinds of cheese (and which are excellent foods) may be made from skim-milk. One of the best examples of this is pot cheese. To make it, skim-milk is allowed to become sour and then it is warmed slightly until the whey and curd begin to separate. The curd is then broken up, care being taken not to break the particles so fine that they will be lost in the whey when it is drawn off. The mass is then warmed slightly and when the curd begins to have a firm texture, the whey and curd are dipped into a cloth bag and allowed to drain. When dry the curd is salted to suit the taste and cream or butter is mixed with it.

Cottage or “dutch” cheese is pot-cheese which is broken up into a granular or mealy condition, about 2 ounces of salt being used to each 10 pounds of product. Butter or cream is added as desired.

207. Measuring the Amount of Fat in Milk

Since milk and its products are important and almost universal foods, a determination of the fat content is of
great importance. The percentage of fat also often indicates whether the product has been adulterated or whether it meets the standards claimed for it.

One of the simplest and most accurate methods of determining the percentage of fat in dairy products is by means of the Babcock test. This test itself is merely a method of operation; but the fat, after certain treatment in specially prepared graduated bottles, is separated in a centrifuge, where-

![One Form of Babcock Tester](image)

upon its quantity may be read in terms of percentage in the graduated neck in which it collects. The centrifuge and necessary bottles constitute a machine usually known as the Babcock tester, of different patterns and sizes.

The Babcock test is made as follows: by means of a glass tube, called a pipette, 17.6 cc. of milk (18 grams) is measured into a test-bottle, which has a neck graduated to read in terms of percentage when this quantity of milk is used. Then 17.5 cc. of strong sulfuric acid is added to the milk in the bottle. The acid and milk are thoroughly mixed at once by shaking the bottle. The acid destroys all the milk solids excepting the fat, on which it has practically no effect. It is better
to test two bottles of each sample, as one is then a check on the other.

The bottles are then placed in the machine and whirled for five minutes. During the whirling the bottles assume a horizontal position, and since the fat is the lightest substance in the bottle, it is forced toward the graduated neck. At the end of five minutes the machine is stopped and enough hot water added to bring the fat to the base of the bottle-neck. The bottles are then revolved for two minutes, and hot water again added until the fat column is within the graduated part of the neck. Whirling is then continued for one minute more, to bring all of the fat into the neck of the bottle. The bottles are then ready to read.

Some test bottles are graduated as small as tenths of one per cent, while others are marked only in fifths. The fat column should be read quickly, as the bottles give percentage readings only when the fat is in a liquid condition. The extreme points of the fat column should be included in reading a whole-milk bottle.

The Babcock test for fat in milk products is similar to the test for fat in whole-milk. In most cases, as for example in testing cream, butter, or cheese, the amount used for the test cannot be measured out with a pipette, but must be accurately weighed.

In nearly all states are laws specifying the lowest legal limit for fat and total solids in market milk. These limits vary with different states, but they are usually from 3 per cent to 3.25 per cent for the fat and 11.5 per cent to 12 per cent for the total solids. Special markets may demand a higher percentage of milk-fat.

208. Pasteurizing

Named for Louis Pasteur, the great French biologist, the pasteurizing of milk is a process of heating to kill most of the germs, particularly disease-producing bacteria. Proper pasteurization holds the milk at a temperature of 142° F.-145° F. for
30 minutes. If the milk is heated for any length of time above these temperatures, the fat will not rise to the surface as readily as in raw milk. Many leading authorities agree that temperature higher than 142° F. to 145° F. changes the chemical composition of milk and makes it less digestible.

Both milk and cream may be pasteurized, but the process is most commonly employed with market-milk as a guard against the spread of disease.

209. CERTIFIED AND GUARANTEED MILK

In some cities are medical milk commissions that undertake to inspect dairy establishments and to test the milk for its sanitary and chemical qualities and who then certify to the quality of the milk. It is then called certified milk. The certification is not given by the producer or the owner himself, but he must comply with the rules laid down by the medical milk commission.

Certified milk is necessarily of high price because of the expense involved in its production.

A producer may guarantee his milk on his own responsibility, declaring that it is of certain quality as to milk-fat, and that it is clean and wholesome. He may make whatever guarantee his milk will warrant.

REVIEW

How important is milk?
Compare milk and meat in nutrition value.
How extensive is milk production?
Define dairying. What is a creamery? What is whole-milk?
What is the consumption of milk per capita?
Give the composition of milk.
What are total solids? solids not fat?
How is the fat contained in milk?
For what is the fat used in manufacture?
For what purpose is the casein used?
Of what service is the milk-sugar?
What is albumin?
What can you say about the ash?
What are germs? How are they present in milk? What do they do?
How are germs kept out of milk? How about straining?
What is cream?
How is cream separated from milk?
What is a separator?
What is butter?
What does churning do?
State the best temperature for churning.
What is overrun?
Explain renovated or processed butter.
What is cheese? curd? whey?
Describe the process of cheese-making.
What is pot cheese?
How is the amount of fat determined?
Describe the Babcock test.
What is pasteurizing? its purpose?
Explain certified milk; guaranteed milk.

THOUGHT-QUESTIONS AND INQUIRIES

Compare the food value of milk with that of the more important meats and cereals and cereal products. How much more for a pint or quart can one afford to pay for milk, and get the same food value as one is now paying for beefsteak or bread?

Make a census of the cow and calf population in your school district. How many dairy cows are there in the county? In the state? What is the total value of the dairy products in the county? In the state?

Describe how the milk is handled in the milk-producing sections of the state. Are there any milk stations, condenseries, butter or
cheese factories in your county? If so, what is the amount and value of their output?

Follow carefully the following steps for demonstrating the constituents of milk:

**Materials.** — Thermometer, bottle, saucer, pan, a few drops of vinegar, and one quart of fresh milk.

**For the fat.** — Let one quart of fresh milk stand quietly in a pan in a cool place until a rich clearly-marked layer of cream gathers at the top. This cream is formed by the rising of countless balls or globules of pure milk-fat, often called butter-fat, which are distributed evenly through perfectly fresh milk or milk that is frequently stirred. The fat is so much lighter than the fluid in which it floats that most of it will be found in the cream layer in twelve hours, provided the milk was fresh when "set" and it has stood undisturbed in a cool place.

The cream should be removed by skimming or dipping, warmed to about 60° F., and shaken in a bottle which is only partly filled. Soon the fat globules will unite and form light yellow granules large enough to be seen. The shaking or churning should be continued until as much fat is collected as possible. After it is washed a few times in clean cold water, it is seen in an almost pure state. This fat is the principal constituent of butter, and also one of the important constituents of cheese.

**For the casein.** — A few drops of acid (or vinegar) should be added to the skimmed milk which was left after the cream was taken off. Soon it will coagulate or thicken. It should then be gently warmed to about 100° F., and carefully broken by a knife or spoon into a few pieces. The skimmed milk will slowly separate into curds and whey. When the whey amounts to more than half of the quantity of milk, it should be removed by pouring through a cloth strainer. The casein remains in the cloth. It is one of the principal constituents of cheese.

**For the albumin.** — Slowly heat the whey to 160° F. It will become somewhat cloudy and soon a soft jelly-like substance will collect on the surface. This is albumin, which has been coagulated by the heat. It is similar to the albumin or white of an egg. It should be separated by straining. This constituent is not used in the manufacture of butter or the ordinary varieties of cheese.

**For the sugar.** — A small quantity of whey which has been freed from its albumin is placed in a clean porcelain dish with a large bottom (as a saucer). This is warmed, care being taken not to burn it. It may be warmed in an oven with the door partly open. When the water has evaporated, a dry substance remains. This is about seven-eighths milk-sugar and one-eighth ash. It is not
practicable to separate the sugar in pure form from the ash. Sugar is not present in large quantity in either butter or cheese.

_For the ash._—A part of the mixture of sugar and ash is placed in a dish which will withstand high heat, or on the stove cover, and allowed to burn as long as it will. The small amount of incombustible matter left is milk ash. It is not an important constituent of either butter or cheese.

Fill two clean and scalded half-pint bottles with milk, labeling them A and B. Drop a very small piece of barnyard manure in B. Loosely cork or cover both bottles and set in a warm place. Note the difference in the contents of each bottle from day to day for a period of three or four days. Also the difference in odor of each.

How much (what percentage) of butter-fat must milk contain that is sold at retail, according to the laws of your state?

Who is Dr. S. M. Babcock? What is the importance of the milk-testing device that bears his name to the dairy industry?

Describe briefly the life of Pasteur. What are some of the important biological discoveries made by him? How have these discoveries affected our daily lives?

What precautions should be taken in producing milk on the average farm? Send for the dairy-barn score-card recommended by your state college of agriculture. Apply it to your own dairy barn and methods, and note wherein improvements can be made.

CLASS PROBLEMS

Let the pupils bring milk to school from different cows and herds, and make tests for fat (by the Babcock tester), for the casein and other contents. If there is not a regular cow-testing association in the district, the class may organize itself into a club for making such tests. It may also keep accounts of the cost of milk production, and post quotations of prices.
TOPIC 28

THE HOME

What is the end and purpose of farming? To grow good crops and raise many animals? No. Only to make money? No. To have the largest and best farm and the biggest and most attractive buildings? No. To be called the best farmer in the town? No. To develop the best personal home life? Yes, verily.

All the outward things are indeed essential or desirable, but they have little value unless they are centered and combined to make better homes and more useful citizens.

As one’s home is, so does one live. Here are gathered all the treasures, all the hopes, all the sacred memories.

210. THE FARM AND THE HOME ARE ONE

Unlike other persons, the farmer develops his occupation and his home at one and the same time. He lives on his farm. The merchant does not live in his store, or the manufacturer in his factory, the lawyer in his office, or the teacher in the schoolhouse.

Whatever adds value to the farm also adds value to the home, for the farm and home are one. The children roam over the farm from the front road to the back lot. They play where they will. When the land is sold, the house is sold also. Whatever improves the one, improves the whole.
If a person comes to buy the farm, he looks through the house to see how it is built and the condition in which it is kept. He looks over the barn, the orchard, the livestock, gives careful attention to the land. But this person might buy a mill or a mine without knowing where the miller or miner lives.

Therefore must we think of a home whenever we think of a farm.

211. IT IS A FAMILY ENTERPRISE

The manufacturer's wife and children may know very little about manufacturing, but every farm wife and every farm boy and girl knows very much about farming. It is said that they are born to it. Much of it they learn before they are aware of it and without knowing how they learned it. They use the words that farmers use and think in terms of land and crops and animals, of barns and fields, of seed-time and harvest.
If the father is away, the mother and the children are competent to "look after things," to feed the animals, to keep the work going. A good farm family is one of the best examples of coöperation.

The members of the family talk together about the crops, the welfare of the live-stock, the prospects, the farm situation. The children may have their own animals, or their own garden. Every member of the family is supposed to work. A farm is a family partnership.

Yet the farm-house has its compartments, to be devoted to particular uses. One is the kitchen, one the living-room, one the store-room. One of the rooms should be the office of the establishment. The farmer is now in business. He does not need to move to town to become a business man. His business should have a definite headquarters, where all the records may be kept.
So also should there be a rest-room for the mother, where she may be at ease and free from annoyance. The entire family should coöperate to make these two rooms of value to the home enterprise.

212. The Work and the Play

The farm is no place for idlers, or for those unwilling to do their part. The work is hard, but it is productive; one can see the results of one's labor. If one is brought up to be busy and to be useful, then does idling seem to be a hardship. It is those who are brought up with few responsibilities and with no expenditure of real effort, who look on farm work with dread. They look on any real work with dread.

Industry is the salvation of any people. The idlers and shirkers are parasites. The fault lies in their educa-
tion and their bringing up. If one is trained to it from the beginning, then does work become a satisfaction. Work is not to be avoided in any walk of life.

The interest of the work lies very much in understanding it, in knowing the reasons why, and in being able to look forward to the results.

There is little mental incentive to work all day and all the year at a machine that makes a small part of a shoe or a mechanism. But there should be great incentive in the thousands of experiences that come to a farmer in the course of the month. How many kinds of work does he do from waking to sleeping, how many things does he see, how many plans does he make?

Often the farmer wishes that he had fewer things to do. Yet he would not change places with the person who does only one thing.

The mind must be opened. This is the purpose of every class-teaching of farming, of every college of agriculture, of every experiment station, every text and book on farming, every farm paper, every farmers' institute, and every farm bureau. There is vast intellectual wealth now within reach of the farmer.

The boy and girl grow into these riches so early and unconsciously that they may not appreciate them. They do not think of the privilege they have to run and roam, to shout, to ride the horse, to find the apples, to build playhouses, to explore in fields and woods.

"All work and no play makes Jack a dull boy," is the old adage. This is true; but there are relatively few
farm girls and boys to which this applies in these days. Great plans are now made to organize play for children. These plans are good; yet we are to remember that there are other forms of recreation than play, and that those who have interesting and useful work and varied experiences may not need to play so regularly as those who work stated hours in shops and who are much given to idling the remainder of the time.

It is good to see some of the older and simpler games come back to the open country. Contests between clubs are good; so, also, are picnics, excursions, and visits. The school may encourage a wholesome play spirit.

213. The Home Premises

With the inside of the house it is not the purpose of this book to deal, but about the lawn and yard it may say something.

This is the day of the lawn mower. A good greensward is the foundation of the home picture, in all climates in which grass makes a good sod. The lawn should be clean, smooth, and kept well shaven. The land should be fertile so that the grass may be good. The grass should be very thick, for we want many fine leaves and stems and not a crop of hay. A lawn is not a mown meadow.

On the front lawn should be very few trees and bushes and no flower-beds. This subject we have discussed in Topic 18. The center should be open in general, free of obstructions, and of boxes and tubs in which plants try to grow. Of course, a few trees may stand here and there for shade, if shade is
needed; but there should not be so many trees and shrubs that there is no place for lawn.

Most of the planting should be at the sides and the rear, to frame the picture. Many of the native plants are good. The hardy and dependable things should be used, those that withstand the winter and drought.

It is a pleasure to experiment with the new things. These may very well be tried in the garden, if they are flowers or shrubs. About the borders of the place, along the fence, by a driveway, an abundance of flowers may often be grown with much satisfaction.

The chief interest in the premises is the residence. An attractive house is a great joy. Let us hope that it is kept in good repair, well painted, and that it always looks clean.

It is the mark of the good housekeeper that her house is neat. So should the yard be neat. It should be spick-and-span, which means that there is no rubbish or litter, that the grass is mown, the fence and gate in repair, the hitching-posts and horse-blocks and clothes-lines straight, the tools under cover, the roadsides in shape. Even the most ordinary place has an air of thrift if it is tidy.

The good housekeeper is also known by the arrangement of the furniture and the decorations. The objects are not scattered, without order. So do the premises gain great attraction if they are well arranged. The layout of the yard should follow a plan.

214. THE PUBLIC HAS A RIGHT

The farm is not locked up. The buildings, crops, and live-stock are not hidden. The house and the premises are seen by every passer-by.
The neighborhood is made up of the farms and premises. The pride of the rural community is the pride in these lands and homes. In a certain sense they belong to the community. Every one is interested to see them kept up.

So is one to have a proper regard for the neighbor. One owes it to the neighbor to keep one's property in good order. One owes it to the community. Neighborhood pride is a power for good. It brings the neighbors together and gives them a common interest. This community includes not only the farmers, but all who live therein.

We trust the time is not far distant when farm residences and other rural homes can be as definitely numbered and located as are houses in cities, and when directories of country people can be printed. This will not only facilitate business and communication, but will give a new public interest to the people in the open country.

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