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Practical Helps

—IN—

AGRICULTURE

—AND—

NATURE STUDY

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"The interest in the teaching of agriculture is but a part of a much larger question,—the movement for teaching by means of things that have come within the student's experience. Laboratory work and all manual work are but a part of the same movement. The primary purpose of teaching agriculture is not to make farmers. It is a human-interest subject. The underlying reason why such teaching is desirable is because it brings the school in touch with the home life—the daily life of the community. A large part of our teaching has had no relation whatever to our daily lives.

The teaching of agriculture will make better farmers who will make more money. It will lead more boys to choose farming as a profession, because it will open up a field for intellectual life whose existence they never suspected. But the great reason for this work is that it is one of the best means of training a student's mind, and it is one of the best means because it studies the things that come within his experience—the things with which and by which he lives."

—G. F. WARREN.

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By EDGAR S. JONES and HENRY L. FOWKES.

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PREFACE.

This booklet is intended to be used by the pupils or teachers of the rural or village schools as a supplementary book. It is designed as a book of material rather than an outline or a manual, containing an abundance of practical information and scientific facts. As it was written from the viewpoint of containing many helps and suggestions, it was impossible to include in a brief survey photographs or drawings. Instead of using the space for pictures, a number of bibliographies, scorecards and tables are inserted. Such topics as birds, soil, corn and cattle are intended as type lessons.

The authors realize that Agriculture and Nature Study can best be taught by observation and experimentation, hence they have endeavored to furnish material that would assist in making keener observers.

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HENRY L. FOWKES.

Taylorville, Ill., August, 1914.

Copies of this book may be obtained by addressing FOWKES AND JONES, Taylorville, Illinois.

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CORN.

KERNEL.—If we know the names of some of the parts of a kernel of corn and what purpose these parts serve, it will help in understanding what we will hear and read from time to time concerning the corn problem. If a few kernels of corn are placed in warm water for four or five hours the parts may be easily separated.

By referring to the above drawing, it will be seen that the general outline of a section of a kernel is shown. The part of the kernel that is fastened to the cob may be called the cap. The top part is known as the crown. By beginning at the cap, the covering may be easily removed. This coat or husk (hull) appears to be a single covering. How many are there? It may be said in brief that there are four parts of the kernel, viz: covering, starch (marked four in the drawing), protein cells, being numbered eight and nine, and the germ (marked six). The germ is also known as the embryo or heart. The end of the germ indicated by A forms the stalk of the plant, while the part designated by B becomes the root. We cannot tell by looking at this embryo whether it is alive or not, hence the necessity of testing seed-corn before planting. The kernel may be defined as a tiny plant with its first food, being protected by a covering. Under proper conditions of heat and moisture it will begin to grow.

Just as it requires several kinds of food for a person, so there is needed many kinds of food to cause the germ (the little stalk of corn) to become a stalk with an ear of corn upon it.

There are about twelve different foods needed for the corn plant. Six of the principal ones are, Oxygen, Carbon, Hydrogen, Nitrogen, Phosphorus and Potassium. The first three are gotten directly from the air or water. The last three are gotten from the soil by very small root-hairs that may be seen on the roots of any plant. Sometimes Nitrogen, Phosphorus or Potassium must be placed in the soil before a very large corn crop can be obtained, as these are the three foods whose supply is limited. (Clover will take Nitrogen from the air and place it in the ground.) Suppose a farmer in September has a mow full of hay. About February first he notices that his supply is becoming low. If he still wishes to feed his horses hay, there are three ways that he may do so: 1st. Place more hay in the mow. 2d. Feed the horses every third day. 3d. Lessen the amount that he has been feeding. Which way would be best? If there is a lack of phosphorus in the soil, it is necessary that there be "more hay put in the mow," if we expect the corn plant to be strong and healthful and produce a good ear.

USES OF THE PARTS OF THE KERNEL.—We usually think of corn as being the food of horses, cattle and hogs. The hull is made into bran, and when mixed with other material is a food for horses and cattle, but it is not as good, of course, as the whole kernel.

The germ is about one-tenth of the entire kernel and furnishes nearly all of the corn-oil. Corn-oil is the highest priced product of the kernel and is obtained by pressure. This oil is used extensively in the manufacture of soaps, paints and oil cloths. It is also mixed with rubber in the making of such articles as boots, shoes and rubber tires. After the oil is extracted the residue remaining is known as corn-oil cake and is used as a food for cattle.

The starch of the kernel is used in the making of laundry starch, candies, jelly and syrup. Large quantities of the starch of corn is used in the making of muslins and gingham.

The parts marked eight and nine in the sketch contain a large percentage of protein—a food for all animals. Some corn contains more protein than other, hence it is better for feeding purposes.

TESTING THE KERNEL.—Two ears of corn may have the same general appearance and the germs from different kernels from both ears will appear to be alike, but still the embryo from one ear may germinate while those of the other will not. With this thought in mind, it is very plain that a better stand of corn will be gotten if every ear of corn to be planted is tested in some way.

There are several simple and practical testing methods. One of the most simple plans is to place a number of ears of corn upon a bench or table. A piece of dampened muslin or other suitable cloth eight or ten feet long and six or eight inches wide should be placed alongside of the ears. Five or six kernels may now be taken from each ear and placed upon the cloth opposite the ear from which it is taken. After the kernels are taken from the ears the cloth should be carefully rolled and placed in a warm place and covered with moistened paper or cloth. The roll should be dampened frequently. By leaving the ears of corn as they were first placed and by unrolling the cloth after the seeds have sprouted, it will be found that the sprouted ones will appear opposite the ears from which they were taken. By this method it will be quite easy to discard the bad ears.

Another method is to take a box two or three inches deep and fill it to the depth of one or two inches with shavings, saw-dust, blotting paper, sand or cloths. The material in the bottom of the box should be well moistened. Cover the layer in the bottom with a cloth or white paper. Divide this covering into two-inch squares. Number the squares and the ears of corn. From ear number one select five grains and place them on the square numbered one. Continue until all the squares are occupied. A wet cloth should be placed over the kernels and a lid placed on the box. If possible, the temperature of the room must be about seventy or eighty degrees and should never be lower than sixty degrees. Prove that tested seed corn will produce more bushels of corn per acre than that which is untested. Seed testers that are heated by oil may be obtained from reputable firms. They are, of course, better than any home-made tester. Why?

QUESTIONS FOR DISCUSSION.

1. Do kernels near the butt of the ear germinate more slowly than those taken from the tip or middle?
2. Is an ear of yellow corn with a white cob as good as an ear of yellow corn with a red cob?
3. Should the kernels from the tip of the ear be planted?
4. Corn contains about ten per cent protein and five per cent oil. Do you think it would be possible to breed corn so that there would be fifteen per cent protein and less starch?
5. A farmer said: "The way to select seed corn is to select the stalks during summer time and then later in the season gather the best ears." Was he right or wrong?

EXPERIMENTS.

1. Simple test to see if there is starch in corn: Place a drop or two of iodine on the white part of two or three mashed kernels. The parts that turn blue are starch. Try the same test for the potato.
2. A test to determine whether there is oil in the corn kernel: Mash

the heart or embryo of the corn kernel on a piece of paper. A grease spot appears. Try the embryo of the bean or cotton.

3. A test to locate the cellulose of the corn kernel: Soak a piece of paper and the outer covering of the kernel. A comparison of the texture shows them to be the same. Cellulose is the framework of the cells and of the tissues in all plant life.

THE CORN PLANT.—If the study of the corn plant is to be made in September or October, the entire plant should be brought before the class. A discussion may then follow concerning the culture, improvement, roots, stem, leaves, flowers and kernel.

ROOTS.—There are two general classes of corn roots. The main or fibrous roots grow outward and downward from the base of the stalk. They are very numerous and often extend out quite a distance from the hill or to quite a depth in the soil. For this reason alone the fertilizer that is used should be scattered evenly over the ground and then plowed under to the depth of at least five or six inches.

The brace roots, the ones that come from the joints, begin to appear at about the time the corn begins to tassel. Quite often some of the brace roots do not reach the ground.

STALKS AND LEAVES.—The joints of the cornstalk are known as nodes and the space between the joints are the internodes. By cutting across the stalk, thready fibers may be seen. These carry the sap and the food that has been prepared in the leaves. By a careful examination it will be seen that these tiny tubes extend into the leaves. It may be said that the main purpose of the leaves is to make food for the growing plant and for the seed. This is done by the sun shining on the food elements in the leaf that have been brought to the leaf through these thread-like bodies.

It will be noticed that the margin of the leaf is much longer than the middle of the leaf. Have you ever noticed the curling of the corn leaf?

In the selection of seed corn the farmer usually chooses the ears from the best appearing stalks. Several characteristics are taken into consideration in determining what is meant by a good stalk. Among these are, height of the stalk, height of the ear from the ground, number of ears per stalk, absence of suckers, freeness from smut, good blades, and a short ear stalk.

FLOWERS.—In a common flower the essential parts are the stamens and pistils. The stamens produce the pollen. Under the microscope this dust-like pollen has the appearance of round-like bodies, something the shape of an egg. In producing the seed, the pollen falls upon the pistil. It begins to grow and form a tiny tube that continues to grow until it reaches the enlarged part (the ovary) of the pistil. In the ovary are, also, two cells. One of the cells unites with one of the ovary cells and forms the germ or heart of the plant. By the uniting of the other two cells is formed the food part of the kernel. The falling of the pollen on the pistil is called **pollination**, and the uniting of the cells is called **fertilization**.

In the corn plant the tassels contain the stamens and the shoots which later become the ear, the pistils.

Each silk is fastened to a round body on the embryo ear. This round body is the ovary. The same process of fertilization occurs in the corn plant as in any other common plant.

EARS.—In the study of the ears there should be two or three varieties at hand. The short stem that bears the ear is called the **shank**. Many corn growers prefer the drooping ear to the one that is partially erect. The erect ear is more liable to be water-soaked and thus become moldy. The drooping ear also has the advantage in that it is more easily shucked.

SELECTION, DRYING AND STORING OF SEED CORN.—It is recognized that the better the seed the better the crop. Many farmers select their seed early in the fall from the part of the field that has the best general appearance, while others pass through the field at the time of the tasseling and check the best appearing stalks. The blades, height of ear from ground, tassels, silks and the condition of the surrounding ears are taken into consideration in the selection of the stalks. Later in the summer, when the ear

is well matured and before the frosts come, the ears are gathered from the checked stalks, husked and thoroughly dried before the freezes may affect the kernels. If a farmer gives the proper attention to the selecting, storing, testing, planting and cultivating of seed corn, it is not long until he becomes interested in corn breeding. There is always a demand for well selected and well bred seed corn.

After the seed corn has been selected from the field it should be placed in a dry, airy room. It may be hung on wires or strings or may be placed on shelves prepared for it. Racks can be made which will keep the ears separate and at the same time the rack may be suspended from the rafters of the roof of an implement shed, hay mow or corn crib. This keeps it from being molested by rats or mice. Farmers quite often dry the seed corn in a summer kitchen or other room where artificial heat may be used.

Many farmers go a step farther in the selection of seed than has been suggested. They make what is known as a breeding plot. This consists of several rows of corn selected in the best portion of the field. At the time of the tasseling of the corn the inferior tassels are removed in order that there may be no self-fertilization. The typical hill of corn should contain at least two stalks. The following characteristics should apply to a type stalk in a breeding plot:

1. The brace roots should be well formed.
2. Gradually tapering from the base to the tassels.
3. There should not be any suckers.
4. The ear should be located just a little above the middle point of the stalk.

SHRINKAGE OF CORN.—Corn on the market is generally known as "White Corn" and "Yellow Corn," and if mixed it is known as "Corn." There are usually three grades of corn. In the grading of the corn there are three points, the **color**, **soundness**, and **moisture**. Number 1 means that the yellow corn must be yellow, sound, clean and dry. Number 1 white corn, must meet the same requirements. Number 2 yellow corn means that it must be three-fourths yellow, dry and reasonably clean. Number 2 white, must be about seven-eighths white, reasonably clean and dry. Number 3 yellow shall be three-fourths yellow, reasonably clean and reasonably dry. Number 3 white must be seven-eighths white, reasonably clean and reasonably dry.

Usually the price in December is much lower than in the following May. One of the causes of this is the shrinkage of corn during the year. If the corn is gathered during a dry fall and kept in good cribs there is not much loss in moisture. Under unfavorable conditions there is often a shrinkage of 10 per cent. If the corn is weighed when it is placed in the crib and then weighed again on removing it, the exact amount of shrinkage can be determined. Should the corn remain in a crib for a year, there will be but little loss of moisture during the second year.

VARIETIES OF CORN.—Corn or maize is a native of North America, being first cultivated by the English after their settlements in Virginia and Massachusetts. There are now several hundred varieties of corn, among which may be mentioned Reid's Yellow Dent, Golden Eagle, Boone County White, Riley's Favorite, Leaming, and the Silver Mine.

There are seven species of corn, four being common to the Middle West. The most common is the Dent corn.

The kernel is wedge shaped, the summit being drawn in making it indented, hence its name. This is the white or yellow corn of the field. Another species is the sweet corn. It has a shriveled condition and is the kind used for canning. The pop-corn is recognized by its small grains. The popping is caused by the explosion of the moisture upon the application of intense heat. The flint corn is hard and smooth, having rather oval grains. This species is used for feeding cattle or for the filling of silos.

CHARACTERISTICS OF A GOOD EAR.—Many of the characteristics of a good ear of corn must be determined by growing tests, but still there are a number of points that may be found by a careful examination of the ear. If an ear is cylindrical in form and rounded at the tip and butt, it will have more and better kernels than an ear of apparently the same size but which has

an irregular form. The size and color of the cob have much to do in increasing the yield in any particular species. The shape, size and arrangement of the kernels are factors in bringing about a typical ear. A wedge-shaped kernel prevents any waste of space. The corn score card given below suggests the detailed characteristics that are considered in comparing a sample ear:

CORN SCORE CARD.

	Length.	Circumference.	Proportion of corn to cob.
Northern Illinois	9 to 10	6.75 to 7.50	88 percent.
Central and Southern Illinois	10 to 11	7.00 to 7.75	88 percent.

Points.	Perfect Ear.	Sample Ear.
1. Uniformity of exhibit	5	
2. Shape of ear	10	
3. Length of ear	5	
4. Circumference of ear	5	
5. Tip of ear	5	
6. Butt of ear	5	
7. Kernel uniformity	5	
8. Kernel shape	5	
9. Color, grain and cob	10	
10. Space between rows	5	
11. Vitality	10	
12. Space between kernels	10	
13. Trueness to type	10	
14. Proportion of shelled corn to cob.....	10	
	<hr/> 100	

EXPLANATION OF POINTS.

1. Uniformity of exhibit.—The ears should resemble each other in size and shape.

2. Shape of ear.—The ear is to be cylindrical. It must taper from butt to tip, the grains gradually getting smaller or else there will be a row or two of kernels dropped.

3. Length of ear.—Different species require different standards.

4. Circumference of ears.—This depends upon the depth of the kernel and the thickness of the cob. A deep kernel is always desirable.

5. Tips of ears.—Kernels should be oval shaped and regular in form. The part of the tip covered is counted.

6. Butts of ears.—The kernels should extend in regular order over the butt, leaving a depression when the shank is removed.

7. Kernel uniformity.—The kernels from the various ears to be uniform in shape and size.

8. Kernel shape.—Kernels should touch from crown to tip, but still be wedge shaped. The tip end should be well formed to insure a healthy germ.

9. Color.—An ear with red cob and white kernel is not desirable. It is a "scrub" ear.

10. Space between rows.—Should be sufficient for drying out of rows.

11. Vitality.—Fully ripe, dry and of strong vitality. Grains of a pinkish hue and the germ white, being somewhat brittle.

12. Space between kernels.—Shows that corn lacks nutritive value and has been improperly matured.

13. Trueness to type.—Compares favorably with other ears of same variety.

14. Proportion of shelled corn to ear.—Suppose there are 10 ears. Shell and weigh the corn taken from five ears. Divide the weight of the corn by the total weight of the ears to get the percent of corn.

Below is given the length, circumference and percent of corn to the cob of three varieties of corn:

	Length.	Circumference.	Percent.
Reid's Yellow Dent	10 to 11	7. to 7.75	88
Riley's Favorite	9 to 10	6.75 to 7.5	90
Champion White Pearl	8 to 10	6.75 to 7.5	85

PREPARATION OF SOIL.—The condition of the surface of the soil determines to a large extent the amount of rainfall that will be absorbed. The condition of the subsoil is also a large factor in preparing the soil for planting and cultivation. In many clay subsoils a better crop can be raised if deeprooted plants, such as alfalfa and clover, are planted. The roots of these plants make openings through which the water may penetrate the soil. Some subsoils, however, are too porous and much vegetable matter must be turned under if the best crops are to be expected. Corn needs at least from five to six inches of rainfall in order to produce a good crop, hence one of the main things in the preparation of the soil is to cultivate the land in such a manner that the rainfall of the spring may be kept in the soil. If the soil is kept thoroughly pulverized it prevents the evaporation of much moisture. After the corn has come up it is often advisable to have the surface layer a mulch of at least an inch in thickness. If a rain makes a crust of this mulch it must in most soils be immediately broken or else evaporation begins again.

An excess of water, however, often does as much injury to the growing corn as does the lack of it. If the soil is to remain in a good state of preparation there must be sufficient drainage to allow the air to enter the soil. The three important foods that the corn plant needs are nitrogen, phosphorus and potash. They are absorbed by the tiny rootlets and then carried to the leaves, and by the action of the chlorophyll and the sunlight these elements are changed into food materials, such as starch, sugar, fats and proteids. Much nitrogen can be stored up in the soil by the planting of clover or alfalfa, hence much attention should be given from year to year to the storage of plant food in the soil. If proper rotation does not occur the careful yearly preparation of the soil lacks the vital factor. It is said that when you sell ten dollars worth of corn you have taken from the farm about four dollars worth of fertilizer.

Bulletin No. 126, of the Agricultural Experiment Station of the University of Illinois says concerning the planting of corn: "On all ordinary corn belt land of the northern part of Illinois, plant corn hills not more than thirty-six inches apart and plant at least three kernels per hill." Also, "In Central Illinois in the common brown silt loam prairie land, of a productive capacity greater than fifty bushels per acre, plant corn 39.6 inches between the hills and drop three kernels per hill."

Usually the early planting of corn produces a larger yield than does the late planting. The depth of planting depends nearly entirely upon the quality and moisture of the soil. The lateness of the season, however, nearly always suggests shallow planting.

CORN DAYS AND CORN CONTESTS.—Farmers' Institutes, private citizens and school officers are doing much to awaken an interest in the growing of more and better corn. Each school in the corn belt should set aside at least one day a year to be known as "Corn Day." Every farmer boy should enter the contest in his school district, township, county or congressional district for the better yield of corn. In Christian County, Illinois, the bankers, in 1913, offered \$200 in prizes for the raising of better corn. There was a one-acre contest and a ten-acre contest. The conditions were as follows:

1. Age limit, 10 to 18 years.
2. The name and type of seed corn must be recorded.
3. An account of the time required for the various operations to be kept.
4. Final measurement of the area and husking shall be under the supervision of a committee.
5. The corn must be gathered and weighed. Two 100 pound lots must be weighed from different parts of the area. Then the contestant must shell each lot and weigh the shelled corn. The weights of the two lots should be added and divided by two, in order to find the average percentage of shelled corn. The total weight of the corn should then be multiplied by the percent thus obtained, and the result divided by 56 to get the number of bushels.

Suppose that the two lots of shelled corn weigh 86 lbs. and 84 lbs. respectively, and the total weight of corn produced on the acre is 7,000 lbs., the process would be as follows:

86 lbs.
84 lbs.

170 divided by 2 = 85, the percent.

7000
.85

35000
56000

5950.00 divided by 56 = 106 with a remainder of 14; hence the area contains 106 bu. 14 lbs.

6. In estimating profits uniform prices will be used, for instance, \$5 per acre for rent, 10 cents per hour for the work of each boy, 5 cents per hour for each horse, \$2 for a two-horse load of stable manure, and market prices for commercial fertilizers.

7. The contestant must show that he did all the work on the corn.

8. In awarding prizes the following basis shall be used:

Greatest yield per acre—50 percent.

Best showing of profit in investment—30 percent.

Best written history of crop—20 percent.

CORN BULLETINS.

List of helpful pamphlets that may be obtained free:

Directions for testing seed corn. Corn Improvement Committee, Board of Trade, Chicago, Illinois.

Distance between Hills of Corn..Bulletin 126, Agri. College, Urbana, Ill.
Shrinkage of Corn.....Bulletin 113, Agri. College, Urbana, Ill.
Ear Rots of Corn.....Bulletin 133, Agri. College, Urbana, Ill.
Corn BreedingBulletin 128, Agri. College, Urbana, Ill.
Corn-field AntBulletin 131, Agri. College, Urbana, Ill.
Physical Characters in Cornplant.Bulletin 132, Agri. College, Urbana, Ill.
Fertilizers in the Corn-Belt....Bulletin 165, Agri. College, Urbana, Ill.
Germination of Seed Corn....Bulletin 253, U. S. Dept. of Agri., Wash., D. C.
Production of Good Seed Corn..Bulletin 229, U. S. Dept. of Agri., Wash., D. C.
School Lesson on Corn.....Bulletin 409, U. S. Dept. of Agri., Wash., D. C.
Corn CultivationBulletin 414, U. S. Dept. of Agri., Wash., D. C.
Corn and Its UsesExtension Bulletin, Agri. College, Urbana, Ill.
Feeding Corn to Live Stock....Bulletin 102, Agri. College, Urbana, Ill.

CORN GRADE RULES ESTABLISHED BY FEDERAL GOVERNMENT FOR ALL MARKETS.

Effective Everywhere July 1, 1914.

NEW GRADES FOR COMMERCIAL CORN.

Promulgated by the Secretary of Agriculture, Washington, D. C. Effective July 1, 1914.

No. 1 CORN.—Shall be sweet, exclusive of heat damaged or mahogany kernels, and must not contain more than

- 14 per cent moisture.
- 2 per cent damaged corn.
- 1 per cent foreign material.
- 2 per cent cracked corn.

No. 2 CORN.—Shall be sweet exclusive of heat damaged or mahogany kernels and must not contain more than

- 15.5 per cent moisture.
- 4 per cent damaged corn.
- 1 per cent foreign material.
- 3 per cent cracked corn.

No. 3 CORN.—Shall be sweet, exclusive of heat damaged or mahogany kernels and must not contain more than

- 17.5 per cent moisture,
- 6 per cent damaged corn.
- 2 per cent foreign material.
- 4 per cent cracked corn.

No. 4 CORN.—Shall be sweet and must not contain more than

- 19.5 per cent moisture.
- 8 per cent damaged corn.
- 2 per cent foreign material.
- 4 per cent cracked corn.
- $\frac{1}{2}$ per cent heat damaged or mahogany kernels.

No. 5 CORN.—Shall be sweet and must not contain more than

- 21.5 per cent moisture.
- 10 per cent damaged corn.
- 3 per cent foreign material.
- 5 per cent cracked corn.
- 1 per cent heat damaged or mahogany kernels.

No. 6 CORN.—Must not contain more than

- 23 per cent moisture.
- 15 per cent damaged corn.
- 5 per cent foreign material.
- 3 per cent heat damaged or mahogany kernels.

May be musty, sour, or include corn of inferior quality, such as immature and badly blistered corn.

SAMPLE CORN.—All corn that does not meet the requirements of either of the six numerical grades by reason of excessive moisture, damaged kernels, foreign matter, cracked corn, hot corn, heat damaged corn, fire burnt corn, infested with live weevil, or otherwise of distinctly low grade.

WHITE CORN (All Grades).—Shall consist of not less than 98 per cent white corn.

YELLOW CORN (All Grades).—Shall consist of not less than 95 per cent yellow corn.

MIXED CORN (All Grades).—Shall consist of corn of various colors not coming within the limits for color prescribed for white or yellow corn.

FOREIGN MATERIAL.—Includes dirt, cob, other grains, finely broken corn, etc.

CRACKED CORN.—Includes all coarsely broken pieces of kernels that will pass through a perforated sieve with round holes, one-fourth inch in diameter, except, that the material defined as finely broken corn shall not be considered as cracked corn.

FINE BROKEN CORN.—Includes all broken particles of corn that will pass through a perforated sieve with round holes, $\frac{9}{64}$ -inch in diameter.

MOISTURE PERCENTAGES.—As provided in grade specifications shall conform to results obtained by the standard method and tester described in Circular No. 72, Bureau of Plant Industry, U. S. Department of Agriculture.

NOTE.—It is understood that the damaged corn; the foreign material, including pieces of cob, dirt, finely broken corn, other grains, etc., and the coarsely broken or cracked corn as provided for under the various grades shall be such as occur naturally in corn when handled under good conditions.

WHEAT.

Wheat is the chief crop in the temperate zones. Wheat may be classified in many different ways, first there is the smooth and bearded, as well as the winter and the spring.

From the fact that the wheat is such a common plant it has a number of enemies, chief among which are, the chinch bug, Hessian fly, the wheat midge, and the army worm. To combat the chinch bug and the Hessian fly, it is necessary to keep the fields and fences free from trash and underbrush.

Among the varieties in the middle west are, Turkey Red, Dawson's Golden Chaff, Indiana Swamp, Fulcaster and Harvest King. The Turkey Red wheat is the more common in central and northern Illinois, while the Harvest King and Fulcaster are the more common varieties of the southern part of the State.

THE CHINCH BUG.—If we are to combat successfully this little brown colored, full grown insect, (the young chinch bug is a bright red), it is necessary that we become more familiar with, where and how he lives. The fore wings are white, each having a dark spot near the middle.

Many insects have but one generation during the entire spring and summer, but this is not generally true in the case of the chinch bug as there are two generations in nearly all latitudes. When the freezes begin in the fall the adult bug leaves the fields where he has been staying and takes up his natural abode for the winter. In most instances these winter quarters are in neglected fence corners or along fences or division lines where the grass and weeds are often allowed to grow. Small brush heaps, tufts of grass along the ditches or scattered bunches of hay and straw are virtually "hot beds" where these pests are able to withstand the most rigorous winters. About the middle of April or the first of May these hardy insects come from their winter home and begin to lay the eggs in such fields as the wheat, the clover and timothy. The eggs are laid on the lower parts of the plants.

The product of these eggs do their greatest injury to the wheat and oats. Formerly the depredations of the chinch bug seemed to be confined to the wheat and corn crops but now he invades other fields and often does as much injury to an oats crop as he does to his choice articles of diet. The chinch bug moults four times and in the stage just preceding the one when they acquire the fully developed wings, they shed their complete covering. Quite often it is taken for granted that these outgrown shells are dead bugs. After leaving the wheatfield, for instance, the bugs travel principally by foot into nearby cornfields. It is while the bug is in this stage of development that it does its greatest damage, however if no check is placed on him now it means a greater number for the propagation of the second generation about midsummer. This new generation does much damage to the corn during the latter part of July and through August. They travel principally by wing during these months.

It may be safely figured that an extermination of a thousand adults in early spring would be about the same as the destruction of one hundred fifty thousand of the first generation that come forth about sixty days later, or to carry the computation to the second generation of midsummer would mean that an army of 22,500,000,000 would have to be destroyed to equal the one thousand adults that have lived through the winter.

Many practical lines of attack on the extermination of this destructive insect have been effectively made but in many instances the attention has been given to the destruction of the pests after they have started on their depredations rather than of attempting to prevent their propagation. If the weeds in fence corners, weed ways, bunch heaps, piles of leaves and other similar places were destroyed in early spring by burning there would be a visible decrease in the number of the pests just as there is an absence of mosquitoes in a well drained tract of land. Of course, much better results could be attained if infested communities would have "clean up" day at about the same time in the spring.

Too often the destruction of these natural breeding places does not occur until after the bugs have flown to the places where they deposit the eggs. Another factor that enters largely into the lessening of the number of the winter adults is the Bob White. If for no other reason than this the quail family should not be molested at any time during the year. During the late fall also

the quail eats many of these brown bugs. The assumption can be made at this time that if neighborhoods and groups of neighborhoods would give the proper attention to the destroying of the breeding grounds that the first and second generations could be reduced to a minimum.

When an army of undeveloped bugs start, for example, from a wheat field to a cornfield something definite must be done at once. A line of crude oil may be placed around an infested field, thus stopping their forward movement. Holes two or three feet deep at certain intervals may be dug just within the oil line. Nearly invariably the bugs fall into these traps and are unable to crawl out. During an extremely dry season a dust furrow may be made around a cornfield. A log, wheel or other cylindrical object may be used to keep the depth of the furrow regular. By this method the drag must be kept continually going as this keeps the dust in a proper condition for stopping the progress of the bugs and at the same time kills the bugs that continually fall into the furrow.

After the bugs have attacked the first rows of corn they will be reduced materially, possibly 80 per cent, by applying a spray of kerosene emulsion or one of water, tobacco and soap. The cost of either spray is a small item when a comparison is made with the good that is done. The cost should not exceed two dollars per acre.

LEGUMES.

Among the plants that are known as legumes may be mentioned, alfalfa, red clover, white clover, sweet clover, alsike, cowpeas, soybeans and vetch. In all the species the leaves are arranged around the stem in a regular order. There is also a great similarity in the roots, there being a main root from which many smaller roots branch. In nearly all soils the roots have small lumps or nodules on them. These nodules are produced by bacteria that live in the soil. They have the power of taking the nitrogen from the air and adding it to the soil. As nitrogen is one of the food elements of nearly all plants it is necessary that to get the best crops some species of legumes must be used.

RED CLOVER.—Probably the most important legume is red clover, but alfalfa is gradually taking its place in many sections. One of the principal factors in a study of red clover is the selection of the seed. Much clover offered for sale contains many weed seeds, as dodder, buck horn and trefoil.

ALSIKE.—Alsike is very similar to red clover but is more adapted to wet land than is the red clover.

WHITE CLOVER.—White clover is used principally for pastures and lawns. It is a much hardier plant than the red clover.

COW PEAS.—The cow pea is a plant that grows in rather a bushy form. It is used in many sections as a substitute for oats, hay, or other farm animal food.

SOYBEANS.—The soybean often grows to a height of three feet, having a hundred or more pods. The leaves of the soybean are the parts that are used for food. This plant has the power of adding an unusually large quantity of nitrogen to the soil.

VETCHES.—The principal use of the vetches is to plow them under so that the soil may be enriched by the decay of the plant.

ALFALFA.—The growing of alfalfa, the typical forage plant, has begun to attract the attention of many farmers of Illinois. Quite often failure to successfully grow this hardy plant is not so much the fault of the plant as it is to lack of knowledge of how the plant grows and the treatment it needs. It can be grown on practically any soil except a wet acid soil. The bacteria found in the nodules on the alfalfa roots cannot live in an acid soil. Lime must be used to neutralize the acidity of such a soil before the attempt is made to plant the alfalfa. In conjunction with the use of limestone there must be the inoculation of the seed bed. Much care must be taken in the preparation of the seed bed in the way of destroying all weeds and grasses. Just preceding the sowing of the alfalfa seed, soil taken from an alfalfa field should be scattered evenly over the plot so that the bacteria may be scattered in all parts of the field. After the dirt has been sown the field should be disked or harrowed. This gives the bacteria a chance of getting below the surface and not being exposed to the sun. If an alfalfa field is not near, the inoculated dirt may be obtained from the bed of the common sweet clover that grows along the public roads.

SEED.—It usually requires about twenty pounds of alfalfa seed for an acre of ground. There are many varieties of seeds but one of the best for Illinois soil is called Grimm's alfalfa. Alfalfa may be planted in August or April.

If a full discussion of the subject of alfalfa is desired address a post card to Illinois Farmers' Institute, Springfield, Illinois, and receive a free copy of *Alfalfa Growing in Illinois*. It is a valuable book of 116 pages.

FORAGE CROPS.

Aside from the forage crops mentioned under the topic of legumes, there may be mentioned the common grasses, and the rougher forms as kaffircorn, sorghum, millet and rape. Among the common grasses are blue grass, timothy, orchard grass and red top. The thing of importance is a study of the plants that are best suited to the local community and at the same time a study of the adulteration of the various seeds. With a fifty cent magnifying glass the pupil will soon learn to recognize at sight the seed as well as many of the common adulterants.

WEEDS.

The main object in a study of the weed is to get the notion that the eradication of the plant depends upon the lessening of the production of the seed. An interest may be awakened in the subject of weeds if a collection of the seeds is made so that the student may know the plant as well as the seed.

Some weeds may be reduced in numbers by merely cutting the plant before the seeds ripen. In other instances the plant must be "dug up by the roots," so to speak, otherwise the mere cutting of the stalk does but little good. Salt or acids may be placed upon the root stalks of many plants, thus destroying them. With but very few exceptions deep plowing destroys the worst of weeds. The keeping of the fence corners, fields, and byways free from weeds means a lesser number in the grain fields, hence a larger crop. (Farmers often raise larger crops on account of the work placed upon the soil in the attempt to exterminate the weed.)

Many weeds are used as medicine. Sometimes it is the leaf, sometimes the root, sometimes the seed, and sometimes the stalk. Among the common medicine weeds are dandelion, burdock, yellow dock, quick grass, mullein, tansy, catnip, and jimson weed.

SEED TESTING.

In the planting of clover, alfalfa, oats, blue grass and timothy it is of much economical importance that the individual distinguish the grade of seed by the physical examination. This can be done by examining the seed under a hand glass. Quite frequently old seed is mixed with the new seed or the weed seed is not separated from the good grass seed. By experimenting with a number of samples it may be easily discovered the proportion of dirt, shriveled clover seed, plump clover seed and weed seeds in a sack of clover seed. Place small quantities of the seed upon a clean white paper and make the inspection with the small microscope, separating the various adulterants into groups. Among the seeds often found in red clover are buckhorn, dodder, trefoil and wild carrot.

SOIL.

ORIGIN.—Soil is the thin covering of the earth which can be tilled and in which plants grow. It is composed of fine particles of rock and decayed plants.

At first the earth's surface was solid rock. Through centuries of time the great forces of nature have been crumbling this rock. The natural forces, or agents, as they are usually called, which break up the rocky material, are given below:

1. GLACIERS.—A glacier is a great mass of snow and ice moving slowly over the surface of the earth. It wears away hills and mountains, fills valleys, and grinds the rock beneath it into fine particles. A great many years ago a large portion of North America was covered by a glacier which gradually moved southward producing in its course the fine soil characteristic of this region. Large parts of Northern and Central Illinois were covered by this glacier, traces of which may yet be seen in the sand banks or gravel banks left by its melting.

2. WATER.—Running water has been an important agent of soil formation. Just as our brooks and rivers now carry muddy soil towards their mouths so they carried many years ago, ground rock, which had been worn from the bed rock by the action of water, or large pieces of rock which were thrown together or against the banks of the stream until they were ground finer. Solid rock is often broken into pieces by the freezing of the water which has found its way into cracks.

3. AIR.—The oxygen and carbonic acid in the air unite with certain substances in the rock causing a kind of rock-decay which results in the crumbling of the rock. This action of the air is called oxidation. A familiar illustration of this action of air, is the rust on a knife blade or the stove pipe.

4. HEAT AND COLD.—The heat of the sun causes rock to expand. Rock is a mineral made up of a number of different substances. These substances do not expand the same amount and in the same directions. When the rock begins to cool the substances do not cool equally. This unequal expansion and contraction cause the rock to break into fragments.

5. PLANTS.—The roots of plants often grow into the crevices of rocks causing them to be broken apart. An acid is formed by the decay of plants and roots which has a tendency to dissolve the rock which it touches.

The decay of plants has helped very greatly in the formation of soil. In fact some soils have been formed almost entirely by decayed vegetation, which is called *humus*. Leaf mold which is found under the carpet of dead leaves is a good example of humus. . . .

6. ANIMALS.—Animals have played an important part in the formation of soil. Burrowing animals, as the gopher, mole, prairie dog, ground squirrel, earthworm and insects, aid in preparing the soil for plant growth by bringing the deeper soil to the surface and keeping it open and porous to aid in the free movement of air and water.

Thus we see how the great natural forces enter into the making of the soil in which our plant life grows.

KINDS OF SOILS.

Soils are named according to the proportion of rock particles of certain size they contain, or according to the amount of vegetable matter they contain. They are usually divided into three classes—sandy, clay and peat. There are many intermediate types of soil between these classes depending on the amount of the different ingredients each contains. These soils are called *loams*.

A sandy soil is one composed largely of sand. It is very loose and allows air and water to pass readily through it. This type of soil is easy to work, but not rich in plant food. It is, however, adapted to the growth of early vegetables and sweet potatoes.

The intermediate types of sandy soils are sandy loams, light loams and

medium sandy loams. Of these the medium sandy loams are best adapted to the regular farm crops.

A clay soil is composed of very fine particles. It is hard to work and when wet is plastic and sticky. Since clay particles have a tendency to cling together and do not crumble on drying, this soil is used in making tile, brick and pottery.

Water does not evaporate from clay soil nor circulate through it very readily.

Clay alone makes a very poor farm soil, but soil composed of as much as 40% or 50% of clay may be well adapted to the growing of regular farm crops.

The clay loams are generally known as medium clay loams and heavy clay loams.

Peat is composed largely of vegetable matter that has partially decayed under water. Usually it does not contain more than 25% of rock particles. It is found in bogs, swamps and other wet places. Many of these bogs are found in Northern United States and Canada. When peat has become more thoroughly decomposed it is called muck.

These soils are excellent for growing celery, onions, cauliflower and cabbage, when they are well drained and supplied plentifully with lime.

In addition to the soils named here are several kinds of gravelly soils known as gravelly sandy soils, gravelly clay soils and gravelly loamy soils, dependent upon the amount of stone and other soil ingredients. In gravelly soils the stone particles vary in diameter from $\frac{1}{8}$ -in. to 2 inches.

Stony soils are those that contain many large stones.

Both gravelly and stony soils are more adapted to orchards and general farming than to vegetable growing.

PRACTICAL EXERCISES.—Ask the pupils to collect and bring to school as many different kinds of soils as they can find in the neighborhood.

These specimens should be classified, put in bottles and marked to show the kind of soil and the place where each was found. Weigh each sample. After a few weeks weigh again and explain the change.

From your knowledge of soils determine which are most common in your neighborhood.

Which soils are best adapted for crop growing? Why?

Put samples of soils in dishes or glass tumblers that are almost full of water. Stir each sample thoroughly and note which settles first. Let them stand for a time and notice the condition of the water in each. Stir again, and after the soil has settled pour off all the water leaving the settlements in the bottom of the glass. Notice the amount of sand in each.

The following table has been adapted from "Soil Fertility and Permanent Agriculture," by Hopkins.

Peat	With 25 to 75 per cent of organic matter.
Peaty Loam	Ten to 25 per cent organic matter with loam.
Muck	Ten to 25 per cent organic matter with clay.
Clay	Plastic clay predominating.
Clay Loam	Much clay with loam.
Silt Loam	Much silt with loam.
Loam	Sand, silt, clay and organic matter, with neither markedly predominating.
Sandy Loam	Much sand with loam.
Sand	Sand without much silt or clay.
Gravelly Loam	Gravel with loam.
Gravel	Gravel without much silt or clay.
Stony Loam	Stones with loam.
Rock Out-Crop	Disintegrating rock.

Write to the Agricultural Experiment Station at the University of Illinois, Urbana, for Bulletin No. 123, Fertility in Illinois Soils. This bulletin will be found very helpful in classifying the kinds of soil in Illinois.

WATER IN SOIL.

Since water in the soil is necessary for plant growth, fertile soils must be liberally supplied with it. All the water in the soil comes from rain. Much of the rainfall runs into streams before it can be absorbed, and is carried away. The rest of it soaks into the soil and becomes available for plant-food.

FORMS OF WATER IN SOIL.—Water in the soil may be classed as free water, capillary water and hygroscopic, or fine film water.

FREE WATER is that which percolates downward through the soil under the influence of gravity until it reaches and maintains a given level. It is called also hygrostatic water and ground water. It is this water which supplies wells and springs.

CAPILLARY WATER is that which is held in the capillary spaces or pores of the soil. It soaks through the soil in any direction much like oil passes through a wick. In soils which have small spaces, as clay, the water does not pass through readily, but it passes very quickly through loose, coarse-grained soil, as sand.

Capillary water is called also coarse film or simply film water, because it clings to the soil particles in little films. It is this water which is used by plants. As the capillary moisture is used by the plants it is supplied from the free water.

HYGROSCOPIC, or FINE FILM MOISTURE is that which is held on the soil particles in the form of a fine film. It does not move like the other forms of moisture, and can be removed only by heating the soil to the boiling temperature. Fine film moisture does not aid plant growth, but helps to keep the plant alive in times of great drought.

PRACTICAL EXERCISES.—Fill three or four lamp chimneys with as many kinds of soil. Tie a piece of cloth over the bottom of each and place this end in a shallow pan of water. Notice the rapidity with which the water rises in the different soils. Take the pan of water away and study the effects of evaporation.

MOVEMENT OF WATER.—Water moves in the soil as a result of two forces, capillary attraction and gravity. The free water moves downward under the influence of gravity. The capillary water can move in any direction on account of the close contact of the particles. This movement is always towards a dry portion of the soil. As fast as the roots of the plants take up soil moisture, there is a movement of the water towards the roots by capillary attraction. Some of this water rises to the surface and is lost to the soil by evaporation.

METHODS OF RETAINING MOISTURE.—In a dry time especially it becomes necessary to stop this movement of water that results in evaporation. This may be done by covering the ground with any loose mulch, like hay or straw, which will keep away wind and warmth and act as a trap to hold the moisture which rises to the top.

Capillary water does not rise rapidly through dry soil, therefore one of the best means of preventing evaporation is to form a dry dust mulch on the surface. This is done by careful cultivation. Cultivators with many small shovels, fine-toothed harrows and weeders are generally used to form the dust mulch. Some farmers get good results by dragging a planter wheel over the ground.

In addition to forming the dust mulch, cultivation tends to break the capillary connection between the spaces or pores of the soil, thereby checking the upward movement of the water, and leaving the soil loose so that it will readily absorb the next rain.

DRAINAGE.—All farm lands that do not drain themselves naturally should be artificially drained.

The benefits of drainage are many. Among the most important are the following:

1. It removes the surplus water and allows air to enter the spaces between the soil particles. The roots of plants will not go down any farther than the air reaches.
2. Much water causes the soil to be cold. By removing the surplus water

the temperature of the soil is increased, making it better for the growth of plant life.

3. It prevents surface-washing whereby much of the plant food is carried away with the soil.

4. It promotes the growth of bacteria which change the unavailable elements into the form most useful to plants.

5. By removing the excess of water the roots of plants go deeper into the ground thus giving them a larger amount of moist soil from which to draw the films of water.

6. Land, rich in plant food, that has been too wet to cultivate, has been reclaimed by proper drainage, and converted into valuable farming land.

AIR IN SOIL.—There can be no plant growth unless there is air in the soil. The roots of plants require air as much as the stems and leaves. If the free water in the soil comes up nearly to the surface, the supply of air is shut off and plant life ceases to exist.

Air is also necessary in the formation of humus. Vegetation will not decay unless air is present in the soil.

The soil-bacteria, which convert plant-food into a form which makes it available for use by plants cannot exist without air.

Since air is so necessary to plant growth farmers should take good care to see that the free water is removed from their farms by proper drainage.

SOIL FERTILITY.—An element is a substance that cannot be divided into two or more substances; e. g., carbon, iron.

A compound is a substance which consists of two or more elements and which possesses some properties or characteristics not possessed by either element alone: e. g., carbon and oxygen form carbon dioxide (CO_2).

About eighty elements exist in nature. In this book we are concerned with only the ten elements which are absolutely required for plant growth; viz., carbon (C), oxygen (O), hydrogen (H), magnesium (Mg), calcium (Ca), iron (Fe), sulphur (S), potassium (K), nitrogen (N) and phosphorus (P).

Of these elements the first three, carbon, oxygen and hydrogen which constitute 95% of our common crops, come from air and water. The next four elements occur naturally in such large amounts that the soil is never deficient in them. This leaves only three, nitrogen, potassium and phosphorus, with which the farmer is mostly concerned.

Nitrogen is contained in the air in large amounts and it may be maintained in the soil by the growth of leguminous plants, such as beans, peas, clover, and alfalfa, which have the power to utilize the free nitrogen of the air. The application of barnyard manure is one of the best ways to keep up the supply of nitrogen.

Phosphorus is contained in combination with lime and other materials. These combinations are called phosphates.

Ground bone and phosphate rock may be applied to land that is deficient in phosphorus.

Fertile land is that which contains all the essential elements of plant growth in sufficient quantities to produce good crops. Land which has been farmed for years without any attempt being made to restore the elements which have been used by the growing crops finally fails to produce profitably, and becomes what we know as "worn-out" land. Attention must then be given to the restoration of the deficient elements by careful cultivation, the rotation of crops, the application of barnyard manure and commercial fertilizers, and proper drainage.

The farmer who sells all his produce each year and returns nothing to the soil makes a great mistake. A better plan is to feed the produce to live-stock and utilize the manure, both liquid and solid, the straw, the roots, stubble and vines for the improvement of the soil.

LIMING OF SOILS.—Soils that are sour, or acid, will not produce good crops. To determine whether land is sour or not, take a few ounces of soil to the depth of six or seven inches and mold into a ball. Break this ball into two parts and place a piece of blue litmus paper between the parts, pressing them firmly together. If the paper turns pink the soil is acid.

Note.—Blue litmus paper may be obtained at any drug store.

To determine whether soil has lime or not, make a ball of moist earth, depress one side and pour a little muriatic acid into the depression. If lime exists in sufficient quantities little bubbles will appear when the acid touches the soil.

The beet test is another good way to determine whether soil is in need of lime. All kinds of beets require lime in the soil. A piece of land sufficiently large for the experiment should be laid off in the field. A piece containing about 3,600 sq. ft. should be selected. After this ground has been plowed deeply and rolled, a complete fertilizer, barnyard manure, preferably, should be applied at the rate of about 500 pounds per acre. This plot should be divided into three equal pieces. On the first apply about 100 pounds of lime, on the second use about 50 pounds and on the third do not apply any. Then a sufficient quantity of beet seed should be sowed. A comparison of the yields from the three plots will determine whether or not lime is needed.

To correct the acidity of soil lime should be used. It is the most effective agent known for this purpose. The most common form of lime used for agricultural purposes is quicklime (CaO , calcium oxide). It is that part left when limestone rock is burned. Limestone rock, finely ground, is often applied to the soil by a lime-spreader, a manure-spreader, or by shovels from wagons. The last method of distribution is not desirable on account of the caustic nature of lime.

The best time to apply lime is in the fall because it will have more time to work down into the soil than if applied in the spring.

The amount of lime to use varies with the kind of soil, the kind of crops to be grown, and the form of lime applied.

C. G. Hopkins, Professor of Agronomy in the University of Illinois, recommends the application of two tons per acre of ground limestone rock with repeated applications in later years.

It is possible to have too much lime in soil, in which event it becomes harmful. It helps to make the plant food in the soil available, and in large quantities it may cause these foods to be liberated faster than they can be used by the growing plants, thus causing waste. Too much lime may also cause the vegetable matter in the soil to decay too fast.

FREE BULLETINS FROM THE DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

- No. 44. Commercial Fertilizers.
- No. 77. The Liming of Soils.
- No. 187. Drainage of Farm Lands.
- No. 192. Barnyard Manure.
- No. 237. Lime and Clover.
- No. 245. Renovating Worn-out Soils.
- No. 306. Some Soil Problems for Practical Farmers.

CATTLE.

BREEDS.—All farm animals were formerly called cattle; the term now applies only to *neat* cattle. Our improved breeds are probably descended from the wild cattle which existed in the ancient forests of Europe.

A breed is a subdivision of a family in the animal kingdom which has been subjected to and reproduced under the same conditions until it has acquired a distinctive character common to all the members.

Cattle have two important uses; namely, the production of milk and the production of beef. In addition to these main uses and the hides are used for making leather, the bones for buttons, fertilizers, etc., the hair for plaster, and the hoofs and horns for glue. According to their main uses cattle are divided into **BEEF BREEDS**, or types, and **DAIRY BREEDS**, or types.

CHARACTERISTICS.—There is a marked difference in general between the dairy cow and the beef type. In the dairy cow the hindquarters are largely developed, the shoulders are usually low and scantily covered with flesh and the neck is long and thin. This gives a decided wedge shaped appearance which is regarded as typical of cows of dairy excellence and which is made more noticeable by a large udder that extends well forward and backwards.

In the beef type the outline of the body is square, the back is straight, the stomach line is parallel to the back line and the whole body is well fleshed, the neck is full and short and the udder small.

The dairy cow does not produce good meat as a rule on account of the thinness of flesh and the beef cow is not a good "milker" because her food goes to fat rather than to milk.

EXAMPLES—BEEF BREEDS.

The leading beef breeds are as follows:

1. Shorthorn, or Durham, an English breed.
2. Aberdeen-Angus, from Scotland.
3. Hereford, from England.
4. Galloways, from Scotland.
5. Sussex, an English breed.
6. Polled Durham.

DAIRY BREEDS.

The principal dairy breeds are as follows:

1. Holstein, or Holstein-Friesian, from Holland and Denmark.
2. Guernseys, from the Island of Guernsey.
3. Jerseys, from the Island of Jersey.
4. Ayrshires, from Ayrshire, Scotland.
5. Brown-Swiss, from Switzerland.
6. Dutch Belted.

DUAL-PURPOSE CATTLE.

1. Devon.
2. Red Polled.

HISTORY OF DAIRY BREEDS.

JERSEYS.—The Island of Jersey lies in the English Channel about thirteen miles from the coast of France. Although it is only eleven miles long and six miles wide it is the home of one of the most important and widely distributed breeds of dairy cattle. Jersey cattle have been purely bred on that island for a longer period than any other breed of English origin. This is largely due to the fact that there is a rigidly enforced law prohibiting under heavy penalties the landing of any outside cattle upon the shores of the island.

Owing to the small farms and the high yearly rental of lands there are no extensive pastures in Jersey and cattle are not permitted to roam at large. They are tethered and are led, instead of being driven, from place to place, usually by women. Grass, hay and roots, chiefly parsnips, constitutes the

bulk of their feed, very little grain being used. These conditions have developed a race of healthy, vigorous, delicate and gentle cattle.

Active importations of Jersey cattle to the United States began about the year 1850. Nearly all of the 2,000 animals or more which the little island exported yearly came to this country. They have proved themselves so well adapted to a wide range of climate and have increased so rapidly in America that they are now more numerous than any other breed.

The Jerseys are smaller than any of the other dairy breeds in this country and are of a squirrel gray or fawn color. White markings frequently appear, and the nose is usually black or dark-colored. The milk is rich in fat and the cows are famous for the large quantities of butter they produce. Normal Jersey milk contains about 5% of butter fat, and in some cases rising as high as 7%.

HOLSTEIN-FRIESIANS.—The Holstein-Friesian cattle are larger than the Jerseys and have strong color markings of black and white. These markings are very irregular and are never mixed, the lines of distinction being sharply drawn. The black predominates in most cases. The name of this breed is derived from the names of Holland and Friesland, where they originated. They are the heaviest milk producers of all the cattle, often giving an average above their own live weight in milk monthly for ten or twelve consecutive months. The Holsteins are the favorites for dairymen doing a milk supply business. The milk is of fair quality but not rich in fat and is often found below the standard fixed by state and municipal laws.

GUERNSEYS.—Guernsey cattle are natives of another island in the English Channel. They are a size larger than Jerseys, stronger-boned and coarser in appearance. They are light in color, yellow and orange predominating with some white. The muzzles are buff or flesh-colored, seldom black. A generous secretion of yellow coloring matter is seen in the skin, especially where the hair is white, in the ears, around the eyes and about the udder. This causes the cream and butter to be highly colored.

The Guernseys produce large quantities of milk which is uncommonly rich in butter fat and natural color. The popularity of this breed is rapidly increasing in this country.

AYRSHIRES.—The Ayrshire Cattle are natives of Ayrshire in the southwest part of Scotland. They are of medium size among dairy cattle, being smaller than the Holsteins and larger than the Jerseys. The prevailing color is red, white, and brown. These cattle are very easily kept, giving a large yield of milk without extravagance of food. The empty udder is quite small and occupies but little space. It is calculated to deceive the unskilled observer as to its capacity. When the milk glands are at work, the wrinkles smooth out, the folds expand and the filled Ayrshire udder is regarded as a model in shape for all dairy breeds.

The milk of this breed is somewhat above the average in richness. The fat globules are small and cream rises very slowly.

The Ayrshire is not recommended as a good butter cow, but the milk is suited for city supply, being above the legal standard and capable of long journeys without injury.

BEEF BREEDS.

SHORTHORNS.—Outside of tradition little is known of the Shorthorns down to the beginning of the 18th century. They are said to be descended from the old Northeast of England breed. An eminent authority says that the breed was probably originally formed by crossing the ab-original British cows with large-frame sires imported from the Continent.

Much attention was given in America to the improvement of cattle about the close of the Revolutionary War. Virginia, Kentucky, New York and Massachusetts led in importations of Shorthorns, which were popularly known as the "milk breed."

Up to 1835 this breed did not do well east of the Alleghanies, although they flourished greatly in Kentucky and neighboring states.

There was remarkable activity in the development of American Shorthorns in the next twenty years, then came a rest of fifteen years followed by another Shorthorn "boom." At this time English breeders admitted that there were better "Shorthorns" in America than could be found in England and sent their agents over to buy some of them at any cost. In 1873 at a great sale held in New York one cow sold for \$40,600, another for \$35,000; eight others averaged \$14,000 and six were sold at \$24,000 apiece.

The Shorthorns are a beef breed and in their general type most of the families of the breed conform closely to the beef type. However, Thomas Bates, an eminent breeder, succeeded in developing milking capacity to such an extent that the Bates family of Shorthorns are classed as general purpose animals.

The prevailing colors of this breed are red and white with various blendings of these two; the head is short and broad; the horns short and blunt, usually with a downward curve, and the ears thin and creamy yellow inside. The Shorthorns are said to be the largest among the pure breeds of cattle.

ABERDEEN ANGUS.—The Aberdeen Angus Cattle originated in the county of Aberdeen and the district of Angus, in Scotland. They are somewhat smaller than the shorthorns and are black in color with short legs and plump bodies.

They fatten easily, producing the best quality of beef and bringing the highest prices on the market.

Their naturally hornless character has gained for them the local name of Polled Angus.

HEREFORDS.—The Hereford Cattle are red with white faces and some white markings on the back, underline and feet. They were introduced into this country in 1817 by Henry Clay. This breed originated in Herefordshire, England.

GALLOWAYS.—Galloway Cattle originated in Southwestern Scotland, and, like the Aberdeen Angus, they are black and hornless and have short legs. However, they are unlike the Angus cattle in that they have a curly or shaggy coat while the former are sleek. As producers of good beef they rank next to the Aberdeen Angus Cattle, and command the next highest prices to them in the markets.

SUGGESTIONS.

1. Make an estimate of the number in your district.
2. Get reports on the number of cows kept in each family, and the purposes for which they are kept.
3. Cut from the farm journals pictures of the different breeds of beef and dairy cows. Paste these pictures in a book or tablet label them carefully, and write a brief description of each. This will make a very interesting and valuable book.
4. Visit a stock-farm if possible and have the owner describe the points of a good cow.
5. Name the different breeds of cattle in your locality.

DAIRY INDUSTRY.

FEEDING FOR MILK.—We feed live stock to promote growth, to repair the waste of the body, to furnish heat and energy and to make special products such as, eggs, milk, etc. Scientific feeding consists in supplying food in the right proportions to meet the various requirements, of the animal without waste. In order to work out the principles of feeding it is necessary to know the composition of feeding stuffs and the requirements of animals when performing different functions. In feeding dairy cattle two things must be taken into consideration; first, the cost, and second, the special adaptations of the different feeding materials for milk and butter production.

Animal feeds are divided into the following classes: (1) Protein, (2)

carbohydrates, (3) fats, (4) mineral salts. These different classes are necessary to meet the demands of similar substances found in the animal body.

PROTEIN in the name of a group of materials containing nitrogen. The white of an egg (albumen) is the best example of protein. The *gluten* of wheat and the *casein* of cheese are other familiar examples of protein. All field grains, hay, clover, beans and peas contain protein in abundance. Since this class of feeds goes to form the flesh, blood, skin, hair, the casein and albumen of milk, etc., it is necessary for an animal to be provided with a certain amount of it in order to grow and fulfill the purposes of its existence.

Foods that contain carbon, hydrogen and oxygen in combination are called *carbohydrates*. They consist of starch, sugar, gums, and plant fiber. Coarse fodders such as hay and straw, contain a large proportion of fiber, while most grains are rich in starch and sugar.

FATS include butter, lard, oils, fat meats, wax and the green coloring matter of plants. Cotton-seed meal, linseed meal and nuts contain a large quantity of fat.

MINERAL MATTER or ash, is what is left when the combustible part of a feeding stuff is burned. It consists chiefly of lime, magnesia, potash, soda, iron, etc., and is found in sufficient quantities in ordinary fodders. Alfalfa is very rich in mineral matter.

A BALANCED RATION.

A balanced ration is one that contains the proper amount of protein and carbohydrates to secure the desired animal product.

It has been found that the proper ration for a dairy cow should contain about six times as much carbohydrates as protein. This proportion of protein to carbohydrates is expressed as a ratio, as 1 to 6 or 1:6, and is called the "nutritive ratio."

Therefore, if it is desired to find the nutritive ratio of any ration divide the amount of protein it contains by the amount of carbohydrates.

FEEDING STANDARDS.—A statement of the amounts of the different nutrients required by animals as indicated by the results of experiments and observation is called a feeding standard.

These standards cannot be made to apply to all conditions, but only to average conditions. They are not infallible guides to be followed without regard to conditions. For them to be of any value they must be applied with good judgment and intelligent observation.

The standard per day for a cow of 1,000 pound weight and giving 16½ pounds (about eight quarts) of milk per day, calls for twenty-seven pounds dry matter. At least fourteen pounds of this should be digestible, two to two and one-half pounds should be digestible protein and eleven and one-half to twelve pounds carbohydrates.

RATIONS FOR A DAIRY COW.

The following rations have been carefully worked out by practical feeders and are considered proper for dairy cows:

Ration No. 1.	Protein.	Carbohydrates. (fat x 2¼)
10 pounds clover hay	0.74 lbs.	4.215 lbs.
10 pounds corn fodder	.23 lbs.	3.487 lbs.
3 pounds corn meal	.19 lbs.	2.185 lbs.
3 pounds wheat bran	.36 lbs.	1.41 lbs.
2 pounds Buffalo gluten meal	.43 lbs.	1.37 lbs.
z		
Total	1.95 lbs.	12.667 lbs.
Ration No. 2.	Protein.	Carbohydrates.
Cowpea hay, 15 pounds	1.62 lbs.	6.15 lbs.
Corn stover, 10 pounds	.17 lbs.	3.391 lbs.
Corn ensilage, 30 pounds	.27 lbs.	4.862 lbs.
Cotton seed meal, 2 pounds	.74 lbs.	.87 lbs.
z		
Total	2.80 lbs.	15.273 lbs.

The last table gives an excellent ration for the feeder who has a silo.

With the aid of the feeding standard and tables showing the amount of dry matter and digestible food ingredients in feeding stuffs, rations for different purposes may be calculated with considerable accuracy. This work will prove both interesting and profitable. It should be borne in mind that such calculations are not mathematically accurate, nor the feeding standards exact. The most that can be done is to calculate a well-balanced ration, and then by closely watching the cows make such changes in it as seems to suit each individual case.

THE SILO.—The silo is an air-tight building for preserving green corn, alfalfa, and other forage plants, in such condition as to retain their freshness. Such feed is called ensilage, or silage, and is very valuable in feeding dairy cows.

Silos are usually built in the shape of a cylinder, from twelve to twenty feet in diameter and from twenty to forty feet high. Any material may be used for building a silo. Cement, brick, stone and wood are all used. Silos built of brick or cement are becoming more common at the present time.

The silo prevents much of the loss of feed as it can be handled with little or no waste. One writer recently made the statement that 50% more cattle could be fed with silage than in the usual way. This statement may be exaggerated somewhat but it is a well established fact that the silo is a feed saver.

Corn grown for silage is not usually planted in hills, but in drills so that there may be a stalk about every seven inches in the row.

The corn should be cut when the grain is fully glazed. At this time the lower leaves will be turning yellow and the grains will begin to be hard and dented. At this stage it is said to keep much better than when ripe or in the milk stage. The entire stalk and grain is then run through a cutter and either thrown or blown into the silo, where it becomes firmly packed.

It begins to decay at once causing much heat. The air in the silo is changed into carbon dioxide by this process which continues until it is stopped by the heat and the exhaustion of the air.

The entrance of air will cause the silage to mold or decay.

While it has been proved that silage is one of the cheapest and best dairy feeds, it is not likely that a silo will be profitable unless there are as many as eight or ten cattle to feed. A cow will eat about half a ton per month.

CARE OF THE DAIRY COW.—It pays to give the cow good shelter and plenty of the right kind of feed. Many farmers provide roomy, well ventilated barns for the cows where they can remain vigorous and healthy, as they should be. Cows should be fed and milked at regular hours and should never be scolded or struck. Rough usage diminishes the supply of milk.

COMPOSITION OF MILK.—Since milk contains all the nourishing substances essential to the growth of the body, it is a perfect food. It contains water to quench thirst and which is necessary for all growth; protein to produce flesh and muscle; ash or mineral matter to make bone; fat and sugar to furnish warmth and energy.

These materials appear in about the following proportions:

Water	87	per cent.
Casein and Albumen (protein)	3.3	per cent.
Mineral matter	0.7	per cent.
Fat	4	per cent.
Sugar	5	per cent.

Fat is the most valuable part of milk. It is lighter than the other parts and rises to the top, forming with certain other parts the cream of which butter is made. The commercial value of milk is largely determined by the amount of fat it contains.

A quart of milk contains about the same amount of nutriment as eight eggs or three-fourths of a pound of beef-steak, and compared with eggs or meat is a cheap food.

CARE OF MILK.

Healthy cows naturally produce pure milk, but, since milk is a substance that is favorable to the growth of bacteria, it often happens that it becomes impure before it reaches the consumer. This is due to careless and improper methods of handling and to unsanitary conditions in the barn. The following conditions are necessary in order to have sweet, clean milk.

1. A barn ventilated in such a way as to remove dust, odors, bad air, etc.
2. The cows must be cleaned before milking. Dirty cows cause the milk to become dirty.
3. The milker must be a healthy person who has clean hands and clean clothes.
4. All utensils used in the dairy should be scalded and, if possible, exposed to steam so as to kill all bacteria.
5. Milk pails should have small tops so that they will admit less dirt.
6. Since feeding always gives rise to disagreeable odors and more or less dust it should be done after the milking time.
7. As soon as possible after the milk is drawn it should be aired and then cooled to a temperature of 50 degrees F. or lower. This prevents the development of bacteria which causes it to sour or spoil otherwise.

PASTEURIZED MILK.—It has been found that by heating milk to a temperature of about 160 degrees F. and then cooling it rapidly to 50 degrees F., it is possible to destroy all disease germs and make the milk keep sweet much longer. This process, called pasteurization, does not otherwise affect the milk, and may be done in the home without the use of machinery. Pasteurized milk should be marked as such, and should be used before it becomes old as it contains certain spore forms that are not killed by the heat.

THE CREAM SEPARATOR.

CREAMING.—There are three ways of separating the cream from the milk.

1. The "shallow pan setting" is the oldest and, to date, the one most commonly used. The milk is "set" in pans or crocks about four inches deep to allow the cream to rise. This method leaves an average of about $\frac{1}{2}$ per cent of fat in the skim-milk.
2. The "deep setting method" is used when a large quantity of milk is to be handled. The milk is poured into large cans which are surrounded by cold water. After the cream rises the skim milk is drawn off through a faucet in the bottom of the can. This method is better than the first, leaving only about $\frac{3}{10}$ per cent of butter fat in the milk.
3. The centrifugal bowl separator is a machine for separating the cream from milk while fresh. It is the quickest and most effective method, leaving only from 0.02 to 0.08 per cent of fat in the milk. The milk is poured into a rapidly whirling metal bowl, and the skim milk being heavier than cream, is thrown by the action of centrifugal force to the outer edge of the bowl where it is carried out by a spout. The cream, being lighter, seeks the center and passes out through another spout.

WEIGHING AND TESTING OF MILK.—Records should be kept of the quantity of milk produced by each cow and of the per cent of butter fat the milk contains, in order that the owner may know which ones are the most profitable. Many cows do not produce enough fat to pay their board and are called "boarders" or "robber cows."

To make it easy to keep these records a good spring balance weighing pounds and tenths of pounds should be kept hanging near a record sheet in the barn. To secure the best results the milk should be weighed each time just after it is drawn from the cow. Fairly accurate results may be obtained by weighing the milk one day each week for three weeks of the month, or by weighing it for three days at the beginning of each month and multiplying the sum of the weights by ten to get the yearly production.

The best method for determining the percentage of butter fat in milk is known as the Babcock test. It was invented by Professor S. M. Babcock of the University of Wisconsin.

By its use the dairyman learns which cows are "boarders," and which are profitable.

If possible every school should own a Babcock tester. A small one may be procured for \$5 or \$6. Full directions come with each machine and it will prove a very profitable exercise to have pupils test milk for the whole community.

In making this test, a measured quantity (17.6 cubic centimeters) of milk is put into a bottle with a long, graduated neck, and 17.5 c. c. of sulphuric acid is mixed with it. The acid dissolves all the milk except the fat which is set free. The acid causes the mixture to become very hot and dark-colored. After the liquids have been mixed thoroughly, the bottle or bottles are put into the tester and the handle turned 4 or 5 minutes at the proper speed for the machine in use, to separate the fat so that it can be measured. It is lighter than the remainder of the milk and will be forced to the surface. Enuf hot water is then added to bring the contents up to the bottom of the neck of the bottle.

A second whirling of about two minutes brings the fat above this water. Enuf hot water is again added to bring the fat within the graduations on the neck of the bottle. A third whirling of one minute brings all the fat together in a clear column in the neck of the bottle where the amount may be read on the scale. The difference between the graduations at the extreme top and bottom of the column of fat is the percentage of fat in the milk. If the top reading is 6.8, and the bottom 2.6 the difference is 4.2, which is the percentage of fat or the number of pounds of fat in 100 pounds of the milk tested.

NOTE.—Sulphuric acid is a *poison* and should be handled with extreme care. If it is spilled on anything, use *plenty* of water and add *lime* or *soda* to neutralize it.

This test is also used by dairymen who no longer buy milk by the gallon but pay for the amount of butter fat it contains.

KINDS OF MILK.

1. Whole milk (unskimmed).
2. Skimmed milk.
3. Buttermilk.

When a cow is just fresh the milk is called *colostrum*, or "calves' milk." It is very rich in albumen, containing about ten times as much as it does in its normal state. Colostrum changes to what is commonly known as milk, in about ten days. It should not be used before the change.

FORMS OF MARKET MILK.

CERTIFIED MILK is that which meets the demands of the milk commissioners for the highest grade of clean, safe milk. It is produced under strict regulations which require the inspection of experts of the barns, milk-rooms, milkers and methods of handling and delivering.

STANDARDIZED MILK is that which has been mixed in such a manner as to give any required percentage of fat.

LEGAL MILK is that which usually contains not less than 3 per cent of butter fat, and at least 12 per cent of solids.

MILK REGULATIONS.

Such diseases as typhoid fever, scarlet fever, or diphtheria are often caused by unclean milk. Therefore many cities will not permit milk to be shipped from a farm on which there is a case of any of these diseases. Water which contains typhoid bacilli is sometimes used by careless persons for wash-

ing milk cans. In this manner the germs get into the milk and people who drink it are liable to take the disease.

Some cities require that the tuberculin test be made on all animals that furnish milk for the city, and that all cows found to be infected with tuberculosis be removed from the herd. (To avoid these dangers milk should be pasteurized).

As there is much temptation to use preservatives to keep milk sweet from day to day, most cities have strict regulations against their use.

BUTTER MAKING.

After the cream has been removed from the milk by a skimmer or cream separator, it is allowed to stand until it "ripens" or sours in order that it may be more easily churned. Ripening is caused by little ferments that get into the cream from the air, causing a change in the taste and odor. Care should be taken not to allow the cream to stand too long or some ferments will get into it that will produce an unpleasant taste and odor.

The proper temperature for churning ranges from 56 degrees to 62 degrees Fahrenheit. The cream should be tested when it is poured into the churn, and if the temperature is not right, warm or cold water as needed should be added until the proper temperature is obtained. The object of churning is to unite the little particles of butter fat into larger masses. This is brought about by agitating the milk, causing the little fat particles to be thrown together and to stick to each other. This operation should be continued until the granules of butter are the size of large grains of wheat. Then the buttermilk should be drawn off and the butter washed twice with cold water, to harden the granules, thereby preserving the grain.

The butter is now ready to be salted. Three-fourths of an ounce of fine table salt should be used for each pound of butter and evenly worked into the butter with a paddle. Never use the hands. The butter should be firmly pressed and rolled, but never rubbed, as that destroys the grain. The working not only distributes the salt evenly, but it drives out the remainder of the buttermilk.

If butter is nicely molded, stamped and covered with oiled paper, it meets with a readier sale.

Butter is judged for its flavor, color, grain or texture, amount of salt and package.

CHURNS.—There are many kinds of churns on the market, but farmers today usually prefer the revolving box or barrel churn, without the dasher. It is claimed that such a churn gives butter with a more desirable grain than that produced in a churn where the agitation is caused by paddles.

CHEESE.

Cheese is the solid parts of the milk in such form as will keep indefinitely. Cheese is usually made from whole milk, but it may be made from cream or skimmed milk. There are said to be more than one hundred fifty different kinds of cheese, each kind caused by a little difference in the process of making. Formerly all the cheese was made in private dairies, but now most of it is made in creameries or cheese factories. The process of cheese-making is rather long but easily understood.

Rennet, an extract obtained from the stomach of calves, is put into the sweet milk. This causes the milk to curdle; i. e., the casein and fat in the form of curds are separated from the water or whey, which is drawn off, carrying with it the sugar and ash material. The curd is heated, salted, pressed, and allowed to stand for several weeks to ripen or cure. The curing of cheese is a very important part of the making. It is done by various ferments or bacteria which work in it giving it flavor and food value.

Whey is adapted to the feeding of pigs as it contains, we will remember, most of the sugar and ash of the milk, and some of the casein and fat.

FREE BULLETINS, U. S. DEPARTMENT OF AGRICULTURE.

No.	
29.	Souring of Milk.
42.	Facts About Milk.
55.	The Dairy Herd.
57.	Butter Making on the Farm.
63.	Care of Milk on the Farm.
71.	Essentials in Beef-Production.
74.	Milk as Food.
106.	Breeds of Dairy Cattle.
166.	Cheese Making on the Farm.
280.	A Profitable Tenant Dairy Farm.
351.	The Tuberculin Test.
201.	The Cream Separator on Western Farms.

SCORE CARD FOR DAIRY CATTLE.

	Perfect Score.
General Appearance.	
Form: wedge-shaped as viewed from the front, side and top.....	5
Form: spare, as indicated by prominent joints and clean bone and lack of muscular development along ribs and loins.....	8
Quality: hair fine, soft; skin pliable, loose, medium thickness; secretion yellow, abundant	8
Constitution: vigorous, as indicated by alert expression, evidently active vital functions, and general healthy appearance.....	6
Head and Neck.	
Muzzle: clean cut; mouth large; nostrils large	1
Eyes: large, bright	1
Face: lean, long; quiet expression	1
Forehead: broad, slightly dished	1
Ears: medium size; fine texture	1
Neck: fine, medium length; throat clean; light dewlap	1
Forequarters and Hindquarters.	
Withers: lean, thin; shoulders, angular, not fleshy.....	3
Hips: far apart; not lower than spine;	5
Rump: long, wide, comparatively level;	
Thurls: high, wide apart.....	
Thighs: thin, long	2
Legs: straight, short; shank fine	1
Body.	
Chest: deep; with large girth and broad on floor of chest; well-sprung rib.	10
Abdomen: large, deep; indicative of capacity; well supported.....	4
Back: lean, straight; chine open	2
Tail: long, slim, with fine switch	2
Loin: broad.	2
Udder: large, long; attached high and full behind; extending far in front and full; quarters even	20
Udder: capacious, flexible, with loose, pliable skin covered with short, fine hair.	10
Teats: convenient size, evenly placed	2
Milk veins: large, tortuous, long, branching, with large milk wells.....	4
Total	100

SCORE CARD FOR BEEF CATTLE.

	Perfect Score.
General Appearance.	
Weight: estimated —— pounds; actual —— pounds; score according to age	10

Form: straight top and bottom lines; deep, broad, low set, compact, symmetrical	10
Quality: hair, fine; bone, fine but strong; skin, pliable; mellow even covering of firm flesh; especially in region of valuable cuts; absence of ties and rolls	10
Condition: thrifty, well fleshed, but not excessively fat; deep covering of firm flesh	10
Head: clean, symmetrical; quiet expression; mouth and nostrils, large; lips, moderately thin; eyes, large, clear, placid; face, short; forehead, broad, full; ears, medium size, fine texture, erect	5
Neck: thick, short, tapering, neatly from shoulder to head; throat, clean.	2
Shoulder vein: full	2
Shoulder: well covered with flesh; compact	3
Brisket: full broad, but not too prominent; breast wide	1
Dewlap: skin not too loose and drooping.....	1
Chest: deep, wide, full	1
Crops: full, thick, broad.....	3
Ribs: long, arched, thickly fleshed	8
Back: broad, straight, thickly and evenly fleshed.....	8
Loin: thick, broad; thickness extending well forward.....	8
Flank: full, low, thick	2
Hips: smoothly covered; width in proportion with other parts, but not prominent	2
Rump: long, level, wide and even; tailhead smooth, not patchy.....	2
Pin bones: not prominent, width in proportion with other parts.....	1
Thighs: full, fleshed well down to hock.....	3
Twist: deep, full; purse in steers full	4
Legs: straight, short; arm, full; shank, fine, smooth.....	4
Total	100

SWINE.

Swine, or hogs as they are often called, are raised in large numbers throughout America. Our present breeds of hogs have been developed from the wild hogs of Europe, Asia and Africa.

The hog excels all other animals in the cheap production of meat. There is very little waste in a hog carcass, as it "dresses out" from 70 to 85 pounds of food to every 100 pounds live weight.

The hog will make more money for the farmer in proportion to its cost than any other animal. As it requires about five pounds of corn to produce one pound of hog flesh, it may be readily seen that it is cheaper to ship the hogs than it is to ship the corn which they eat. In addition to the grain which they consume, hogs will eat waste products which other animals will not touch.

Another argument in favor of feeding farm products to hogs instead of selling them is the value of the manure which is estimated as being worth \$12 per year for each animal.

The breeds of hogs are divided into two classes known as the **lard** or **fat** type, and the **bacon** or **lean** type.

LARD HOGS.

Hogs of this type have well-developed hams and shoulders, small heads, short thick necks, and deep, fat sides. As the name implies, they produce large quantities of fat.

The leading breeds of swine in America of the fat type are:

1. BERKSHIRES, black in color, with white markings and ears erect.
2. POLAND-CHINA, black, with six white points and drooping ears.
3. DUROC-JERSEYS, cherry red or chestnuts, with ears that point forwards and downwards.
4. CHESTER WHITE, white, with drooping ears.
5. VICTORIA, white, with occasional dark spots on the skin, ears erect and a good coat of fine, soft hair.
6. ESSEX, black, with erect ears and no white markings.
7. CHESHIRE, white, with erect ears.
8. SMALL YORKSHIRE, white, with occasional black markings. Very small.
9. MULE-FOOT, black, with white markings. Hoofs solid like those of a mule. A very hardy breed.

BACON HOGS.

Hogs of this type have long legs, long, narrow bodies, long necks and long, deep sides. They produce most of the expensive cuts of meats, such as choice hams and breakfast bacon. The leading breeds of this type are:

1. TAMWORTH, red or chestnut hair, long, straight snouts and large pointed ears.
2. LARGE YORKSHIRE, white, with occasional blue spots. Long, deep bodies. Yorkshire bacon is said to be the best.
3. HAMPSHIRE, black, with a broad, white belt encircling the body and with white fore legs. Ears inclined forward.

According to size, the breeds of hogs are sometimes grouped as follows:

LARGE BREEDS.

1. Chester White.
2. Large Yorkshire.
3. Tamworth.

MEDIUM BREEDS.

1. Cheshire.
2. Berkshire.
3. Poland-China.
4. Duroc-Jersey.
5. Hampshire.
6. Victoria.
7. Mule-Foot.

SMALL BREEDS.

1. Essex.
2. Small Yorkshire.

CARE OF HOGS.

When hogs are raised in large numbers they should have plenty of pasture. When allowed to run with cattle they use the corn and other feeds which the cattle waste.

Small houses called "colony houses," which are scattered widely about the hog pasture, are coming into use very rapidly. The object of these houses is to prevent hog cholera, the most serious obstacle which confronts the hog-grower. They provide a certain isolation which prevents the spread of disease.

The United States Bureau of Animal Industry has produced a remedy recently whereby hog cholera can be controlled. Using as a basis the fact that one attack rendered an animal immune for the rest of its life, they experimented until they discovered what they term an absolute preventive. In this method virulent blood is drawn from a diseased pig. This virulent blood is injected into the veins of a pig that has recovered recently from an acute attack of cholera. After nine or ten days the blood of this pig becomes potent and will, when injected into the veins of susceptible hogs, prevent them from taking the disease.

In order to secure good results, this work must be done with great precision, but it is believed that its application will save the farmers many millions of dollars.

A letter of inquiry addressed to the Bureau of Animal Industry, Washington, D. C., will bring much interesting information concerning hog-vaccination.

References: Free Bulletins, Department of Agriculture, Washington, D. C.

No.

100. Hog-Raising in the South.
133. Profitable Crops for Pigs, pp. 27-29.
183. Meat on the Farm.
222. Market Classes and Grades of Swine.
272. A Successful Hog and Seed Corn Farm.
296. Grinding Corn for Hogs.
379. Hog Cholera.
329. Hogging Off Corn.

SUGGESTIVE EXERCISES:

1. At the present prices for corn and hogs, which would be more profitable to feed corn to hogs or to sell it by the bushel?
2. Name the breeds of hogs raised in your community.
3. What advantage is there to the farmer in raising "blooded" pigs?
4. Which do hogs prefer, clean or filthy sleeping quarters?
5. Describe the different plans of housing and feeding hogs in your neighborhood.
6. What annual profit may be reasonably expected from a good brood sow?

HOG SCORE CARD—LARD (FAT) TYPE.

General Appearance.		Perfect Score.
1. Weight: score according to age		6
2. Form: deep, broad, low, long, symmetrical, compact, standing squarely on legs		10
3. Quality: hair, silky; skin, fine; bone, fine; mellow covering of flesh, free from lumps and wrinkles		10
4. Condition: deep, even covering of flesh and fat over all parts of body.		10
Head and Neck.		
5. Snout: medium length, not coarse		1
6. Eyes: full, mild, bright		1
7. Face: short, cheeks full		1
8. Ears: fine, medium size, soft		1
9. Jowl: strong, neat, broad		1
10. Neck: thick, medium length		1

Forequarters.

11. Shoulders: broad, deep, full, compact on top	6
12. Legs: straight, short, strong; bone, clean; pasterns upright; feet, medium size	2

Body.

13. Chest: deep, broad, large girth	4
14. Sides: deep, lengthy, full; ribs, close and well sprung	6
15. Back: broad, straight, thickly and evenly fleshed	10
16. Loins: wide, thick, straight	8
17. Belly: straight, even	4

Hindquarters.

18. Hips: wide apart, smooth	2
19. Rump: long, wide, evenly fleshed, straight	2
20. Hams: heavily fleshed, plump, full, deep, wide	10
21. Thighs: fleshed close to hock	2
22. Legs: straight, short, strong; bone, clean; pasterns upright; feet, medium size	2

Total 100

HOG SCORE CARD—BACON TYPE.

Perfect
Score.

General Appearance.

1. Weight: score according to age	6
2. Form: long, level, smooth, deep	10
3. Quality: hair fine; skin thin; bone fine; firm covering of flesh free from bunches of fat and wrinkles	10
4. Condition: deep, uniform covering of flesh, especially in region of high-priced cuts	10

Head and Neck.

5. Snout: fine, medium length	1
6. Eyes: full, mild and bright	1
7. Face: slim	1
8. Ears: fine, medium size	1
9. Jowl: light, trim	1
10. Neck: medium length, light	1

Forequarters.

11. Shoulders: smooth, compact and same width as back and hindquarters	6
12. Breast: wide and full	2
13. Legs: straight, short, strong; bones clean; pasterns upright; feet medium	2

Body.

14. Chest: deep, full girth	4
15. Back: medium, uniform in width, smooth	8
16. Sides: long, smooth, level from shoulders to hindquarters	10
17. Ribs: deep, uniformly sprung	2
18. Belly: trim, firm, thick, without flabbiness or shrinkage at flank	10

Hindquarters.

19. Hips: wide apart, smooth	2
20. Rump: long, even, straight, rounded toward tail	2
21. Hams: firm, round, tapering, fleshed deep and low	8
22. Legs: straight, short, strong; feet, medium size; bone, clean; pasterns upright	2

Total 100

POULTRY RAISING.

Farm poultry consists of domestic fowls, or chickens, turkeys, geese, ducks and guinea fowls. Of these kinds chickens are most common. There is hardly a farm or a home that does not have its flock of chickens. Many farmers have small flocks of turkeys, geese and ducks. Formerly chickens were allowed to grow without any particular attention and anything in the way of eggs, meat and feathers which they produced was considered clear gain. At this time they are receiving careful attention and are proving themselves a profitable source of revenue. Statistics show that nearly \$700,000,000 worth of poultry and eggs are produced annually in America.

It is supposed that our domestic fowls originated from the jungle fowl of India.

BREEDS OF CHICKENS.

There are four well-defined breeds of chickens grouped according to their purposes: (1) Egg breeds, (2) meat breeds, (3) dual-purpose breeds, (4) ornamental or fancy breeds.

1. EGG BREEDS.—Many varieties of chickens are kept for egg production. They are small, light weight chickens, with large combs, which mature early and begin laying very young. Some of the common varieties of the egg breeds are as follows: Leghorn, Minorca, Spanish, Blue Andalusian and Ancona of the Mediterranean family, and the Red Caps of the English family.

2. MEAT BREEDS.—The varieties of the meat breeds are heavy, low-maturing fowls that belong to the Asiatic family. They are not noted for their egg-laying, but their meat is excellent. The Brahmas, Cochins, Langshans, Dorkings and Indian Games belong to this group.

3. DUAL-PURPOSE BREEDS.—Most of the varieties of this breed, but not all, belong to the American family. They are medium in weight, their meat is nice and tender, and they are good layers. These chickens are the best for farmers to keep. This group includes the Plymouth Rocks, Wyandottes, Javas, Dominiques, Rhode Island Reds, Orpingtons and Houdons. Some authorities class the Dorkings and Indian Games also as general-purpose fowls.

4. ORNAMENTAL, OR FANCY BREEDS.—The Bantams, Polish, Sultans, Frizzles, Silkies, and Games (except Indian Games), are included in this group of chickens. They are kept mainly for fighting and for show purposes.

CARE OF CHICKENS.

FEEDING.—When chickens are allowed to roam over a large range they easily find for themselves a balanced ration consisting of insects and seeds, but when they are confined in pens or coops the feeding problem becomes an important one. They must be fed foods that will produce eggs, or meat or both, according to the particular purpose.

Laying hens require food rich in protein. A dry mash is used by many poultrymen for egg production. This is made by mixing a number of finely ground grains together and feeding them dry from a hopper. In addition to this dry mash, whole grain should be scattered in the straw or litter so that the chickens will have to scratch for it, thereby getting the exercise which they need.

Skim milk, meat scrap, insects and plenty of green food should be fed to produce the best results. In winter, oats which have been sprouted on boards or in flat boxes in a warm room, cabbage, beets and turnips meet the requirement for green food.

Hens have no teeth, so they must have access to oyster shells, sand, ground bone or grit which are taken into their gizzards to grind the food. Since these materials contain much lime, they are also used for making egg shells. An abundance of fresh water should be supplied daily.

Another system of feeding chickens, known as the "wet mash" system, consists in giving them wet ground feed daily supplemented by dry grain at times.

Pupils should be encouraged to tell about the systems of feeding and watering followed in their neighborhood and of the rations fed.

HOUSING.—Chickens should have comfortable, clean, well-ventilated houses in which to roost and lay eggs. These houses should face the south or south-east in order to shut off the coldest winds, and to allow the sunlight to reach every part. In many houses the south side is made up of windows and muslin curtains, thus admitting light and air and preventing drafts. Extra cloth curtains are often hung so that they may be pulled down in front of the roosts on cold nights.

The roosts should be built along the north side of the room with a platform about six inches below them to keep the floor and nests clean. If space is limited the nests may be built under this platform.

The floor should be dry and covered with deep litter in which the whole grain is fed. Scratching for the grain will keep the chickens strong and healthy. The litter should be kept fresh and clean. Some poultrymen hang vegetables a little above the floor, so that the birds are forced to jump for bites of them. This gives them more exercise and of a different kind than that afforded by scratching.

Boxes filled with fine ashes and dry soil should be put in sunny places, so that the birds can wallow in them. They like to do this, and the dust aids in keeping them free from lice.

The roosts, nests and platform should be made so they can be removed easily and cleaned. Whitewash, containing some disinfectant, should be used liberally on the interior, and scalding water and sunlight should be employed often as cleansing agents. Spray crude oil (petroleum) on the walls, nests, boxes and roosts once a week in warm weather.

With provisions for ventilation, drinking fountains and self-feeding hoppers, we may feel certain that our domestic fowls are cared for properly, and they will amply repay such attention. Artificial heat often leads to sickness among fowls, hence it is not desirable in a poultry house.

DRINKING FOUNTAINS.—As chickens require much water to drink, it should be supplied to them in liberal quantities and in clean ways. A simple but effective water fountain may be made by making a hole on one side of a can or jar about one-half inch from the top. The jar should be filled with water and covered by a shallow pan. When the fountain is inverted the water will flow down into the pan, and will continue to do so as fast as it is used. These fountains should be cleaned daily and kept filled with fresh water.

INCUBATORS AND BROODERS.—An incubator is a machine that hatches eggs by keeping them at the same temperature as when covered by a hen. When eggs are to be hatched in large numbers the incubator is much cheaper than feeding a number of hens to do the work. An additional advantage claimed for the incubator is that its use causes the hens to begin laying sooner than they would if they were used as sitters and brooders.

Chickens hatched artificially are usually reared in brooders which take the place of the mother hen in affording warmth and protection.

Incubators and brooders may be seen and their workings explained in nearly any hardware store or place where implements are sold.

PERIOD OF INCUBATION.

PERIOD OF INCUBATION.—Chicken, 21 days. Duck, 28 days. Turkey, 28 days. Guinea, 25 days. Goose, 28 days.

PRESERVING EGGS.—The growth of a germ which makes its entrance through the shell in a way that is not fully understood, causes the egg substances to decay. This decay is more rapid in the summer for the reason that warmth favors the development of the germs.

The most satisfactory way to preserve eggs is to select clean (not washed) fresh ones and pack them in a jar that has been rinsed thoroughly with boiling water. Then pour over the eggs a solution consisting of twelve parts of boiled water, cooled to ordinary temperature, and one part of sodium silicate, which is commonly known as "water-glass" and which may be purchased at a drug

store, covering them to the depth of one inch. Eggs treated in this manner and kept in a dry, cool and dark place, will keep indefinitely.

It will prove a profitable exercise to have pupils preserve some eggs in April and May (these months are the best) for use the following winter.

EXERCISES.

1. How does a chicken drink? Why?
2. Explain the methods in use in your neighborhood for testing eggs.
3. Is there any advantage, in marketing eggs, in having them uniform in size and color?
4. Have pupils make and keep an egg record from their flocks of chickens. Compare frequently with others and explain the difference, if possible.
5. Name and describe all the varieties of poultry raised in your neighborhood.
6. Find out by observation and inquiry whether chickens pay for themselves or not.
7. Keep an account with poultry.
8. Write to the Secretary of Agriculture, Washington, D. C., for the following:

FARMER'S BULLETINS.

- No.
41. Fowls: Care and Feeding.
 51. Standard Varieties of Chickens.
 64. Ducks and Geese.
 128. Eggs and Their Uses as Food.
 141. Poultry Raising.
 177. Squab Raising.
 182. Poultry as Food.
 200. Turkeys: Varieties and Management.
 234. The Guinea Fowl.
 236. Incubation and Incubators.
 287. Poultry Management.
 355. A Successful Poultry and Dairy Farm.
 390. Pheasant Raising in the United States.
 452. Capons and Caponizing.

The following bulletins contain much useful and interesting material on poultry feeding, poultry-house construction, preserving eggs, incubators and other phases of poultry farming:

Nos. 84, 97, 103, 114, 122, 225, 227, 281, 296, 305, 309.

SCORE CARD—POULTRY BREEDING.

Breed..... Variety..... Sex.....

Weight

	Rel. Val. in shape.	Rel. Val. in color.	Total. Rel. Val.
Symmetry			4
Weight or size			4
Condition			4
Comb			8
Head	2	2	4
Beak	2	2	4
Eyes	2	2	4
Wattles and ear-lobes	2	3	5
Neck	3	5	8
Wings	4	5	9
Back	6	5	11
Tail	5	5	10

Breast	6	5	11
Body and fluff	5	3	8
Legs and toes	3	3	6
Total			100*

*Note: These relative values are given for the American Class. They differ on some points for the Asiatic and Mediterranean Classes.

SHEEP.

HISTORY AND USES.—It is supposed that our domestic sheep are descendants of the strong and agile wild sheep known as *Argali*, that live on the plains of Asia, and those of Southeastern Europe, known as *Musmon*.

Sheep are mentioned frequently in the Bible, they being used in ancient times to provide food and clothing for man and for sacrificial purposes. Like cattle to which they are related, they chew the cud, have cloven hoofs and four stomachs.

Sheep are valued for the production of wool and mutton. Since they increase rapidly and can live on a great diversity of food, they should be kept on every farm. In addition to their other good qualities, they are useful in helping to maintain the fertility of the land over which they graze.

BREEDS.—Sheep are bred either for wool or mutton, hence we have the two great classes known as *mutton breeds* and *wool breeds*. Since these classes are not wholly distinct, they are more commonly grouped according to the length or fineness of their wool.

The following breeds are found in America:

I. Fine or Short-Wooled Breeds:

American Merino, Delaine Merino, and Rambouillet (Ran-boo-ye) or French Merino.

These breeds have descended from Spanish stocks. They are hardy animals and good grazers. Their wool is very fine in quality and uniform in length.

II. Medium-Wooled Breeds:

Southdown, Shropshire, Oxford Down, Horned Dorset, Hampshire, Suffolk, Cheviot and Tunis.

III. Coarse, or Long-Wooled Breeds:

Lincoln, Cotswold and Leicester.

The first group are the best wool breeds, while the other two groups are grown principally for mutton.

However, it must be kept in mind that the fine-wooled sheep are eventually converted into mutton, and that wool is sheared from the medium, and coarse-wooled sheep.

CARE AND FEEDING OF SHEEP.—Since sheep have their own warm coats, their winter quarters should not be kept warm. They must, however, be protected from wet weather, and the sheds and lots in which they are kept should be well drained.

Sheep are good grazers and make good use of land that might otherwise be worthless. In winter they should be fed plenty of corn fodder, clover hay, oat straw, turnips and sugar beets.

FREE BULLETINS, DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

- No. 49. Sheep Feeding.
- No. 96. Raising Sheep for Mutton.
- No. 159. Scab in Sheep.
- No. 457. Early Spring Lambs.

SCORE CARD FOR MUTTON SHEEP.

..	General Appearance.	..	Score.
			Perfect
Weight:	score according to age and breed	4	4
Form:	straight top and under line; deep, broad, low set, compact, symmetrical	10	10
Quality:	hair fine; bone fine but strong; even covering of firm flesh; features refined but not delicate; stylish	10	10

Constitution: chest capacious; brisket well developed; flank deep; bone strong; movement bold and vigorous	10
Condition: thrifty; skin pink; fleece elastic; well fleshed, but not excessively fat; deep covering of firm flesh	5
Disposition: quiet but not sluggish	2
Color and markings: according to breed	2

Head and Neck.

Muzzle: mouth and nostrils large; lips thin	1
Eyes: full, bright, clear	1
Face: short, according to breed	1
Forehead: broad, full	1
Ears: texture, fine; size and form, according to breed	1
Neck: thick, short, neatly tapering to head; throat clean, according to breed	3

Forequarters.

Shoulder: covered with flesh; compact, smoothly joined with neck and body	4
Brisket: well developed; breast wide	1
Fore legs: straight, short, set well apart; pasterns upright; feet squarely placed, neither close nor sprawling	2

Body.

Ribs: long, well sprung, thickly fleshed	3
Back: broad, straight, thickly and evenly fleshed	5
Loin: thick, broad, firm	5
Flank: full, even with under line	1

Hindquarters.

Hips: level, smoothly covered; width in proportion with other parts.....	1
Rump: long, level, wide and even in width; not covered at tailhead with excessive fat	3
Thighs: full, fleshed well down to hock	2
Twist: deep, plump, firm indicating fleshiness	5
Hind legs: straight, short, set well apart; bones smooth, strong, being neither coarse nor fine; pasterns upright; feet squarely placed; neither close nor sprawling	3

Wool.

Quantity: long, dense, even, according to breed	5
Quality: structure and color true; fine, soft, even, according to breed.....	5
Condition: strong, bright, clean, slight amount of yolk	4

Total100

SCORE CARD FOR WOOL SHEEP.

..	General Appearance.	..	Perfect Score.
Form: level, deep, stylish; round rather than square			8
Quality: clean, fine bone; silky hair; fine skin			6

Head and Neck.

Muzzle: fine; broad, wrinkly nose; pure white	1
Eyes: large, clear, placid	1
Face: wrinkly, covered with soft, velvety coat	1
Forehead: broad, full	1
Ears: soft, thick, velvety	1
Neck: short, muscular, well set on shoulders	1

Forequarters.

Shoulder: strong, deep and broad	4
Brisket: projecting forwards; breast wide	1
Legs: straight, short, wide apart, shank smooth and fine	2

Body.

Chest: deep, full indicating constitution	10
Back: level, long; round ribbed	4
Loin: wide, level	4
Flank: low, making under line straight	2

Hindquarters.

Hips: far apart, level, smooth	2
Rump: long, level, wide	4
Legs: straight, short, strong; shank, smooth, fine	2

Wool.

Quantity: long, dense, even covering, especially over crown, cheek, armpit, hind legs, and belly	15
Quality: fine fiber; crimp close, regular; even quality, including tops of folds	15
Condition: bright, lustrous, sound, pure, soft, even distribution of yolk. with even surface to fleece	15
Total	100

HORSES.

HISTORY AND BREEDS.

When the Spaniards came to North America they did not find any horses, hence they soon brought over a number to Cuba, Mexico and the southern confines of the United States. The English in colonizing the Atlantic Coast soon found a need for horses and imported the breeds then common to England and France.

Where the climatic conditions and food were favorable the horses became a large type, but where these conditions were unfavorable there was produced the small type of horse, such as the Shetland pony or the burros of the mountainous countries. For convenience horses may be divided into three general groups, viz., Draft, Carriage, and Roadster breeds.

The typical draft horses have short and stout legs. Their body is nearly cylindrical and should be of a depth equal to the length of the legs. They should have upright shoulders, and a very wide hock. The legs should be straight. A straight line from the shoulder to the hoof should divide the knee, fetlock and foot into two equal parts. Among the draft breeds may be mentioned the Percheron, from France; the Belgian from Belgium; the Clydesdale from Scotland and the English Shire from England. The Percherons are usually gray or black. The English Shire is commonly a black or a bay. The Clydesdale has much the appearance of the Shire, but is somewhat smaller.

The carriage or coach horse is much lighter in weight than the draft horse. They are used to draw heavy carriages. They might be called the combination horse as they combine strength, style and action. The Cleveland Bay Coach is from England, the French Coach from France, the German Coach from Germany and the Hackney from England.

The roadsters have a light bone, their legs, however, being longer than those of the draft. They represent the highest type of speed. There are three distinct types of roadsters, the American trotting or pacing horse, the Thoroughbred, the English running horse and the Saddle horse from Kentucky and adjoining states. The American bred trotters have more than been able to compete with foreign bred horses. The importation of the trotting horse into America began about 1790 when "Imported Messenger" was brought here. Many of his descendants have become famous sires. Enormous sums are often paid for a single horse. In 1913 \$250,000 was paid for Prince Palatine, an English thoroughbred. Dan Patch is one of the most famous of the American pacers, having a record of 1.55¼. For a horse to make such a record means that he must travel about 45 feet a second. Trotters and pacers that travel miles in 2:04 or better, often step 20 feet.

A thoroughbred is a running horse. England has developed the running horse to a higher degree of speed than has the American horseman. Many running horses are able to make a mile at the rate of 1½ minutes for a mile.

The saddle horse is a product of Kentucky, being used extensively in the hilly regions. He can be taught several gaits.

CARE.—The horse does not have a very large stomach, hence the food must not be too bulky. Although the horse shows much strength and endurance it becomes sick very easily. Much attention should be given to the sudden changing from dry food to green food such as oats, clover or corn. When the horse is heated it is not a good plan to feed it much grain or let it drink large quantities of cold water. There are two general classes of foods, carbohydrates and protein; grains contain much more carbohydrates than protein. The carbohydrates produce fat and heat and the protein produces muscle. Horses should be fed regularly, the heavier meal being given at the supper. It is not advisable to feed a horse corn and hay three times a day for a month at a time. Oats is a good food and the working or driving horse should be given some at least once a day. A bran mash should be given at least once a week. This is made by heating bran and water. It should be

flavored with salt. Dusty hay should never be fed to horses unless it has been well sprinkled. Much care should be used in watering horses when they are very warm. A small amount of water will always allay the thirst and at the same time will not cause any serious trouble.

If the horse is to remain in the best of condition, he must be carefully groomed both morning and evening. There is not much need of cutting the frog of the hoof when shoeing the horse. During the dry season the horses' hoofs often become brittle and break off causing lameness. This may be avoided by oiling the hoofs frequently—once every two weeks at least. It is a good plan to wash, quite often, the under surface of the foot. This is especially true where the horse stands in an uncleaned stall. This keeps the frog of the foot in a healthy condition and gives the owner the opportunity of discovering any corns that may be making their appearance.

HARNESS.—(Discussion).

1. What are the two purposes?
2. Name all the parts.
3. What is the approximate cost of a set?
4. How should the collar be fitted to the neck of the horse?
5. Some farmers oil their harness at least twice a year and "soap it" at least once a month. Why? How is harness soaped?

BREAKING COLTS.

The secret of teaching the colt to obey lies in the two factors, kindness and firmness. The average colt requires but little training if he is properly handled. The first and most important step is to teach him to lead. After a halter has been placed upon him a long common wrapping cord (string) about twenty feet long should be secured. The ends should be held in the hand and the loop end placed just above the hocks. (A rope is too heavy). By standing in front of the colt and pulling lightly on the cord he will soon move forward, following wherever you go. This plan is much better than using the halter strap alone. Horses should be taught to stand still and not start until given the signal. The word "Whoa" to the horse ought to mean to stop. The second step in teaching the colt to obey is to drive him about with the lines fastened to the halter, the bit being omitted. Colts should seldom be jerked, whipped or frightened. The horse is intelligent and will usually do what is asked of him. Balking and kicking horses are those that have been improperly trained. One new thing a week is enough for a colt to learn.

Balky horses may be made to move by the following simple arrangement. A brow band should be placed in the middle of a 30 or 40 foot rope. The rope should now be placed on the horse as a bridle. When the rope reaches the right side of the mouth it should pass through the horse's mouth to the left side. The rope on the left side should pass through the mouth to the right side. (It is best to have the rope that passes through the mouth covered with leather.) The rope on the left side should pass to the ring in the back band, passing through it. Do the same with the right side rope. Gather the ends of the rope and stand in front of the horse. By a little practice a balky horse can be made to move forward. An even and a light pull should be made on the ropes until the art of using them is learned.

TERMS.

The HOCK refers to the rear part of the hind knee joint.

The CANON is the part of the leg between the knee and the fetlock.

The FETLOCK is the first joint below the knee.

A PASTERNA applies to the space between the fetlock and the coronet or upper part of the hoof.

The part just back of the ears is called the POLL.

THINGS TO DO AND QUESTIONS FOR DISCUSSION.

1. Make a study of the ration of the farm horses in the community. The pupils to report on the kinds of feed.
2. Trace the origin and history of one of the common breeds of pure bred horses in the immediate neighborhood.
3. Make a chart of the pictures of the various breeds of horses. They may be obtained from farm magazines or from the periodicals devoted to the subject of horses.
4. A light draft horse weighs about 1,500 pounds, a medium draft 1,700, and a heavy draft about 2,000 pounds. Classify the draft horses of the community.
5. Does it cost any more to raise a well bred colt than it does a scrub?
6. Mention some things that were formerly run by horse power. (Such as street-cars, corn-sheller, threshing machines and traction plows.)
7. Will the automobile finally take the place of the horse?

FREE BULLETINS.

Horse-shoeing—Bulletin 179, Department of Agriculture, Washington, D. C.
Principles of Horse-breeding—Bulletin 170, Department of Agriculture, Washington, D. C.
Feeding of Farm Animals—Bulletin 22, Department of Agriculture, Washington, D. C.

BIRDS.

BIRD STUDY.—It may be said that the main purpose in the study of birds in the public schools is to awaken in the child the powers of observation so that he will naturally learn to love and appreciate bird life. If the child, or adult, for that matter, will familiarize himself as to what the bird is doing, he will soon become intensely interested. Judicious discussion and careful observation soon arouse the spirit of helpfulness on the part of the student and he will in most instances devise ways and means of affording protection to the song birds from the weather and from its natural enemy, the cat. Bird descriptions are all right in their place, but they can never take the place of the individual observation. The logical beginning is the study of the habits of the bird—how and where it secures its food, its fight against its enemies, its defense of its home and the rearing of the young.

Birds as a group make their appeal to us through their song, beauty, attitude toward each other, or for the good they do in the destruction of weeds or animal pests. They all seem to have in their constant struggle for existence their happy times and their times of sorrow. In the early morning all bird life seems to be unusually joyful, but should the young be killed we find that the mother bird, especially, hides in the underbrush or hedge rows for several days. Her disposition during this period is apparently one of sorrow.

To become familiar with bird lore it is absolutely necessary to enter the by-ways, the field and the forest, as it is by this method that we are able to get first hand things that give us the joy of discovery.

It is necessary for the bird to adapt itself to a given community so that it may obtain food, be secure from its enemies and rear the young. The peculiar structure of a particular group of birds fit it so that it will have the best of opportunity to secure its food. The eagle has a strong bill for tearing food and sharp talons for grasping and holding its prey. Along with these the long sweeping wings of the eagle give it the power of long, rapid flights and of remaining in the air for a great length of time.

Such birds as the wood cocks have long bills which they can push into the soft earth and secure the worms near the surface. The wood pecker has a sharp bill with which he can bore holes into the trees and is thus able to get his food or to make a hole large enough in which he can build his nest. His spreading toes also assist him in hanging onto the trunk of the tree while he performs his work. Many other examples might be enumerated of the relation of the form of the bird to its habits.

If bird study is to be a vital thing and have real meaning it is necessary that we become in touch with the bird as it lives out of doors. The essentials of bird life are the food and the home, a knowledge of which will cause us to assist in the partial domestication of the wild bird by a feeding now and then of our feathered friend, and by affording him means of protection.

PROTECTION OF BIRDS.—There has been growing steadily during the past few years a genuine sentiment favorable to the protection of the song birds and those whose food consists of destructive quadrupeds or insects. The Audubon Societies have done much to bring about this condition, but there still remains much to be done. In many States the stringent laws are not enforced for the reason that many persons fail to appreciate the real worth of the birds to the community. Quite frequently nothing is done to add to the bird's propagation, but instead an attempt is made to drive them away from the locality. Below is briefly mentioned some of the things which birds have to contend with in securing food, in rearing their brood, or in living out their natural life time.

1st. Many persons still continue to wear the feathers or wings of certain birds in their hats.

2d. The destruction of the nests, eggs, and the young birds by boys or men who assume that the bird is doing an injury to the fruit or the grain.

3d. Some quadrupeds such as the weasel, rat, mink, raccoon and fox destroy birds of all kinds. The cat, however, is the natural enemy of the song bird. The good that a cat might do in catching mice and rats is greatly overbalanced by the harm it does in killing the young birds.

4th. The cultivation of the waste lands and the timber tracts lessens the natural brooding places, hence the chances for final extermination are much increased by this one factor alone.

5th. Hunters seldom discriminate in the killing of birds. The most beneficial are slaughtered along with those that are apparently injurious or with those that are secured for food.

With some of the more common hindrances to bird propagation in mind it is easily seen how some birds are becoming practically extinct. We will all agree that the bird is as much a part in the cycle of life as are the trees and flowers and that more definite organization be done so that effective work can be accomplished. The Audubon Societies' pledge is, "To encourage the study of birds, particularly in the schools. To work for the betterment and enforcement of State and National laws relating to birds. To discourage the wearing of feathers and the wanton destruction of wild birds and their eggs." Under the auspices of the Audubon Societies there may be organized in every school Junior Societies. If carefully organized the children will become interested in the protection of wild birds.

In the selection of their nesting place and in the building of the nest the bird should be offered some means of protection. To have the birds build their nests in the rose bushes, peach trees, apple trees or in ornamental trees near our homes is the vital problem. It may be accomplished within a year if the birds are seldom molested. Most birds soon learn to know their friends and do not show alarm at their presence. Strings, pieces of cloth, cotton and straw placed in the vicinity of the selected nesting places will always be used by the birds. Overgrown vines and bushes may be left here and there as they will usually attract such as the red bird, the thrashers and the robin. Bird houses will also assist in attracting the bird as he is looking for a nesting place. This is especially true of the wren, blue bird, martin and swallow. A little attention to grassy spots—the omission of the cutting will be a benefit to the finches, bobolink and meadow lark. The screech owl, barn owl and swallow will make their homes in the attics of barns and out-buildings, if there is an opening where they may enter. One owl in a barn is worth a dozen cats when it comes to the destruction of rats and mice.

Except during periods of droughts or cold weather birds are able to secure the necessary food, but very frequently the water supply is what causes them to seek what would appear to us more unfavorable quarters. By placing a basin of water in the neighborhood of a nest will soon prove how much the bird will enjoy the little kindness. Birds also bathe quite often and in many instances will travel a considerable distance to obtain a drink or a bath. It may be said that if the protection of birds is to become of vital moment that it must be reached by teaching the child the proper status of the bird so that he will respond with acts of helpfulness. It is a difficult proposition to enact laws that materially assist in the protection of the birds until a proper spirit has been created for obeying them.

The outline given here on the robin may suggest a general plan of studying any of the common birds.

THE ROBIN.—Although the robin is one of the most common birds, we find out daily that there are many things to learn about him. If we will but look we will be able to find out many interesting facts. It is by observing a bird in its natural home that we become interested and appreciate its real purpose in the world and its actual worth. The stories and descriptions of birds in books are valuable, but they will not cause us to have a better feeling toward the bird family as will an hour or two, now and then, spent in the field and forest or along the stream. It is possible to learn many things with the naked eye, but a field glass may be obtained for a small sum and then the bird may be observed as he works or plays—every bird has its play time. Few wild birds act naturally if they are aware that they are being watched, hence the advantage of a field glass.

The following brief outline is given for the reason that it may help you in becoming better acquainted with the robin (or any other bird for that matter.) The suggestions, however, are of but little value unless we experience at least a few of them.

* 1. Notice when and where the robin sings. Does he sing during a rain? Learn to imitate his song. (A boy ought to be able to imitate any bird that he hears).

2. Selection of the site for his nest. Does his judgment seem good? Do they ever partly build a nest and then leave it to start another?

3. Building of the nest. Do you suppose that it would help the robin any if you would place a box or pan of mud near the place where he has begun the nest? Try it. Of what material is the nest constructed?

4. Hatching period. Does the mother do all the sitting upon the nest? What does the robin do if molested by another bird? Did you ever see a robin's nest in a well protected place?

5. Care of the young. Does the male or female bring most of the food to the young? What kind of food is brought? Watch the mother as she teaches the young birds to fly and to eat. For several days after the robins are hatched they merely open their mouths to receive the food brought to them. Would it not be possible for you to help the robin during a dry season by furnishing him with a supply of fishworms or caterpillars for the four or five tiny fledglings? He will carry five or six fishworms at a time. By following this plan you will have the satisfaction of making him your intimate friend.

6. The food supply. Determine for yourself whether he eats more animal food or more cherries. By careful observation you will find that his daily food consists of about 60 per cent of animal food and about 35 per cent of wild fruit. He will travel quite a distance to make a dinner on the wild cherry, wild grape or the elderberry. The tame cherry crop will be decreased many per cent if the robins are driven away. Why?

7. Peculiar habits or traits. What becomes of the first brood of robins while the female is hatching the second brood? Do robins ever fight each other? Watch the robin as he gets a cut-worm or an angleworm (fishworm). Did you ever see him listen to determine whether an angleworm was working near the surface of the soil?

8. Simple way to help. Did you ever place a shallow pan of water in the vicinity of the nest? The robin will use it as a drinking fountain as well as a bath tub. Try the experiment. The pleasure that you will have in watching him drink and bathe will more than pay for the trouble. The pan should be so placed that the birds will be entirely free from danger when drinking or bathing.

The following life histories of common birds are intended to suggest what may be worked out about any bird that may be studied:

BOB WHITE'S AUTOBIOGRAPHY.

The name which is given to me in books is *Colinus Virginianus*—rather a long name. The name that suits me best, however, is "Bob White" although I am often known by the name of quail or partridge. We live in nearly all parts of the United States, and as we do but little migrating, are among the first birds to indicate the coming of spring. Our family of the previous summer live together during the fall, winter and early spring months. As the spring approaches we divide into small groups of two or four.

About the middle of April or the first of May the selection of a nesting place is made. It may be quite a distance from the winter home that was located in a brush-pile, hedge row, a bunch of grass or in a cluster of leaves in a bushy thicket. Our nests are usually to be found in bunches of grass, near a small bush, by a stump or along an old lane-fence—in same color as our coat of feathers. If you will notice closely, you will see that our feathers resemble in color, dead leaves, dead grass or the bark of trees or posts. For this reason but very few people are able to see us when in the nest. In many nests there will be found as many as two dozen white eggs. As the eggs are pointed the mother bird is able to arrange them so that they may all be covered by her. If the eggs were not pointed it would not be possible for the small nest to hold all of them.

During the nesting and hatching season you can hear the male bird in the early morning or in the late evening giving his thrilling call, "Bob White." The male and female take turns in covering the eggs during the hatching season. After the hatching season the whistle FORE-A-FEE, FORE-A-FEE is often heard. It is a whistle given to gather together the covey. It will be easy for you to discover whether the whistle FORE-A-FEE is given by the male or female. As any form of danger approaches, the young Bob Whites scatter and hide in any form of undergrowth. As they become larger, however, they endeavor to escape danger by running rapidly in a zig-zag way and then by flying in a peculiar undulating manner. The amateur hunter can seldom hit us while we are on the wing.

Our food during the spring, summer and fall months consists mainly of the seeds of weeds, chinch bugs, ants, beetles, grass hoppers, potato bugs, cut worms, caterpillars and small quantities of grain. If farmers would be more careful in protecting us from the hunters, it would not be necessary for them to spend much time and money destroying the insects that we depend upon for food. We hope that sometime the farmer will recognize our worth and will give us more protection from the depredations of the annual sportsman.

As the droughts of the summer approach we seek the nearby streams, but return of evenings to our roosting place. During the fall and winter the covey sleep in the same place unless they have been disturbed by some nocturnal visitor, such as a weasel, fox or mink. In sleeping we group ourselves in the form of a circle upon the ground, all having our heads outward. By this method we can more readily discern the approach of an enemy. Quite often a number of our family are killed by being covered with deep snows. Frequently the deep snows cause many to starve. If a farmer could supply us with a small amount of grain during the worst winter months, we would pay him back many fold during the summer season by the eating of destructive insects.

THE BIRD THAT SHOWS THE WHITE FEATHER.—Meadowlark.

With the possible exception of the robin this bird is the first to announce the approach of spring in the northern states east of the Mississippi River. To appreciate his song the most it must be heard in the early morning as he flits from one knoll in a meadow or pasture to another. It is when standing on a knoll, post or tuft of grass that he renders his best selection, which consists of a clear, musical whistle. The earnestness with which he sings attracts our attention and we need to hear him but a few times to be convinced of this fact. He is never to be seen standing around and apparently out of tune with even the worst weather. Except when searching for food he walks with his head erect and the way in which he moves is very striking. He walks as though he was intimately interested in the work that he is doing. He can rightly be called an optimist.

The meadows and pasture lands are the natural home of this bird. Should he arrive at his summer home too early in the spring, as he often does, the chances are that he will have some trouble in evading the deep snows. He always sleeps on the ground in a tuft of grass. In crossing a meadow in the springtime after a light snow you will often be surprised by having one spring from his cozy nest where he has been protected from the wind and snow. To you and me it would seem to be a lonesome and a dreary place to spend the night alone. It is another story if the snow is a deep one, as he may be covered to the depth of several inches and in this event would freeze or starve.

In looking for food he walks rapidly through the grass in a stooping position. He raises his head quite often to see if there is any danger near. It is said that at least three-fourths of his food consists of beetles, ants, grasshoppers, caterpillars and cut-worms. During the spring and fall he eats a great number of weed seeds.

The nests are usually located in a tuft of grass. Generally the nest has a natural covering of grass, leaving but one place for entrance. This opening is in most instances on the south side of the nest. The feathers on the back

and wings of the bird bear a close color resemblance to the mixed grasses. The bird on the nest is seldom seen by the passerby, as at the approach of danger they crouch closer to the ground. There are usually five or six white eggs with brown spots. The eggs are often destroyed by snakes or field mice.

This bird has a bright yellow breast with a black crescent on it; his back, wings and sides are of a brown and black. He does a great deal of walking, consequently his legs and feet are very strong. The most interesting point about his description is that the outer end of the tail feathers are white. When he alights he moves the tail feathers very rapidly several times, showing the white on the ends of the feathers. In a natural flight this white on the feathers is also very noticeable. He has but few associates during the nesting season. He is known as the bird of the "white feather," because he will not enter into combat with another bird. Of course he shows the white feather in making a flight, but he also shows it when forced to stand for his rights. When trouble appears he evades it by taking flight or by hiding in the grass. He seldom offers any resistance to an intruder, even though it be an English sparrow.

Our admiration for the bird ought to increase when we take into consideration his songs, his destruction of insects and his qualities of peace.

IDENTIFICATION CHART OF THIRTY COMMON BIRDS.

1. RED-HEADED WOODPECKER.—9 to 10 inches in length. Head and neck a crimson; wings and back a glossy black, excepting the tips of the wings which are a white. Breast and under part a white. Eggs are nearly spherical. Eats larvae found in wood, ants, insects and nuts. Non-migratory. Two or more broods a year. Nest generally in hole in tree. More good than harm.

2. BROWN THRASHER.—11 to 12 inches in length. Bright, rusty, red back and wings. Small bands of white on wings, the breast and under surface are white, but marked with brown spots. Long bill and tail; yellow eyes. Eggs are white with brown spots. Migratory. Eats insects and berries. Nests made from fiber and twigs; located in hedge-rows or bushes, sometimes on the ground. Destroy weeds and insect pests.

3. WHIP-POOR-WILL. 10 inches in length. Color a mixture of brown, black and white; white band across breast. Under side of tail feathers white. Tail is broad and rounded. Near base of bill, many bristles. Lays two eggs that are marked with yellow spots. Nest is on log or bunch of leaves. In perching sits lengthwise on limb. Eats insects. A valuable bird.

4. MEADOW-LARK.—10 to 11 inches in length. Back, wings and sides are a brown and black; the breast is a bright yellow with a black crescent. Outer end of tail feathers are white. Nest in tuft of grass, in meadows or pastures; white eggs with brown spots. Eats beetles, ants, grasshoppers, caterpillars, weed seeds and cut-worms. Walks through grass in stooping position but raises head quite often. Songster and a destroyer of pests.

5. DOWNY WOODPECKER.—A little larger than English sparrow. White band down the middle of back, remainder of back and wings striped with black and white. Under parts white. Red band on neck of male bird. Eats larvae of codling moth, ants, beetles, grasshoppers and wild berries. Often runs down trunk of tree. Nest in hole of dead tree. Often mis-called sap-sucker. Highly beneficial.

6. WHITE-BREASTED NUTHATCH.—About 6 inches long. Upper parts of a light slate color, top of head being black, sides of head and under parts a white. Wings and tail aslate color mixed with white and black. Eats nuts, canker worms, insects, weed seeds, and many larvae. Does not brace the tail against the tree as does the woodpecker. A help to the gardener and fruit grower.

7. SCREECH OWL.—About 10 inches long. Upper parts of a gray or brownish red, the under parts a whitish hue or yellow. It is mottled with

yellow or black. Coats vary quite a great deal. Tufted ears and yellow eyes. Nest in hollow tree or attic or building. Eggs very nearly round. Eats mice, caterpillars, grasshoppers and beetles. Of more value than a cat.

8. BELTED KINGFISHER.—About thirteen inches long. Wings, tail and back are an ashy blue, the wings and tail being marked with spots of white. Neck and breast are white with a belt of blue across breast. Crest on head; white spot in front of eye. Bill longer than head. Outer toe is fastened to middle one for one-half length. Flies near surface of water. Nest in hole in side of bluff. Eats fish, frogs, decaying animal matter, bird eggs and mollusks. Eggs, white. Practically harmless.

9. CAT BIRD.—About nine inches long. Dark slate color above, below a light slate color. Top of head and tail black. Feet and bill black. Nest in bushes, being roughly made. Eggs a greenish-blue. Eats insects and caterpillars. It sings like the brown thrasher, and at times utters a cry something like a cat. Is constantly moving about. Migratory. Valuable on account of song and the destruction of insects.

10. KING BIRD.—Smaller than the robin. Upper parts a grayish slate. Light slate color below. Small crest. Tail black with white tips. Nest on branches of trees. Egg a white with brown spots. Eats bugs, caterpillars and winged insects. Attacks crows and hawks. Seen about orchards or hedges. Migratory. Often misnamed Bee-martin. Beneficial to fruit grower.

11. SCARLET TANAGER.—A little more than seven inches long. In spring, the male is a bright scarlet, with black wings and tail. Underneath wing feathers are a white. During the fall the male and female look very much alike, having an olive green hue above and the underneath a yellow. Nest on branches of trees. Blue eggs with brown spots. Makes nests in groves. Usually sings from top branches of a tree.

12. BLACK-BILLED CUCKOO AND YELLOW-BILLED CUCKOO.—Somewhat larger than the robin. Black-billed is gray above and below. Bill long. Skin about eye is red. A long tail. Yellow-billed is a bronze gray above and below. Lower mandible of bill is yellow. Outer tail feathers tipped with black. Long tail. Seldom comes out in open. Often called rain-crow. Eats caterpillars. Lays eggs in nest of other birds. Disappears noiselessly if approached.

13. MOURNING DOVE.—Grayish brown above. Reddish brown below. Upper part of head a greenish blue. Easily recognized by its low mellow notes. Nest poorly made in lower branches of small trees or on the ground. Eggs white and two or three in number. Nests in wooded tracts or grain fields. Gathers in flocks in early fall. Eats weed seeds, insects and small quantities of grain. Highly beneficial to farmers. Does but little injury.

14. FLICKER.—Called yellow-hammer or golden winged woodpecker. Head and neck a gray, with red crescent across back of neck. Black crescent on breast. Above a bright brown with black. Below a cinnamon brown with black blotches. Yellow lining of wings and tail. Nest in hollows of trees. Feeds upon the ground quite often. Migratory.

15. RED-WINGED BLACKBIRD.—Male is a black. Shoulder a scarlet with an edge of yellow. Female a rusty black with less scarlet. Lives in swampy tracts or along small streams. Nests are fastened to bushes or slumps of weeds or grasses. Eggs a pale blue marked with black. Eats worms, weed seeds, insects and grains. Lives in flocks. Highly beneficial.

16. AMERICAN GOLDFINCH.—Often called wild canary and yellow bird. Black crown, wings and tail. Remainder of covering a yellow. In winter an olive brown. Nests in low bushes. Bluish white eggs. Nesting period in July. Often seen in thistle patches or by roads. Live principally upon weed seeds. Found in flocks. Of much value to the farmer.

17. COW BIRD.—Male, black, with head, neck and breast a brown. Female, a dull slate color. Both are smaller than the other black birds. Has a conical beak. Seen among cattle in pasture. Lays eggs in nests of other birds. Eggs, white with brown spots. Eats weed and grain seeds. Congregates with other species of black birds. Beneficial.

18. **BRONZED GRACKLE** or **COMMON BLACKBIRD**.—Black with blue, purple and copper tints. Tail longer than wings. Yellow in eye. Builds nest in trees. Often carries tail rudder-wise. Eats insects, weed seeds and growing grain. The flocks separate during hatching season, but gather together in early autumn. Does a slight damage to growing corn. More than pays for all damage it does.

19. **SHARP-SHINNED HAWK** and **COOPER'S HAWK** (Male).—The Cooper's hawk is much the larger. The upper parts are of a brown slate. Under parts lighter, the throat being white. Under parts barred with brown. Long tail. Nest in top of trees. White speckled eggs. In fields, orchards or woods. Flies very swiftly. Eats mice, rabbits and chickens. The only species of hawk that lives on poultry. All other species highly beneficial.

20. **SPARROW-HAWK** (Male).—About ten inches long. Upper parts a reddish brown, being barred with black. Under parts a yellowish white. Wing feathers a slatish hue. Makes nests in barns, roofs or a hollow tree. Eats insects and mice. When searching for prey in meadows it hovers above and then drops down. Should not be killed.

21. **RED-TAILED HAWK** (Male).—About twenty inches long. Often called hen-hawk. Upper parts brown, being mottled. Lower parts a light brown. Tail a red-brown. Eats insects, mice, rabbits and small birds, but seldom poultry. Makes nest in top of trees. Beneficial.

22. **MARSH HAWK**.—Male bird is smaller than the female. Back wings and tail are of a grayish color. The tail has bars across it. The throat and breast a white gray. The lower parts a white, but mottled with a reddish brown. Long wings and tail. Lives in open. Flies low. Can often be seen turning a somersault in the air. Nest in bunches of grass or in shrubby patch. Eats moles, frogs, insects, mice, ground squirrels, lizards and small birds. Does not eat poultry, hence should not be killed.

23. **RED-SHOULDERED HAWK** (Male).—Upper parts a grayish brown, barred white. Under parts blotched with black. Lives in wooded tracts. Seldom visits poultry yard. A benefit to farmer.

24. **PRAIRIE HORNED LARK**.—A little larger than the English sparrow. Lives in open fields. Permanent resident. Pinkish brown. Erect feathers on both sides of head. Throat a yellow. Breast has black blotch. Tail black. Under surface a pale white. Seen often in by-roads, grain fields, and meadows. Nests in meadows of pastures. Eats weed seeds and insects.

25. **BALTIMORE ORIOLE** (Male).—Head, throat, back and wings black. Wings have white spots. Rest of body an orange. Female a yellowish brown. Wings dark brown. Has a hang nest on end of limb. Nest made of string and pieces of cloth or pieces of inner bark. Eats worms, flies, ants and caterpillars. Noted for its song.

26. **RED-EYED VIREO**.—About the size of an English sparrow. Upper parts an olive green. Crown a slate color. White just above eye. Above this is a black hue. The iris of eye is red. Under surface a white with a greenish yellow on sides. Lives among bushes and small trees. Sings at midday. Eats insects and worms.

27. **SONG SPARROW**.—About the size of English sparrow. Reddish brown. Brown stripe on side of throat. Below is white. Black spot on breast. Tail a light brown. Nest on ground or in small bush. Raises two or three broods a year. Found in fields, in by-ways, or in patches of underbrush.

28. **HOUSE WREN**.—About five inches long. Brown barred. Darker except on head. Wings finely barred. Light brown on under surface. Often has tail erect. Nest in boxes, openings in buildings or in hollow trees. Very domestic. Eggs are speckled. Eats worms and small insects. Valuable to gardener and fruit grower.

29. **WOOD THRUSH**.—Reddish brown on head and shoulders. Rear of back an olive brown. White beneath but spotted with dark brown spots. White eye ring. Rather domestic. Common in parks, orchards and gardens. Nest in low bushes. Lively singer. Lives principally upon insects.

30. **NIGHT HAWK**.—Black and brown spots. Yellow spots on under sur-

face which is barred. Throat a white. Long wings. Large white spots noticeable only in flying. Small bill. Nest on logs or ground. Flies in flocks in late afternoon in summer. Eats insects that it catches on the wing.

BIRD CALENDARS.—During the spring, vacation and fall a bird calendar should be made. It may include any points that have been learned by observation, as:

Name	American Goldfinch	Food eaten	Weed seeds
Color	Bright Yellow	Number of broods	One
Arrives	May	Number of eggs	Five or six
Location of nest	In small tree	Color of eggs	Pale blue
Material in nest	Grass and moss	Migrates	October

BIRD MAPS.—A map should be drawn of the yard, garden and orchard of a home or of the neighborhood of the school showing location of all the nests made. It may be indicated on the map as to whether the nest is in a bush, tree on the ground or in a prepared nest. Taking a census or survey of a neighborhood in this way makes anyone more familiar with bird life.

BIRD FOOD CHART.—A simple outline may be kept of the food that the bird is seen to eat. In course of time, a complete chart can be made of twenty-five or thirty and much will be learned about the habits of the bird. A check may be placed after the name of each food that the bird is seen to eat. Where it eats a great deal two crosses may be made.

Tame fruit	Screech Owl	Robin	Jaybird	Bluebird	Wren
Wild fruit	.....	....	....	....	....
Caterpillars	 X	....	....	....	....
Grasshoppers	 X	....	....	....	....
Ants	.....	....	....	....	....
Grain	.....	....	....	....	....
Weed seeds	.....	....	....	....	....
Mice	 XX	....	....	....	....
Worms	.....	....	....	....	....
Potato bug	.....	....	....	....	....
Cut worms	.....	....	....	....	....
Bird eggs	 X	....	....	....	....
Birds	.....	....	....	....	....

SPECIAL POINTS ABOUT A FEW COMMON BIRDS.

KIND OF RESIDENTS.—Birds that stay in the same immediate neighborhood are called permanent residents. Six such birds near the fortieth parallel are: blue-jay, crow, red-headed woodpecker, downy woodpecker, flicker and horned lark. Some birds remain near the fortieth parallel during the winter but at the approach of spring they migrate toward the north. Such birds as these are, the ruby crowned kinglet, brown creeper, white throated sparrow and tit-mice. Again there are those that remain with us during the summer. These are called migratory or summer residents. The majority of our birds belong to this class.

TREE-PROTECTORS.—Many birds are helpful in that they destroy many insects that injure either the tree or the fruit. Among these may be mentioned the flicker, hairy woodpecker, white-breasted nuthatch, kinglet, downy woodpecker, red-headed woodpecker, chickadee, vireos, brown creeper, yellow-bellied sapsucker and cuckoo.

BIRDS OF PREY.—In this class may be grouped the hawks and owls. They are usually solitary in habit, excepting during migration. They live principally upon mice, large insects, rabbits, birds, squirrels, eggs and poultry. There are only two members of the hawk family that invade the poultry yard. They are the sharp-shinned hawk and the Cooper's hawk. The marsh hawk, the red-tailed hawk, the red-shouldered hawk and the sparrow hawk

should not be blamed for the depredations of the first two mentioned hawks. The screech owl, and the short-eared owl are all highly beneficial.

SOURCES OF MATERIAL.—Colored bird pictures may be obtained from *Birds and Nature*, Chicago, Ill. (Price 2 cents apiece.) Any of the following magazines will be found helpful in the study of birds:

Bird Lore, Harrisburg, Pa.

Nature-Study Review, Chicago, Ill.

Birds and Nature, Chicago, Ill.

The Illinois Audubon Society, Lincoln Park, Chicago, Ill., will be pleased to send bird leaflets to any teacher.

The bulletins mentioned below may be obtained free from the Department of Agriculture, Washington, D. C.:

Common Birds—Bulletin 54.

Relation between birds and insects—Bulletin 486.

Economic value of Predaceous birds—Bulletin 474.

Does it pay the farmer to protect birds?—Bulletin 443.

Migratory movement of birds—Bulletin 545.

Economic value of Bob White—Bulletin 309.

How birds affect orchards—Bulletin 197.

Food of nestling birds—Bulletin 194.

The Blue-jay and its food—Bulletin 66.

Our Grosbeaks—Bulletin 456.

Among the bird books are:

Chapman's *Birds of Eastern North America*.

Merriam's *Birds of Village and Field*.

Blanchan's *Bird Neighbors*.

Lange's *Our Native Birds*.

Reed's *Our Birds*.

THE FOREST AND ORNAMENTAL TREES.

If an appreciation for the presence of trees is to be instilled in the pupils of the public schools there must of necessity be considerable attention paid to the planting and caring of trees. The trees aside from being of an economic value, also add much to the appearance of the landscape and at the same time afford a place for the nesting of nearly all species of birds. The element of shade is a question that also enters into the consideration of the study. The planting of the seeds or the trees so that our descendants may enjoy the fruits of our labor is one of the highest motives that can grow out of the study of trees. There is something uplifting in seeing an old man plant a hard maple in preference to the rapidly growing soft maple.

The study of trees can be carried on at all times of the year. The collecting and planting of such as acorns, maple seeds, walnuts, hazel nuts, linden seeds and box elder seeds may be carried on during the fall. Careful observation should be made as to how the seeds are propagated. Many of the seeds of the hardier trees do not germinate until the second year. The seeds may be planted in either the spring or the fall. It is always best to plant the seeds very shallow—not more than two inches deep. It will also help the seed to germinate if the seed plot is covered lightly with leaves or grass. A corner of a school ground is an excellent place to have a tree plot so that the school grounds or community could be furnished with the necessary young trees.

During the study on trees much time should be spent in the discussion of the care of the school yard and home. It is not an uncommon thing to neglect a scar on a tree or a partially broken limb. In the collection of samples of wood there should not be the wanton destruction of small trees and the limbs of trees as is often done. A collection of leaves may be made during the late spring or the early fall. These will help in the identification of many species. Tree study to be successful must be principally by observation and not by breaking limbs of trees in an haphazard manner.

Too much of this kind of work has already been done as is evidenced by the number of imperfect trees.

When the buds begin to appear in the early spring there should be a study of the flower bud, the leaf bud and the bark. It is also interesting to keep a calendar of the flowering and leafing of the trees. It may be as follows:

Name.	Time of leaves.	Leaves fully developed.
Elm.	April 25.	May 10.

The culmination of the tree study should end on Arbor Day when a special exercise of some kind should be held.

GENERAL SUGGESTIONS.

1. Make drawings of leaves and trees.
2. The following poems or prose selections refer to tree life:
October's Party, Hiawatha's Sailing, The Crooked Fir Tree, The Brave Old Oak, Planting of Apple Tree, Rhoecus, The First Christmas Tree, Woodman Spare That Tree.
3. Make a list of all the nuts common to Illinois.
4. Describe the white oak telling where it is commonly found, shape, color of bark, seeds and shape of leaves.
5. Make tree booklets.
6. Draw a map of school district showing the location of trees.
7. Make a list of insects that infest the trees.
8. Make a collection and then a study of the twigs of various trees. The color, buds, general shape, smoothness and the seeds.
9. Learn to recognize the following trees (take into consideration the shape, bark and leaves):

soft maple	sassafras	birch
hard maple	sycamore	walnut
Norway maple	linden	cotton wood
box elder	elm	hickory
white oak	red oak	red haw
beechnut	hackberry	chestnut
pecan	mulberry	burr oak
catalpa	ash	wild cherry

Describe the following, telling some places where they should be planted:

lilac	honeysuckle	ivy
spirea	barberry	wistaria
privet	clematis	grapevine

Questions to be proposed and answered after observations have been made:

1. What trees do not lose their leaves during the winter?
2. Are the leaf scales covering the buds, sticky? For what purpose?
3. Do pecans grow in Illinois?
4. Is coal formed from trees?
5. What is the layer under the outer bark called? How does the tree get its food from the soil?
6. How can you tell the age of a tree?
7. Name a common tree that does its own pruning?
8. Why is it necessary to dig the hole for planting a tree two or three times as large as seems necessary?
9. Why is it better to transplant a tree in the early fall?
10. What trees grow close to the smaller waterways?
11. What are Forest reserves?
12. What are some of the ways in which forests are destroyed?
13. Does the absence of forests cause a decrease in the amount of rainfall?
14. In what ways are forests being preserved?

FRUIT TREES.

The successful growing of fruit trees is one of the most interesting and helpful studies in the nature study field. The results of Burbank, the spraying of trees, the grafting, the fruit pests, the care of the trees and the storing and marketing of the fruit are some practical illustrations of what the general field suggests.

Some of the things that ought to be done in the study of the Apple: (Other fruit trees should also receive attention.)

1. Make a list of the various fruit trees of the neighborhood.
2. Draw a home plot showing the location of the fruit trees and follow this with a discussion as to where more trees can be set out.
3. In orchards it is the best arrangement to set the trees of each row opposite the spaces of the next row.

Draw a diagram showing that sixty-eight trees twenty feet apart can be set on a plot 160 feet square, no tree within ten feet of the edge of the plot.

4. Apple trees (results to be gotten by observation).

- (1) Average height of the trees?
- (2) Color of the bark?
- (3) What is the arrangement of the branching?
- (4) How and where are the flowers located?
- (5) Compare the flower bud and stem until they are easily distinguished.

5. Send to a nursery for their catalogue and make a study of the common varieties of apples, such as Winesap, Red Astrachan, Northern Spy, Jonathan, Snow, Greening, Grimes Golden and Russet.

6. Make a collection of seeds and plant a few to show the process of germination. Other fruit seeds should be planted at the same time.

7. **PLANTING APPLE SEEDS.**—The apples from the apple trees that have been raised from the seeds are usually very small and do not resemble the apples from the original tree. This may be avoided by grafting the sprout or young tree after it is a year or two old. This may be done by taking the stem buds and placing them on the stem of the tree that has been developed directly from the seed. (This phase of work will be the most interesting and vital of any of the work on the trees for the reason that it concerns the propagation of trees for future generations. One stem bud will often produce a hundred or more during a summer.

To do simple grafting it will be necessary to have a sharp knife, pieces of cloth and wax. The wax may be of equal parts of tallow, resin and beeswax.

Four or five stems (scions) may be cut from the same tree or a scion from each of several trees may be used. There are several methods of grafting, but in this instance only two are mentioned—cleft grafting and the slanting cut grafting. The cleft grafting consists of splitting the stock, the stem on which the graft is to be fastened and then placing a thinned end of the graft stem into the slit. The other plan is to cut down obliquely across the graft stem and obliquely up the stock stem. The main thing in any plan of grafting is to unite the living parts of the two stems. It is the layer lying next to the bark that finally unites the two stems. This is called the cambium layer. After the stems have been united and covered with a thin cloth or hemp, the cloth should be given a thin coat of the wax. Grafting should be done at the first approach of spring.

8. **BUDDING.**—Budding consists in cutting a small T-shaped slit in the tree and inserting just the stem bud into the opening. The bark should then be fastened back in its original form. Budding can be done more successfully on the old peach tree or on the yearling sprout than on the apple tree.

9. **PRUNING.**—If the trees are carefully pruned they will have a better shape, and will produce a better apple. They will also be less susceptible to decay. The pruning should be done at the close of the winter months. When large limbs are cut off they should be removed close to the body of the tree and the exposed surface given a thin coat of paint.

10. **APPLE AND APPLE TREE PESTS.**—Among the common pests of the apple orchard are:

Codling Moth
Apple Tree Borers

Tent Caterpillar
Canker Worms

Locust
San Jose Scale.

CODLING MOTH.—The Codling Moth lays the eggs at about the time the bloom is falling. The larvae or worm upon hatching eats its way into the apple, causing the apple to fall to the ground before ripening. The larvae then emerges from the apple and crawls up the tree and makes a cocoon. The moth comes from this cocoon.

If the orchards are kept clean of all trash it will assist in lessening the number of cocoons. The spraying of the tree at the time of the falling of the bloom will be found very effective. The following mixture may be used:

Copper Sulphate	3 lbs.
Lime	3 lbs.
Water	50 gallons.
Paris Green	4 ounces.

TENT CATERPILLAR.—The moth lays the eggs in the late summer. When spring approaches the larvae eat their way through the covering and begin to devour the leaves. As they reach full growth they leave the trees and spin the cocoons. By the first of July the moth appears and soon after the eggs are laid.

The number of these pests may be greatly lessened by the burning of the nests. The spraying of the codling moth mixture also tends to eliminate them. Many birds, such as the chickadee, woodpecker, nuthatch and catbird feed upon both the larvae and the cocoons.

CANKER-WORM.—The measuring worm or canker-worm, in the early summer burrow into the earth. In a few days they come forth as moths, the male with wings and the female wingless. The female crawls up the tree and deposits eggs. The larvae then soon appear.

A band of tarred paper placed around the tree will prevent the female from crawling up the tree. The codling-moth spray may be also used. Nearly any of the common song birds feast upon the canker worm moth.

SAN JOSE SCALE.—One of the difficult orchard pests to check is the San Jose scale. They are very minute and propagate very rapidly—often there are five generations in a year. The bark and the tree appear to have tiny gray specks on them. If the scale is unmolested the tree will often die after a fight of three or four years.

The most simple treatment is to burn the infested trees, otherwise the entire orchard will become infested.

TREE BULLETINS.

Grafting	Bulletin 408, Dept. of Agri., Washington, D. C.
Forestry in Nature Study	Bulletin 486, Dept. of Agri., Washington, D. C.
Arbor Day	Bulletin 96, Dept. of Agri., Washington, D. C.
Tree Planting	Bulletin 134, Dept. of Agri., Washington, D. C.
Growing of Apples	Bulletin 113, Dept. of Agri., Washington, D. C.
Pruning	Bulletin 181, Dept. of Agri., Washington, D. C.
Spraying	Bulletin 283, Dept. of Agri., Washington, D. C.
Spraying Peaches	Bulletin 440, Dept. of Agri., Washington, D. C.
San Jose Scale	Bulletin 124, Dept. of Agri., Washington, D. C.
Pear Blight	Bulletin 50, Dept. of Agri., Washington, D. C.
Handling of Fruit	Bulletin 387, Dept. of Agri., Washington, D. C.
Diseases of Ornamental Trees..	Bulletin 463, Dept. of Agri., Washington, D. C.
Enemies of Shade Trees	Bulletin 99, Dept. of Agri., Washington, D. C.
Lumber Supply	Bulletin 25, Dept. of Agri., Washington, D. C.
How Birds Affect the Orchard...	Bulletin Dept. of Agri., Washington, D. C.
Bitter Rot of Apples	Bulletin 118, Agri. Ex. Station, Urbana, Ill.
Insects of Illinois Shade Trees..	Bulletin 115, Agri. Ex. Station, Urbana, Ill.
Apple Score Card	Department of Horticulture, Purdue, Ind.
Pruning	Bulletin 30, Dept. of Horticulture, Purdue, Ind.

FUNGI.

Fungi are plants of a low order. They do not contain the green coloring matter (chlorophyll) as do most plants and, therefore, are compelled to be dependent upon other organisms for food. They bear no flowers, and consequently produce no seeds. Instead of seeds they produce little bodies called **spores**, which answer the same purpose.

Mushrooms, puff balls, molds, rusts, blights, mildew, rot, scabs, smuts, etc., belong to the fungi. These plants obtain their food in two ways, viz.: from living animals and plants, and from dead bodies or organic waste products. The fungus that attacks living bodies is called **parasite**, and the body which it attacks is called the **host**. The plant which attacks dead bodies or obtains its food from organic waste products is called a **saprophyte**.

THE MUSHROOM—A TYPE STUDY.

The rusts, puff-balls and mushrooms represent the most highly specialized and extensive group of fungi. The mushroom, being the easiest to observe on account of its size and abundance, is chosen for the type study.

Have the children bring in some mushrooms. The common meadow mushroom is abundant in the fall. If possible it would be advisable to buy some of the *thespawn* and raise a crop in the school room. Bulletin 53, U. S. Department of Agriculture gives full directions for cultivating this fungus.

Mushrooms are found in the woods, around stumps and barns, in the meadows and fields, and on trees or wherever there is decaying organic matter. The stem or stalk-like part is called the *stipe* and the expanded umbrella-like part the *pileus*. The leaf-like plates found on the under side of the *pileus* are called the *gills*. The surface of the gills is covered by a membranous layer bearing club-shaped cells from the ends of which project from two to four delicate branches each bearing a minute spore at its tip. When the gills are ripe these spores shower down in great abundance, and germinate, producing new plants.

Attached to the end of the *stipe* are small whitish threads which branch extensively through the sub-stratum of decaying organic matter upon which the fungus grows. These threads make up the *mycelium* and are called *spawn* by some growers. The *mycelium* is the real vegetative body of the plant upon which buttons are produced which develop into the umbrella-like plants commonly regarded as mushrooms, but which are only the fruit or reproductive organs.

An exact print of the under side of the top (*pileus*) of a mushroom may be obtained by breaking the stem off and laying the top gills downward, on a piece of clean white paper, leaving it for from twelve to twenty-four hours.

An examination of the print thus made will show an exact representation of the under side of the *pileus*. By rubbing the fingers over this print the discharged spores in the form of a fine powder, may be felt.

MUSHROOMS, EDIBLE AND POISONOUS.

The popular classification, which limits mushrooms to a certain species and classes all others as toadstools, is erroneous. All toadstools are mushrooms and all mushrooms are toadstools. The real distinction is between puff-balls and mushrooms. Puff-balls differ from mushrooms in that they have the spores enclosed until they are ripe, while mushrooms have the spore-bearing surface exposed.

The color of the spores is an important aid in distinguishing the edible type from the poisonous. The latter generally have white spores while the favorite edible kinds have dark purple brown spores which can be clearly distinguished in the print mentioned elsewhere.

FUNGIOUS DISEASES.

Plants have diseases just as animals do. Most of these diseases are caused by fungi the spores of which float around through the air, and settle

on the healthy plant. Here they grow and cause much injury to the plant. Indeed, if they are not destroyed they may kill the plant or seriously impair its usefulness. The diseases caused by spores are called fungous diseases. The most common forms are potato *scab*, peach leaf *curl*, fruit *rot*, *fire blight* of the pear and apple, *smut* in corn, *black knot* in plum, potato *blight*, and apple *scab*. Mildew and mold belong also to the fungus diseases that affect plants.

HOW PLANT DISEASES SPREAD.

1. The spores of the fungi are very light and are easily carried from one plant to another by insects, wind or water. They fall upon the surface of plants and work their way into the tissues through wounds, cracks or stomata.

2. The soil in new fields is often infected by tools that have been used in infected soils or by diseased plants which have been transferred from infected soil.

3. Tools that have been used to cut off diseased portions of plants often retain some of the spores on their surfaces and, when used on healthy tissues, deposit them where they begin to grow immediately.

4. When oats infected with smut are threshed the spores of the fungus arise in a cloud and often settle on the threshed grain. If any of this grain is planted the spores soon develop in the growing plant. In this way a whole field is often ruined at a cost of many dollars to the farmer.

5. Many of the diseases are contagious. This is especially true of the rots. Healthy fruit may become infected by coming in contact with diseased fruit. This may be clearly shown by putting a rotten apple or potato in a box or barrel with some sound ones. In a very short time the good ones will begin to decay.

HOW PLANT DISEASES MAY BE PREVENTED.

Fungous diseases can seldom be cured, therefore, they must be prevented. It is very important that the ways of preventing these diseases should be given careful study. Some of the general means of prevention are given below:

1. **BURNING.**—Since plant diseases spread very rapidly, it follows diseased fruit, leaves, limbs or vines should be destroyed. These parts are often cut off and thrown into the fence corners, or the brush heap where they remain a menace to every healthy plant. Instead of this, all the affected parts should be burned, which is a very effective means of destroying disease.

2. **ROTATION OF CROPS.**—It is a well known fact that in most instances diseases confine themselves to only one or two kinds of plants. By growing some other kinds of plants on the land for a year or two the spores which have been left in the ground will die and the chances of injury from these diseases will be materially lessened.

3. **SELECTION OF VARIETIES.**—It has been found that some varieties of plants are able to resist disease much better than others. By a careful selection of the most resistant varieties, farmers are able to reduce their losses to a great extent.

4. **SPRAYING.**—By spraying the foliage of plants with a poisonous solution the spores may often be prevented from developing. A preparation used for this purpose is called a fungicide. Bordeaux mixture and lime-sulphur are the principal fungicides.

Spraying is a common remedy for the following named diseases. Scab of apples, pears and peaches, peach leaf curl, potato blight and rot.

BORDEAUX MIXTURE.

5 lbs. copper sulphate (bluestone).
 5 lbs. unslacked lime.
 50 gal. water.

Dissolve thoroughly the copper sulphate in 25 gallons water. Slack the lime and add 25 gallons to it. When the lime and copper sulphate are thoroughly dissolved, mix them and strain through a coarse cloth into a spray pump, barrel or tank. Always use wooden vessels.

A weaker mixture for trees in foliage may be made by using $2\frac{1}{2}$ lbs. each of lime and copper sulphate with the amount of water called for in the above recipes.

An excellent table containing directions for spraying is given in the Appendix of "Agriculture for Beginners," published by Ginn & Company.

5. COATING CUT SURFACES.—When big limbs are pruned off decay often sets in, caused by the spores entering the fresh wounds.

This decay may be prevented by covering the cut surface with a coating of paint, tar, wax or some other substance to prevent the spores from entering and germinating. Valuable trees are often lost if this precaution is not taken.

6. PLANTING CLEAN, HEALTHY SEED.—Vigorous seeds produce strong plants that are able to resist disease more effectively than weak plants. Before seeds are planted they should be dipped for a few minutes in a solution of formaldehyde. Especially should this be done if there is any danger that the seeds are infected with spores of fungi. This treatment will kill the spores thereby preventing the disease from developing in the young plants.

FORMALDEHYDE SOLUTION.

1 pint formaldehyde (40 per cent).
 40 gallons water.

Put the seed in a "gunny sack" and soak in this solution for about ten minutes. Then spread out to dry.

TREATMENT OF SPECIAL PLANT DISEASES.

1. OATS AND WHEAT SMUTS.—It is very important that seed grain should be free from smut. If it is not the spores will develop with the sprouting seed and will attack the young plant, causing the blackened heads of grain which are a familiar sight in many oats and wheat fields and which cause the farmer a loss of millions of dollars every year. This loss can be prevented largely by soaking the seed in the formaldehyde (formalin) solution directions for the making of which are given in the preceding section.

It would be well to have one of the pupils to bring a peck of oats to school and treat them with this solution. The spores that are on the oats will be killed and the crop coming from this seed will be free from smut. No doubt some of the farmer boys will be glad to try this experiment in the spring and sow the seed in some place where the result of the treatment can be watched.

2. CORN SMUT.—Corn smut is a parasitic fungus that develops among the growing tissues of the kernels of Indian corn. It causes the kernels to swell and finally destroys the plant cells, developing in their place large numbers of tiny blackish spores. These spores being very light are readily carried from place to place by the wind or running water. Each of these spores will germinate under favorable conditions, producing secondary spores, which will penetrate the tissues of young corn plants thus completing the life cycle.

To prevent this disease it is necessary to destroy all infected plants thus checking the dispersal of the spores. Care should be taken that no smutted ears are left in the fields or gardens. Rotation of crops is another way by which corn smut may be fought.

3. **THE POTATO SCAB.**—Potato scab lessens the yield of potatoes and decreases the selling price. Scabby potatoes used for seed will produce scabby potatoes. This disease can be prevented in a large measure by soaking the seed potatoes in the formaldehyde solution for about two hours. Potatoes treated in this way should not be eaten nor fed to stock.

4. **POTATO BLIGHT.**—The blight is another serious disease of the potato that is quite different from the scab and which requires a different treatment. This disease is caused by a fungus which attacks the leaves causing them to turn yellow and dry up. There are two kinds of potato blight known as Early Blight and Late Blight. The Early Blight does not usually attack the tubers but it decreases the yield materially. The Late Blight is much more serious since it causes the decay of the tubers as well as the death of the leaves and stems. It is caused by a fungus known as the Downy Mildew the spores of which are carried by the wind and find lodgment on the surface of the potato leaves. Moisture will cause these spores to germinate and the little filaments thus produced find entrance into the leaf through some of its many open breathing pores. There they begin to grow very rapidly sending little threads in all directions.

After penetrating through all the tissues of the leaf these little threads (mycelium) extend down the stem to the tuber causing it to rot.

Millions of tiny summer spores are produced on the tips of branches which the mycelium in the leaves sends to the surface. These spores mature quickly and are readily carried away by the wind. In this way the Downy Mildew of the potato is spread.

In some cases this disease is so bad that the crop is entirely destroyed.

To prevent blight the seed should be rolled in sulphur, and when the vines appear above ground they should be sprayed with Bordeaux Mixture. Resistant varieties should be selected and crop rotation practiced.

It is well to remember that (1) potatoes should never be planted in a field where the preceding crop was affected by this disease, (2) potatoes grown in a field where the disease was present should never be used for seed.

Downy Mildew of the Tomato, of Lima Beans, of the Grape, of the Onion, etc., have about the same life history and similar means of prevention are employed.

6. **THE BLACK KNOT.**—This is a disease which attacks the branches of the plum and cherry tree. The knots are caused by a parasitic fungus which produce a large number of spores during warm weather. These spores are easily blown about and when they fall on green and tender bark they are likely to germinate causing the knotty growths which gradually enlarge and extend themselves. When this growth reaches entirely around the branch, the part beyond soon dies.

Since this is a contagious disease, it follows that all diseased branches should be cut out and burned each year. This should be done sometime in the fall or winter, not later than January. Spraying with a good fungicide will also help to control this disease.

THE RUSTS.

The *rusts* are destructive fungi that attack nearly all seed plants. Those that attack the cereals are of most importance. In the United States alone wheat rust causes a yearly loss of millions of dollars. For many years scientists have been investigating the cause of this disease and the means of destroying it, but, as yet, no remedy for it has been discovered. The life history of some of the rusts is very interesting and complex.

The mycelium of rust burrows among the tissues of young, infected plants, sending out sporophores, which reach the surface about harvest time. A reddish spore called the summer spore, or *uredospore*, is produced at the tip of each sporophore, from the appearance of which the disease gets its name. These *summer spores*, falling upon other plants, germinate in a few hours, producing new mycelia, which penetrate the host plant. Formerly this was thought to complete the life cycle of this fungus and the name *red rust* was applied to it. However, it is now known to be only a phase in the life history

of the plant. The summer spores are scattered through the field, causing the disease to spread very rapidly. It is in this stage, therefore, that the greatest damage is done by the rust fungus.

The *winter spores* of rust, called *teleutospores* (completed spores), are produced in the late summer. They have very heavy walls and are two-celled. They form black lines and dots on the stubble and remaining wheat stalks and are produced by the same mycelium that bore the uredospores, although it was thought formerly to be caused by a different fungus. It is now known to be only another phase in the life cycle of this interesting plant. It is in this stage that the fungus persists through the winter.

In the early spring the winterspores (teleutospores) begin to germinate, each cell sending out a short, stout thread called a germ tube, which is divided into four cells by means of cross walls. Each cell sends out a little branch on the tip of which is developed a single small spore called a *sporidium*. These are named *Early Spring Spores*. And now comes a most curious circumstance in the life history of wheat rust.

When these early spring spores ripen they are scattered by the wind and those falling on barberry bushes germinate immediately, producing mycelia, which enter and spread through the leaves, sending to the surface of the leaf groups of sporophores that produce orange-colored pustules, called "cluster cups." These *cluster cups* or *Late Spring Spores*, when ripe, find lodgment on wheat or other grains where they germinate rapidly, forming new mycelia, which later produce the *summer Spores* (uredospores) thus completing the life cycle.

Coulter, in his excellent treatise, "A Text Book of Botany", states that since the barberry is not widely enough distributed in the United States to play so important a part in the life history of the rusts, other plants have been found to be used as hosts for the "cluster cup" stage. Many authorities also hold that this fungus can live from year to year without going through the "cluster cup" stage, *uredospores* living through the winter in sufficient number to start the disease on the grains in the following spring.

Attention is called to the fact that, in the "cluster cup" stage of the life history of rust, it is parasitic, having chosen an entirely different host which has no relation to wheat.

The only progress made in the prevention of this disease has been the discovery of resistant varieties of wheat and oats.

A SUMMARY OF THE LIFE HISTORY OF WHEAT RUST.

1. Early Spring Spores.
 - a. Produced by teleutospores.
 - b. Infect barberry leaves.
2. Late Spring or "Cluster Cup" Spores.
 - c. Spores on barberry infect wheat, etc.
3. Summer Spores or Uredospores.
 - d. Infect other wheat plants.
4. Winter Spores or teleutospores.
 - e. Produce Early Spring Spores.

OTHER RUSTS.

The cedar apple is another rust which is well known. We are all familiar with the little swellings that appear along the twigs of cedar trees. The spores from these swellings are blown about by the wind in the spring and any that fall on apple trees soon germinate and infect the apples. Apple rust is checked in a measure by destroying the cedar trees and spraying the apple trees with a good fungicide.

Other rusts that are common in most neighborhoods are:

Asparagus Rust
Corn Rust
Plum Rust
Hollyhock Rust

Bean Rust
Clover Rust
Beet Rust
Raspberry rust

MOLDS.

Mold frequently appears on leather articles which have been left in a dark, warm place, in a damp condition, upon meat, lemons, cheese, etc. The common bread mold is most abundant around our homes. It will soon develop on a piece of bread which has been moistened and placed under a cover. Mold is found frequently on the top of canned fruit.

That mold is a plant which will reproduce itself very rapidly may be shown by the following interesting experiment. Dip a toothpick or end of a match in the mold which forms on bread or a lemon and draw it across a piece of moistened bread. Then put the bread in a damp place for a few days and watch the results. You will find that the same kind of mold you planted will grow on the bread, and only in the path of the toothpick or match, unless some of the light spores were blown about when you made your planting. The pupils will like to perform this experiment by making their initials on the moistened bread with the toothpick, and watching the letter become outlined in the rapidly developing mold. To get the best results, one should have a small magnifying glass or microscope.

Another experiment is easily performed by pouring boiling water over a piece of dry bread and placing over it a glass tumbler which has just been sterilized with boiling water. Then soak a piece of the same kind of bread in cold water and turn over it a cold tumbler. Watch for results and tell what this experiment has taught you.

By planting the spores on a piece of bread which has been soaked in cold water which contains a small amount of formalin or formaldehyde, one may learn that formalin or formaldehyde will kill spores as well as the hot water.

EXERCISES AND REVIEW QUESTIONS:

1. Why does canned fruit mold? How may it be prevented?
2. How do the fungi differ from other plants?
3. Why should not scabby and mildewed weeds and bushes be left in or around grain fields?
4. What are the objections, if any, to leaving grain stalks standing in the fence corners or along the roadside?
5. Why should cedar trees not be allowed to grow near an apple orchard?
6. What disposition should be made of diseased plants?
7. What objection are there to leaving diseased fruits hanging on the trees?
8. Why should decayed fruit or vegetables be discarded from crates or bins?
9. Draw a mushroom and label its parts.
10. How much damage is done by oats smut in your neighborhood?
11. Is corn smut more injurious to field corn or sweet corn in your neighborhood.
12. Make a list of the plant diseases that you know to occur in your locality and the remedies that are used for each.
13. Write a brief account of your observations upon some of these diseases. This outline may be used:
 - (1) Name of disease.
 - (2) Its abundance.
 - (3) Name of host plants affected, and part of host affected.
 - (4) Amount of damage.
 - (5) Appearance of diseased leaves or fruit.
 - (6) How it persists through the winter.
 - (7) Preventive measures.

Your account may be illustrated by sketches showing the appearance of the disease.

14. Make a collection of some leaves or stalks that are diseased, press them and mount them on pages in your booklet. The name, date and locality should be printed on each sheet.

15. Fill out the following form as you study specimens of diseased plants:

.....

Name of Disease.	Plant Affected.	Remedy.
.....		

16. Compare a field of potatoes that has been sprayed, with a field that has not. If possible find out the yield and the selling price in each case and compute the loss or gain on each.

FUNGI THAT ATTACKS INSECTS.

By close observation in the autumn you will find dead flies sticking to the window panes or other objects, encircled with a line of white dots and with their bodies swollen beyond all proportions. These flies have been killed by a parasitic fungus very similar to those that attack the higher plants. By an examination of one of these flies you will discover that the body is filled with a network of fine whitish threads, and that the white dots are the spores which these threads have thrown out. The disease spreads readily to living flies by means of these spores.

Chinch bugs, plant lice, caterpillars and grasshoppers are often attacked and killed by fungi. Scientists are now experimenting with the fungus that occurs in chinch bugs in the hope that they may be able to discover a remedy that will check the ravages of that pest.

You should find and bring into the schoolroom bodies of caterpillars that have been killed by a fungous disease. Care should be taken to distinguish between caterpillars that have been killed by a fungus and those that have been attacked by the insect parasite known as the ichneumon fly. For a description of the latter see a good work on zoology.

Parasitic fungi also prove very destructive to the white fly which is injurious to many kinds of trees. Attempts to spread this disease artificially are made by washing the spores from dead infected insects into water and using the water as a spray on infested plants.

The fungi that attack insects can be said to be friends to mankind, inasmuch as their ravages are confined principally to injurious insects.

Look carefully for any dead flies, chinch bugs, caterpillars and grasshoppers and when you find them place them in a glass and add a few drops of water. Watch them daily for the development of spores.

Try the experiment of spreading these diseases. In addition to the method already described leaves on which have been placed some dead insects may be put where living insects will come into contact with them.

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PLANT SOCIETIES.

The conditions for plant life are so varied that plants have become adapted to different environments; i. e., they have become grouped according to the condition most favorable for their growth. These groups or sets of plants living together under similar conditions are called plant societies or associations.

In order that the term *association* or *society* may be better understood we may take for an example a forest where conditions are favorable to the growth of certain trees, or a meadow where the conditions favor certain grasses.

The plant life of the forest and the meadow are good examples of Societies. Trees and grasses are the type plants but many others which the same conditions favor, grow with them.

Farmers take advantage of plant societies in planning their crops. They have discovered that timothy and clover, corn and pumpkins, etc., are close companions and will grow together in the same field.

Water and the temperature of the air and soil are the most important factors in determining plant societies.

THE GREAT GROUPS OF SOCIETIES.

For convenience the great societies of the plant world are associated chiefly with the water supply.

They are as follows:

(1) *Hydrophytes*.—Plants that grow in water or bogs, such as water-lilies, pond-weeds, cat-tails, bulrushes and mangrooves.

(2) *Xerophytes*.—Plants with a scanty water supply comprising the vegetation of sand-regions and deserts. Among these are the mosses, lichens, cacti, pines, etc.

(3) *Mesophytes*.—The plants of this group thrive best with a moderate water supply. They comprise the vegetation of the intermediate regions.

The grasses and flowering plants of the meadows, *deciduous* trees, and all the common vegetation of the temperate regions are classed in this group.

In addition to these three groups some authorities give two others: namely,

(4) *Trophophytes*.—Plants which are *hydrophytes* during part of the year and *xerophytes* during another part.

(5) *Halophytes*, or salt loving plants. These flourish on the seashore and in salt-areas.

ADAPTATION OF PLANTS.

Plants usually grow in regions where the soil and climate are favorable to them. Vegetation of the arctic regions would not flourish in the tropics, and that of the tropical regions would be destroyed in a short time by the cold climate of the arctic regions. However, important exceptions to this rule are given. It is now recognized that numerous plants exist under conditions which are unfavorable to their growth, not on account of the unfavorable conditions but because these conditions are severe enough to prevent the development of other plants which would crowd or overshadow them.

1. What is a plant society?
2. What societies are most abundant where you live?
3. Visit a field and make a special study of the vegetation. Count the kinds of plants it contains and estimate the relative abundance of each. Collect specimens of the different kinds of plants and learn their names.
4. In the same way make a study of a forest, a roadside, a fence row, a pasture, a barnyard, etc.

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POTATO.

INTRODUCTION.—A study of the potato may begin by having a discussion on the raising of potatoes in the immediate neighborhood. In connection with this some of the interesting facts about the potato and the growing of the crop may be brought out. Below are some of the general facts concerning the potato.

1. The potato was found in Peru, South America, by the Spanish.
2. It is the common food of Americans.
3. More than 300,000,000 bushels are produced annually.
4. Colorado, Michigan and Minnesota are potato producing states. Illinois ranks about fifth or sixth.
5. The potato scab may be lessened by treating the seed potatoes with the formalin solution. A pint of formalin should be mixed with 30 gallons of water and sprinkled over the potatoes. After this is done the potato heap should be covered with old carpets or other heavy cloths and left for a day. The seed may then be cut and planted.

IS IT A SEED?—By comparing the potato with the seeds of the pea, bean, corn and clover and tracing the growth it is easily discovered that the potato is not really a seed. In comparing the potato with the stems of certain plants it will be seen that the potato is a stem, and that the eyes of the potatoes are small buds. The potato has a stem end and a bud end. The bud end is where the potato was fastened to the root of the plant. There are a great number of eyes near the bud end. The botanist calls these underground stems, tubers.

THE TYPE.—To be a good type, a potato must be regular in shape, about four inches long, two or three inches wide and weighing about $\frac{3}{4}$ of a pound. The eyes should be shallow otherwise there is considerable waste in preparing for cooking. Among the interior qualities that may be mentioned are, a good flavor, mealiness, and fineness of texture. Much can be done in getting a better type by a careful selection of the tubers at the harvest time, but the best manner of the selection of seed is to take the seed from the hills that produce a good quantity and a good quality.

STARCH.—By scraping finely a potato and placing it in a partly filled cup of water a starchy substance is formed in a few hours. If the water is poured off and warm water is placed upon the residue a paste similar to common starch is formed. Another simple test to determine the presence of starch is by pouring a few drops of a mixture of iodine and water upon the soaked part of the potato. There should be two parts of water and one part of iodine in the mixture used. The iodine will change the color of the starch to a blue.

PREPARING THE SEED AND PLANTING.—Two eyes on a portion of the tuber used for seed is better than just one eye. The plan of using the small potatoes for planting will not get the best results. Fall plowing is often a good plan to follow in preparing the seed bed although clover sod under ordinary conditions would make a typical bed. Usually early planting is preferable to the late planting.

HARVESTING.—Potatoes should be dug as soon as they have matured. After they have been thoroughly dried they should be placed in a dry, cool, dark cellar.

THINGS TO BE DONE.—Many experiments may be carried on at the home during vacation and reported upon at school, during the year. Just below are found questions and suggestions following each question.

1. Does the planting of small potatoes have any effect upon the yield? This may be determined by planting a row of the smaller pieces or smaller potatoes and the remainder of the field in well selected seed. Each row should receive the same cultivation.

2. Which is the better shallow or deep planting? Plant a row covering the potatoes to a depth of an inch, another row three inches deep and still another row six inches deep. Use the same grade of seed and the same manner of cultivation.

3. Which will make the better yield, the bud end or the stem end of the potato? Place the eyes of the stem end in one row and the eyes of the bud end in the other row.

4. Which is the better, level or ridged cultivation? Keep one part of a plot level and an adjoining part the rows well ridged. If both parts of the field are given the same cultivation it may be determined which is the better plan.

5. How destroy the potato bug? Place one pound of Paris green and one pound of lime to a barrel of water. Use as a spray in the early morning.

6. How does heat affect the stored potato? Weigh four potatoes and place them in a warm room. Two weeks later weigh again. Do the same for potatoes placed in a cool room.

7. How learn varieties of the potato? Pupils should bring the varieties they raise to school. A comparison and a study of the kinds will result in a more definite knowledge of the types.

8. How produce a new variety of the potato? Secure a potato ball that is produced by the bloom and plant it. It should be planted in a hot-bed, and then transplanted to the field. The potatoes the first year will be very small, but they should be saved and planted the next year. Quite often a new variety of a potato will be the result of the second year crop.

FREE BULLETINS.

Potato Growing Bulletin 35, U. S. Department of Agriculture.
 Potato Diseases Bulletin 91, U. S. Department of Agriculture.
 Potatoes as a Truck Crop Bulletin 407, U. S. Department of Agriculture.
 Potatoes and Corn Normal University, Normal, Illinois.

INSECTS.

The thing of importance in the study of insect life is the life history. From this life story will arise many factors that need special attention. For convenience, insects can be divided into two general classes, those that are beneficial and those that are destructive. Many insects are beneficial, such as the honey bee, bumble-bee, ichneumon fly, ladybugs and dragon flies. The helpfulness of the first two mentioned lies principally in the fact that they scatter pollen, while the three latter ones live upon some of the insect pests.

It will assist considerably in becoming familiar with the various insects if a collection is made. Great care should be used in capturing and preparing the insect, otherwise the work is of little importance. A careful study should be made of the life histories of such insects as the fly, mosquito, canker worm, grasshopper, ants, honey-bee. Practical and scientific methods of combating the many pests should receive much attention. Blow are brief life histories of two common insects.

PEACH TREE BORER.—The worst enemy that the peach tree has to contend with is the borer, that can be distinguished at quite a distance by the broad yellow band across the abdomen in the moth stage. The moths resemble a great deal the common bluish wasps, but in their flight there is a marked difference in the movements; the wasp being the more rapid of the two.

Through the months of June, July and August the moths come from their cocoons and fly about through the orchard, depositing the eggs usually on the trunks of the peach or plum trees, and in most instances within a few inches of the ground. The eggs, of course, are very minute and are nearly the color of the bark, being located in tiny crevices or on a decayed part of the outer bark. They are fastened to the bark by a sticky substance which does not allow them to fall to the ground. An individual often lays 600 eggs, being scattered about over the trunks of three or four trees. After the hatching of the borer he immediately enters a slit in the outer bark and soon bores his way to the inner bark, where he may remain for several months, living upon the nutritious sap. After a period of at least four or five months the borer appears again upon the surface of the trunk, making his cocoon, in which he sleeps only two or three weeks, coming forth in the fully developed moth. These moths do not flit about in the early morning or late evening, as do many moths, but spend their moth period in flying about among the blossoms, flowers or among the leaves of the trees.

As one moth may lay 500 or 600 eggs, it is readily seen that the borers may soon girdle a tree and thus kill it. In any event they lessen considerably the life of the tree and the ability of the tree to bear. It is not an uncommon thing for infested trees to be the source of the infection of an entire orchard and virtually the ultimate cause of its destruction.

It is comparatively an easy matter to determine the presence of this effective larvae, as there is always an exuding gummy substance at the entrance made by the borer. The borer may be captured by digging into the bark with a knife. This is a very simple plan, and in a small orchard the borers may soon be destroyed. If such a method is used it is necessary to visit the trees four or five times during the year and destroy all borers that have left any traces at all. For the sake of the better trees it is often advisable to chop down an old tree if it is badly infested, and in this way destroy many borers that would soon become moths. Sprays are often used, but the most effective procedure is to dig out the individual borers. The number of borers may be considerably lessened in any orchard if such birds as the martin, flycatcher, kingbirds and nuthatch are given the slightest protection from the cat. An afternoon's observation of the flycatcher will prove to the most skeptical that his principal diet consists of many species of moths. The common barn swallow and the purple martin are often seen spending much time in a peach orchard where there is an abundance of peach tree borers.

As the results of the borer, if left alone, is the killing of the tree, it behooves the owner to assist the tree in overcoming the large wounds. The

peach tree seems to be able to cause all small wounds to heal quickly, but not so with the larger wounds that have been caused by several borers. Aside from killing the borers singly, there should be some special attention given to the exposed heart of the tree. This may be done by banding the tree with a cloth or by using wax. In this way the tree is helped in starting a new growth which eventually may heal the wound and prevent further decay. With just a little attention the tree's life may be prolonged twelve or fifteen years, and during all this time be a bearing tree.

THE CABBAGE WORM.—There is a story to the effect that the common cabbage worm was brought from England to the United States about fifty years ago, and in that time it has spread to all parts of North America that are suitable for insect life. The principal factor in causing the rapid spread of this harmless looking butterfly is that there are three or four generations during a summer. It is seen from May to October flying about among the cabbage or kindred vegetation depositing its eggs. The butterfly or moth is white with dark spots on the fore wings, the male being of a slightly darker hue than the female.

This wonderfully prolific insect passes the winter in the pupa state in the soil or in heaps of straw or trash. After changing to the butterfly form in early spring it soon deposits eggs on vegetation belonging to the cabbage family. The larvae are a light green and eat nearly continuously for a week or ten days, when they make a cocoon, thus ending the cycle. In a few days the life history is begun again and it may be that five generations are produced in a single season.

It is a law of nature that each form of animal life is in constant struggle with some other form of animal life. This law of the survival of the fittest is well demonstrated in the case of the cabbage worm. There is a small larva that enters the body of the cabbage larvae and soon kills it. On the leaves of nearly any cabbage plant may be seen tiny white cocoons in which are the future slayers of the cabbage worm. They are merely passing through the pupa. Quite frequently persons think that these little cocoons are the eggs of the butterfly and destroy them, thus increasing the number of cabbage worms at least 50 per cent. The eggs of the cabbage butterfly are always of a dark color. There are also other parasites that assist in killing a large number of the larvae and pupa.

As the butterfly of the cabbage worm flies with ease, it is not any particular advantage to use the system of rotation of crops in an attempt to decrease the number of worms during another season. About the only successful method to pursue is the one of early spraying, as it is not safe to use an ordinary spray after the heads are formed. Arsenate of lead may be used, or better still, a preparation of Paris green. Small gardeners often use a mosquito netting to cover the cabbage heads while they are forming.

Under these conditions the butterflies soon leave to seek fields where they may deposit their eggs. In using poison, great care must be used, otherwise deposits will remain in the head, making it unfit for food.

It is always noticeable that where the purple martin, bluebird, kingbird, wren, or orioles nest that there is a scarcity of the cabbage butterfly. Last year, near a cabbage garden, there was a small colony of purple martins, and it was noticed throughout the summer that there was a limited number of butterflies. A pair of house wrens that have a nest adjacent to a garden will keep the growing cabbage free from the green larvae. During the fall and winter a number of the pupa may be found on the old cabbage stalks, on weed stalks, among the grasses, or on the lower part of the fences. It is a white, funnel-shaped cocoon, having a sharp, needle-like point on the upper end of it.

Along the sides are small dot like marks that help in identifying the pupa. By ridding the garden of trash, cabbage leaves, twigs and grasses, a number of the pupa will naturally be destroyed. One pupa destroyed in the fall is about the same as the destruction of 500 butterflies in June or 100,000 of the green larvae in July.

LIST OF FREE BULLETINS.

Garden Insects	Bulletin 4, Farmers' Institute, Springfield, Ill.
Wheat Insects	Bulletin 132, U. S. Dept. of Agri., Wash., D. C.
Insect Poison	Bulletin 127, U. S. Dept. of Agri., Wash., D. C.
Stored Grain Insects	Bulletin 156, U. S. Dept. of Agri., Wash., D. C.
Insect of Shade Trees.....	Bulletin 99, U. S. Dept. of Agri., Wash., D. C.
Gipsy Moth	Bulletin 275, U. S. Dept. of Agri., Wash., D. C.
Hessian Fly	Bulletin 146, Experiment Station, Urbana, Ill.
Cornfield Ant	Bulletin 131, Experiment Station, Urbana, Ill.
Shade Tree Insects	Bulletin 151, Experiment Station, Urbana, Ill.
Pests of Clover	Bulletin 134, Experiment Station, Urbana, Ill.
Bitter Rot of Apples.....	Bulletin 117, Experiment Station, Urbana, Ill.

EARTHWORM.

The earthworm, commonly called the fish-worm, plays an important part in the ventilation and drainage of the soil. It also assists in the growth of the plants, as the roots often follow the burrows made by this worm. They also bring much plant food to the surface or near it, and thus help in the fertilization of the soil. They also eat vegetable matter, and their deposits are often left three or four inches below the surface, thus adding humus to the soil.

Earthworms are usually nocturnal in their habits. In the late evening, however, they may often be seen dragging bits of grass or leaves into their burrows. The earthworm's principal sense is the one of touch. It does not have any ears or eyes, but is able to distinguish the light from the dark. Except during very wet weather the earthworm does not leave its burrow very far. It finds its way back to its home again by following the scent of the slime it leaves in its path. The eggs are very tiny, being found in little sacs near the opening of the burrow.

FARM MACHINERY.

SIMPLE TOOLS.—Most farmers have at least a corner in a corn crib or a shed for the storing of such tools as, the saw, hatchet, screw driver, chisel, jack plane, carborundum grindstone, vise, small anvil and brace and bit. Many farmers also have a small forge so that they may weld the simpler breaks in the farm machinery. With four or five of the common tools, it is not long until any farmer boy can make handles for the simple tools, chicken coops, double-trees, yard swings, flower stands and road drags.

A good road drag can be made by splitting a ten-foot log that is about twelve inches in circumference. The halves should be set on the edges and placed about thirty inches apart, the flat sides to be toward the team. The logs may be fastened together by four heavy pieces that are driven into auger holes in the center of the slabs. The chain to which the doubletrees are to be attached should have two large rings in it. In this way the clevis may be easily changed in getting the proper slant for the drag when it is in use.

LEVERS.—A bar that will turn about a fixed axle is called a lever. The axis is generally called the *fulcrum*. From the fulcrum to the weight is called the *weight arm*, and from the fulcrum to the power, the *power arm*. A weight of 200 pounds applied four feet from the fulcrum will be moved if any weight or power above 20 pounds is applied forty feet from the fulcrum on the power arm.

A common crowbar is an example of a simple lever. A sixteen-foot board, one end on the ground and the other end on a three-foot box may be called an *inclined plane*. It is easier to roll a barrel of salt up an inclined plane than it is to lift it directly to the height of a plane.

In the wheel and axle, the diameter of the wheel, times the power applied, equals the diameter of the axle, times the weight.

A windlass or capstan is an example of the wheel and axle.

A pulley or system of pulleys is really a movable lever. A combination of pulleys is often called a block and tackle.

PLOWS.—Much of the ease with which good plowing is done depends upon the shape of the plow bottom. The point of the plow should dip down so that the plow will go into the ground. If the point and the heel of the landside lie in a straight line, it will be difficult to plow at an average depth. There should be a dip of about three-sixteenths of an inch, that is, if a straight edge is laid on the bottom when the plow is turned upside down it will be about that distance from the straight edge to where the landside joins the share. It is better to have a new point put on the plow than to have the much worn one merely sharpened. The point of a plow also turns into the land to about three-sixteenths of an inch. If a plow is to run level, it is necessary that the point farthest away from the landside have a bearing surface and especially is this true in a walking plow. This bearing surface should extend back nearly one and one-half inches from the corner of the share. When worn away the plow naturally will lean toward the furrow. A gang plow does not need a bearing surface because it is held in a level position by the framework.

Many farmers are now using the kerosene-gasoline tractor. They can pull as many as ten or fifteen plows. Such a tractor may be operated by two men.

Machines used in preparing the soil:

Stalk Cutter	Manure Spreader	Planter
Plow	Harrow	Drill
Disc	Roller	

Machines used in cultivating the crop:

Cultivator	Disc	Harrow
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Machines used in harvesting the crop:

Mower	Corn sheller
Binder	Corn husker
Hay loader	Threshing machine
Hay tedder	Corn cutter
Hay rakes	Hay press

CARE AND OILING.—One of the most important things to do in the care of a machine is to see that all the parts are in working order. The breakage on any machine can usually be attributed to the looseness of some part.

When the cultivators, plows, mowers and binders are placed in the implement shed, the polished parts should be cleaned and oiled or greased.

HISTORY.—Every boy and girl has read the statement in history that Jethro Wood invented a cast-iron plow in 1816—just ninety-eight years ago. Did you ever think, however that it was really the beginning of a long line of inventions in farm machinery? This invention made it possible to plow five acres of ground, where before but one could be done. Aside from doing a greater amount, the work was much better done. What would this mean? It simply meant that more people would move from the east to the west and settle in the Mississippi valley to engage in farming. It also meant that a greater quantity of grain of all kinds could be raised.

At this time the only implement for cutting the grain was the cradle. (The cradle was a scythe with a wooden guard on it so arranged that the mower could throw the grain in a bunch as he cut it.) It was now possible for one man to care for twenty acres, instead of only four or five. The facts were, that more grain could be raised and cut than could be threshed, as the methods of threshing were very crude.

As the reaper became more perfected, improved methods of threshing were used. What do you suppose would result from this increased yield of wheat, oats, rye and corn? Would the farmers engage in cattle raising? Would the prices of grain decrease on account of the increased yield?

One plan about this time, that was discussed, was as to how the extra grains raised could be hauled to the eastern states to be used by the factory workers or could be shipped from there to buyers. At first a wagon road was begun, which was to extend from the east to the Mississippi river. Before it was completed, several canals were dug and railroads were built to take the place of the wagon road. It was not long after the lines of transportation were made that more improvements on all kinds of farm machinery occurred.

The first corn planting was done by hand and was covered with a hoe or spade. Soon a hand dropper was invented. This was followed by a corn planter, something similar to the one of today, with the exception that there was not any wire to check the rows. It also took two persons to do the planting, one to do the driving and one to do the dropping. It is an interesting story to trace the effect of the improvements of farm machinery upon the settlement of the Central and Western states and how, in a way, it had to do with the building of railroads and the location of certain cities. By a little study of the problem we can have at least a general idea as to the far-reaching effects of a single invention, such as the gang plow, the self-binder or the corn sheller.

From what has been said, it is very evident that the improvement of any farm machinery reduces the cost of producing grain. In 1830 it required about three hours of labor to raise one bushel of wheat, and in 1900 it required only one-sixth of an hour. In 1850, four hours of labor were necessary to produce one bushel of corn, while in 1900 the labor for one bushel, was reduced to two-thirds of an hour.

The saving of time is nearly entirely the result of the improvement of machinery. (Farmers are now becoming as much interested in how to improve the soil as they have been in the past in the various forms of improved farm machinery. Why? Do you think that an improvement of the soil will have as great effect upon industries as did the improvement of machinery?)

Suppose we now trace briefly the most common forms of machines. After the invention of the cast-iron plow, it was not long until the steel plow was made. Since then many kinds have been used, such as the riding plow and the disc plow. On large farms at the present time, the gang plow, drawn by an engine, is frequently used. Under favorable conditions fifty acres can be plowed in one day.

Following the invention of the reaper by McCormick, came a reaper that had a rake that divided the grain as it was cut into bundles. This was much

better than the first reaper, but it still took a number of men to bind the bundles and put them in shocks as rapidly as the reaper could cut the grain. In about 1880, Appleby invented the self-binder. It made possible greater quantities of wheat, oats and rye and, at the same time, reduced the number of laborers in a field from twelve or fifteen to three or four. If you are interested in the development of the improvement of machinery, trace out the development of the threshing machine, the corn sheller and the drills or seeders.

In thinking about farm machinery, it is well to give some thought to the care of all implements. We are all aware that if machinery is left exposed to the sun and rain, that it will soon rust and if any of the parts are made of wood, that it will soon decay. The average life of a self-binder, seeder or cultivator should be at least fifteen years, with ordinary care. If left exposed to the weather its life is reduced to four or five years and the work done is seldom satisfactory. At the close of a season any machine should be well oiled on the wearing parts to prevent rust. It should then be stored in an implement shed or other dry place.

If all farm machinery was examined regularly to see if any repairs were needed, much loss of time might be saved and better work be done. An implement shed will pay for itself in two or three years' time. Show that the cost of the material and labor for a farm machinery shed, according to the following estimate, would be \$175.36:

24 post, 8 ft. by 8 in., at 50 cents.
 25 2 by 4's, each 16 ft.
 26 2 by 4's, each 12 ft.
 42 2 by 4's, each 14 ft.
 21 2 by 4's, each 12 ft.
 2 gables, each containing 216 sq. ft.
 Roof, 20 by 4 ft. (each side).
 Wall, 152 by 8 ft.
 All of the above at \$26 per M.
 Roof, 16 squares at \$2.
 10 days' labor at \$2.

GASOLINE ENGINES.

The gasoline engine is made to do many of the difficult things on the farm. It is a labor saver and at the same time, a money saver. Being made in practically any horse-power, they are easily adapted to any form of service. They are used in operating such as a washing machine, corn sheller, fan mill, churn, wood saw, pumps and a dynamo.

QUESTIONS FOR DISCUSSIONS.

1. What are some of the things that may be done with a tractor?
2. Which is it better to do, sow grain broadcast or use a drill? Why?
3. Estimate the approximate cost of all kinds of farm machinery.
4. Which is the best of the four binding twines: sisal, standard, manila or pure manila?
5. After the spring work is over what should be done with the plows and planter?
6. How can the rivets in a section be quickly removed?
7. Would it be cheaper for the farmer who lives near hard roads to use auto wagon?
8. Name the common parts of an automobile.
9. Why is a gasoline preferable to a windmill?
10. What is the average life of a self-binder? A cultivator? A wagon?

SUGGESTIONS:

1. Make a blackboard list of the various places that the different machines are kept during the winter? During the summer?
2. Send to the I. H. C. Service bureau, Chicago, Ill., for their booklets on farm machinery.
3. Make a list of the labor-saving machines used in the home, including the electric iron.
4. Name the parts of a wagon, plow (such as beam, moldboard and handles), selfbinder, mower and cultivator.
5. Study the construction of an incubator by having one present.

COMPOSITION OF AIR.

Air is the mixture of odorless, colorless and tasteless gases which surrounds the earth. It consists of oxygen, nitrogen, carbon dioxide, water-vapor and various other chemical agents. * Nitrogen and oxygen occur nearly in the ratio of four parts to one, i. e., nearly four-fifths of the air is nitrogen, and nearly one-fifth oxygen. Water-vapor and carbon dioxide occur in small and varying amounts.

Oxygen is a powerful and active element which supports life and combustion. The carbon dioxide is the source of carbon used by growing plants. The other elements of which air is composed are simply inert diluents.

AIR PRESSURE.—We are living at the bottom of an ocean of air which extends perhaps 100 miles above the earth. This air has weight—twelve cubic feet of it to one pound. This being true, it follows naturally that the air near the surface of the earth is subjected to a pressure which has been found to amount to about fifteen pounds per square inch. (We do not notice this pressure, because it pushes upward with about as much force as it pushes downward). This pressure is enough to support a column of water of the same size, about 32 feet high, or a column of mercury, which is 13.6 times as heavy as water, about thirty inches high.

When the lower end of a tube is dipped into a liquid and the air exhausted from the upper end, the liquid will rise in the tube. This may be proven by the common illustration of drinking lemonade through a straw. The rise of the liquid in the exhausted tube is due to the pressure of the air upon the surface of the liquid and not to the sucking power of the vacuum, as is generally supposed.

* argon, helium, neon, krypton and xenon.

EXPERIMENTS.—Fill a tumbler with water and slide a heavy card over its top. Holding the card firmly in its place, invert the tumbler. If no air bubbles have been left below the card, it will remain pressed against the tumbler, keeping in the water.

Put one end of a small glass tube into water. Close the upper end of the tube with the finger, and lift it out of the water. Explain what happens.

An interesting experiment may be performed with a wide-necked bottle and an egg from which the shell has been carefully removed. The egg should fit nicely into the neck of the bottle, but should not pass through it. Put a piece of burning paper into the bottle. When the paper is almost consumed, replace the egg in the neck, and see what happens.

The burning paper heats the air in the bottle, causing it to expand and part of it to leave the bottle. Since there is not sufficient resistance to the downward pressure of the air the egg will be forced into the bottle.

THE BAROMETER.—Galileo, the great Italian philosopher, discovered that air has weight and that a suction pump would not raise water more than thirty-three feet. By means of a long glass tube, and a quantity of mercury, Torricelli, a pupil of Galileo, proved that the pressure of the air balanced a column of mercury twenty-nine or thirty inches high. (33 ft. ÷ 13.6 the sp. g. of mercury. A lighter liquid than mercury will be forced correspondingly higher.

Torricelli's device may be set up permanently as a means of measuring atmospheric pressure. It is then called a *barometer*. A mercurial barometer consists of a glass tube three or four feet long, filled with mercury, and inverted, with its lower end below the surface of the mercury, in a receptacle. Reading a barometer is simply noting the height of the mercury column above the surface of the mercury in the receptacle as indicated on a graduated scale.

If a barometer is carried to a mountain top or other high altitude the column of mercury falls gradually, showing that atmospheric pressure decreases as one ascends.

The Weather Bureau makes use of the barometer in foretelling weather

changes. The weather is related to the atmospheric pressure indicated by the rise and fall of the mercury, as follows:

1. When the mercury rises, fair weather is indicated.
2. When the mercury falls, foul weather is indicated.
3. A sudden fall of the mercury precedes a storm.

The aneroid (without fluid) barometer is more convenient to carry about than a mercurial barometer. It consists of a circular metal box with a thin corrugated metal top. When the air has been partly removed from this box it is sealed up, making it airtight. As the pressure of the air changes, the thin, metallic top of the box moves in or out, to correspond. The motion of the top is small, therefore it is magnified by a system of levers by which the changes are transmitted to a pointer, which moves around a graduated dial. These instruments are very delicate and will show the slight difference between the air pressure at a table top and that of the floor.

THE LIFT PUMP.—The common lift pump was used by the ancients as early as the fourth century B. C., although its working was not understood. It consists of a cylinder which is connected with the well by a pipe. At the bottom of the cylinder is a valve which opens upward. A piston is moved up and down in the cylinder by means of a handle. This piston also contains a valve which opens up and the air is exhausted below the valve by the strokes of the piston and the air pressure on the water in the well forces the water up into the cylinder. The lowest valve must be within thirty-four feet of the surface of the water to obtain results. Why? In practice this distance is usually about twenty-eight or thirty feet. Why?

An effective lift pump may be made in the following manner: Take a lamp chimney which is used on a student lamp, and fit a cork tightly into the bottom of it. Take a spool that is of the right size to move easily up and down the chimney and fasten two small screw eyes into one end of it. Between these screw eyes fasten a wooden rod about eighteen inches long. Now cut a small hole in the center of the cork. Fasten a thin piece of leather about the size of a dime over the holes in the cork and in the spool. For this, use only one pin or tack, driving it as near to the edge of the leather as possible. Wind twine or thread around the spool so that it will form an airtight piston in the chimney. Insert a slender glass tube (a drinking-tube, such as is used in drug stores, will do) in the cork. Make the cork air-tight by covering it with paraffin or other wax. Now insert the tube in a basin of water and work the piston.

If this experiment is carefully worked out it will prove very interesting and instructive.

If a spool of the size needed in this experiment cannot be obtained, a cork cut to the right size may be substituted.

FORCE PUMP.—In force pumps, the piston has no valve in it, and the outlet pipe and a second valve are at the bottom of the cylinder. When the piston is raised the cylinder is filled with water. Pushing the piston down forces the water out of the pump. The height to which water can be thrown by a force pump depends upon the amount of force used on the piston.

Steam fire engines are simply powerful force pumps.

EFFECTS OF HEAT UPON BODIES.

MATTER is that which occupies space. There are different kinds of matter, which are called **substances**, such as water, air and gold. Bodies are certain definite portions of these substances.

Substances assume the state or form of gases, liquids and solids, dependent upon the kind of motion and the velocities of the molecules which compose them.

A **gas** is a fluid having no independent shape or volume, that has a tendency to expand indefinitely, such as hydrogen, oxygen, nitrogen and coal gas.

The molecules of gases move in a straight line with great velocity. This is called the kinetic theory of gases and, by it, are explained many of the phenomena of gases.

A **solid** is a body that, up to a certain limit, is capable of retaining its shape at ordinary temperatures and under slight pressure, such as gold, stone, wood and ice.

The molecules of solids have a fixed position in relation to each other, and their motion is restricted to a limited space.

A **liquid** is a fluid that is only slightly compressible, and not capable of indefinite expansion, such as water.

The molecules of a liquid move freely upon one another in every direction, causing it to take the shape of the containing vessel. No sharp line can be drawn between liquids and solids, there being all gradations, as viscous solid, semi-solid and viscous liquid.

The terms fluid and liquid are not synonymous, fluid being of broader significance and including both liquids and gases. It should be kept in mind that conditions of temperature and pressure determine largely the state or form of matter.

EXPANSION.—The application of heat to a body produces two principal results. One is a change in the size of the substance, which we call **expansion**, and the other is a change in its form or physical condition.

The following experiments may be performed to show that gases expand when heated:

Put a piece of glass tubing through a rubber stopper and insert the stopper into an empty glass flask or bottle, which, of course, is filled with air. Invert the flask and hold the end of the glass tube under water. Now heat the flask gently and evenly on all the sides. If this experiment has been performed carefully, little bubbles of air will be seen escaping from the tube, which proves that the air in the flask is expanding and flowing out through the tube.

Another interesting experiment may be performed with this same apparatus. Put a drop of ink in the glass tube and insert the stopper as before. Apply heat to the flask, and the drop of ink will be forced up the tube by the expanding air.

Air increases exactly $\frac{1}{273}$ part of itself for each rise of 1 degree C or $\frac{1}{491}$ for each degree F. This fact was discovered by a Frenchman named Charles, and from him, is called Charles' Law.

To show that heat expands liquids, use the same apparatus as described in the preceding experiments: Fill the glass flask with water, and insert the stopper and tube so that the lower part of the tube will just reach the water. That water expands when it is heated may be easily determined by its action in the tube when heat is slowly applied to the flask.

What causes a tea-kettle filled with cold water to overflow when it is heated?

Similar experiments may be made with any other liquids, such as alcohol or mercury. They prove that heat causes liquids as well as air to expand or to occupy more space.

Solids expand when heated just as gases and liquids do. This may be shown by heating red hot an iron bolt or a piece of heavy wire, the length of which has been marked on a board or other material, and laying it on the measure. The hot iron will be found to be longer than it was when cold.

A knowledge of this fact is made use of in building railroads. A space

is always left between the end of the rails to allow for the expansion of the steel in summer. If the steel is laid in cold weather the gaps are much wider than when it is laid in hot weather.

Tires are heated before they are set on wheels, because they are then bigger and will go on more easily. They contract as they cool, causing them to become tight on the wheel.

Telegraph or telephone wires which are taut in winter sag greatly when the hot rays of the summer sun heats them. If these wires were stretched taut in summer they would break quickly when caused to contract by cold weather. Bolts used in the building of steel structures are inserted red hot and the taps tightened as they cool.

Another practical illustration of this principle may be found in the ordinary clock, which loses time in the summer because its pendulum is expanded by the warm weather, causing it to swing more slowly.

As mentioned elsewhere in this book (see Soils, p. 17), heat plays an important part in soil formation by splitting the rocks which are not able to withstand the expansion and contraction.

The broken concrete floors and walks seen in many places show another result of expansion caused by heat. This result is avoided by cutting the soft concrete into squares, thus leaving room for expansion.

CHANGES IN PHYSICAL CONDITIONS.—Solids may be changed into liquids, or liquids into gases by the application of heat. If, on a cold day, when the temperature is several degrees below zero, a pail of snow or ice is brought into a warm room, a thermometer placed in the snow will indicate a rise in temperature until 0 degree C. or 32 degrees F. is reached, when it becomes stationary until all the snow is melted. If now the pail is put on a stove, the temperature will remain at 32 degrees F., but the snow will melt more rapidly. As soon as all the snow is melted the temperature will rise steadily until the water boils, and again remains stationary until the water is changed into vapor.

The change from a solid to a liquid state caused by heat is called **fusion** or **melting**, while that from a liquid to a gaseous state is called **vaporization**, when the temperature is at the boiling point, and **evaporation** when below.

EVAPORATION.—Water, gasoline, alcohol and other liquids soon disappear or evaporate when left in an open dish or an uncorked bottle. The warmer and drier the air is the more rapid is the evaporation, although it can take place at a low temperature. Wet cloths will dry more quickly on a dry, hot day than on a cold day. When they are hung out on a cold day they will freeze first and then soon become dry.

When air contains all the moisture it will hold at a given temperature, it is said to be **saturated**, and evaporation is decreased.

COOLING BY EVAPORATION.—Heat is absorbed in the process of evaporation, i. e., when a liquid evaporates its temperature and that of objects near it falls. The evaporation of moisture from our skin causes us to become cooler, and when water is sprinkled on a floor or street its evaporation lowers the temperature of the air and surrounding objects.

ARTIFICIAL ICE.—A knowledge of the principles of evaporation is made use of in the manufacture of ice. The water to be frozen is put in cans around which brine is made to circulate. Ammonia, which is a gas, at ordinary temperature, is forced into coils by a compressor and there liquified. During this process the heat of condensation is evolved, which is removed by the circulation of running water around the coils. The liquid ammonia is then allowed to pass into coils in the brine, where, under reduced pressure, it evaporates very rapidly. While doing this it absorbs heat from the brine, reducing it to a temperature of 16 degrees or 18 degrees F. At this temperature the freezing of the water in the cans surrounded by the brine goes on very rapidly.

Butter and other foods may be kept cool by putting them in porous vessels wrapped in wet cloths. The evaporation of the water keeps the food cool.

THE TRANSMISSION OF HEAT.

Heat is transmitted in three ways—by conduction, radiation and convection.

CONDUCTION.—If one end of an iron poker is put in the fire, the poker will soon become hot through its entire length. When a silver spoon is put into some hot liquid, the handle becomes warm. These experiments prove that silver and iron are good conductors of heat, it being carried along the molecules by a method known as conduction. Practically all the metals are good conductors of heat. The heating of a flat iron on a stove is another example of conduction.

On the other hand, a stick may be held in the fire until it is burned close to the fingers, showing that wood is a poor conductor of heat. Stone, glass, air, wool, fur, liquids and gases are classed with wood as poor conductors, and therefore are called heat **insulators**.

A practical application of conduction may be seen in the Davy safety lamp, the thermos bottle and the refrigerator. For a description of these appliances the reader is referred to any good work in physics.

CONVECTION.—Convection is the transmission of heat by means of currents in liquids and gases resulting from changes in the temperature. For example, air expands and becomes lighter when heated. It is then pushed up by the cooler, heavier parts of the surrounding air, thus creating an ascending current over the source of heat and downward lateral currents in the other parts. These currents are called convection currents and are the basis of all systems of heating and ventilating buildings.

Convection currents in a room may be tested by holding a piece of lighted "touch paper" in different positions and observing the direction of the currents indicated by the smoke. "Touch paper" is made by dipping blotting paper into a solution of saltpeter. It will burn without flame, but with much smoke when dry.

Winds are convection currents caused by the unequal heating of the earth's surface. The air over a given area expands and rises while the cooler, heavier air rushes in to take its place. Land and sea breezes, and ocean currents may be explained in this manner.

HOT WATER HEATING SYSTEMS.—The hot water system is a very common and effective way of heating both public buildings and private dwellings. The water is heated in the basement by a furnace. By means of convection currents it is carried through pipes to iron radiators located in the various rooms. It gives out its heat through these radiators to the surrounding air and, when cool returns to the base of the heater.

It is possible to provide ventilation with this system by opening air vents through the walls back of the radiators.

HOT AIR SYSTEMS.—The hot air furnace is a large stove surrounded by a galvanized sheet iron or steel jacket. The cold from the outside air enters the heater at the base, is heated between the stove and the jacket and is then forced upward into the delivery pipes, which distribute it throughout the building. Taking the cold air from out of doors and removing the vitiated air by means of the open grate or through ducts near the floor, insures good ventilation, and is an important detail that should not be overlooked in installing a furnace. Some persons contend that enough fresh air is admitted and foul air is removed through windows, doors and crevices in floors and walls. This may be true in the case of private dwellings, but it becomes an absurdity when mentioned in connection with schoolhouses, churches and other public buildings.

HEATING AND VENTILATING SYSTEMS.—Heating a large room by means of a bare stove is very unsatisfactory indeed. It is difficult to tell which are the more uncomfortable, the ones who are forced to sit close to the stove, where they are too warm, or the ones who are so far away that they are too cold. An attempt to remedy this situation was made by placing an iron or steel jacket around the stove, thus making use of the convection currents. This was a decided improvement, but still had many defects. The modern heating and ventilating systems, many of which are now in the market, seem

to have solved all the problems connected with heating and ventilating public buildings. They are simple in construction, and, in brief, consist of a large stove, surrounded by a jacket, which is set in a corner of the room to be heated. A fresh air intake which connects with the heater from outside of the building, gives a plentiful supply of fresh, pure air. This air is heated inside the jacket and is forced up to the ceiling and thence to all parts of the room. As it cools it sinks to the floor and is removed by a foul air outlet near the floor. This system gives an equal distribution of heat to all parts of the room, and, best of all, insures pure, clean air for breathing.

RADIATION.—One can feel the heat coming from all sides of a hot stove. Since the air currents are moving toward the stove, and since air is a poor conductor of heat, this phenomena cannot be explained by conduction or convection. This third method by which heat is transmitted from one body to another is called radiation. The earth receives heat from the sun by radiation.

The following Laws of Radiation have been carefully worked out:

1. Radiation takes place through a vacuum as well as through air. Example: Heat from the sun or an incandescent lamp bulb.

2. Radiation takes place from a heated body in straight lines. Proof: Radiation may be cut off by placing a screen between the source of heat and the body receiving it.

3. The rate of radiation is proportional to the temperature of the source.

4. Radiation may pass through a medium without heating it. Proof: The upper regions of the air are always very cold, but radiant heat from the sun passes through them.

SIPHONS.

A siphon is a bent tube with arms of unequal length used for transferring a liquid from one vessel over its edge to one at a lower level. This is done by atmospheric pressure, the liquid being forced upward through the short arm of the siphon and carried downward by its own weight. A familiar example of the siphon is one made from the fork of the hollow Jimson weed, one arm being longer than the other. By placing the short arm below the surface of the water and sucking on the other arm, the water will begin to flow and continue until it is below the end of the short arm. (Why is it necessary to suck on the end of the long tube?) A flexible rubber tube makes a very good siphon. If this tube is filled with water before it is placed in position, it will not be necessary to "suck" on the outlet. Why? Siphons are used for emptying vessels which cannot be overturned and for removing the upper portion of a liquid without disturbing the lower portion. A siphon cannot raise water more than thirty feet. Why?

Large siphons are used extensively in engineering projects to carry water from one level to another. Unless the water to be removed is open to atmospheric pressure the siphon will not work.

COLLECTION AND PRESERVATION OF MATERIAL FOR USE IN THE STUDY OF AGRICULTURE.

Collections of seeds, plants and wood specimens, and other materials useful in the study of agriculture, may be obtained in almost any locality. The collection of these specimens affords an opportunity to teach their identification and their relations to soil and climate.

Care should be taken to make such work constructive, rather than destructive.

WHAT TO COLLECT:

1. Plants of value to the farmer.
2. Injurious plants and weeds.
3. Seeds of plants valuable to farmer.
4. Weed seeds.
5. Collection of wood specimens and leaves to show characteristics of the trees from which they are taken.
6. Collections of fungi.
7. Beneficial insects.
8. Injurious insects.

SUGGESTIONS FOR COLLECTING AND ARRANGING MATERIALS.

For collecting plant specimens, a covered box such as a shoe box, is necessary. The specimens should be labeled accurately when collected to avoid confusion in identification later. They should then be pressed and mounted in some permanent way so that they may be used when needed.

Small cloth bags or ordinary paper envelopes may be used in collecting seeds. Each bag or envelope containing seeds should have written upon it the name of the plant from which the sample is taken, together with the date, locality and other data desired.

After the seeds are collected they should be cleaned and treated with carbon bisulphid or with formaldehyde to kill any insects which may be about them.

To do this, put the seeds in a receptacle. Then pour enough of the disinfectant on a piece of cotton to wet it thoroughly. Place the wet cotton on a saucer in the receptacle with the seeds and cover the receptacle tightly so that the fumes will not escape. Keep fire away from the carbon bisulphid.

One of the simplest methods of mounting seeds for study or display is to put them in small glass vials of uniform size and then place the vials in a

strong, cardboard box with a separate compartment for each vial. If it is inconvenient to get such a box the vials may be fastened to a piece of board by means of shoe laces.

Another holder is made by sewing strips upon a rectangular piece of cloth so as to form rows of pockets, each pocket being just large enough for one of the vials.

Wood specimens should be collected in autumn. At this season there is less sap in the wood, and the fruit and leaves aid in identifying the specimen. Cut a section five or six inches long from a branch that is two or three inches in diameter. Try to find a branch the bark of which is characteristic of the tree. After writing the name on each specimen, put them away until they are thoroughly seasoned. By gluing heavy paper over the ends of the wood the checking, which occurs in dry wood, will be lessened.

When the wood is thoroughly seasoned, split off one side to a depth equal to about one-third of the diameter to show the grain. Then cut one end of the block squarely across and slope the other at an angle of about forty-five degrees from the bark out to the flat face. Screw eyes may then be inserted in one end of the wood by which it may be hung on nails in a cabinet or on the wall. Each specimen should be labeled with the scientific and common name of the tree from which it was taken.

The split or sawed surface of wood specimens should be scraped with the sharp edge of a piece of glass, sand papered and treated with linseed oil. The oil will bring out the colors and grain of the wood more clearly, and will prevent cracking of the wood.

SCHOOL GARDENS AND SCHOOL YARDS.

In many rural communities the home gardens are such that it would seem that a school garden would not be necessary. A school garden, however, can be of much moment in any community, as it gives an opportunity for a study of the soil, method of planting and testing seeds and the cultivation of special types of seeds. Aside from the common garden seeds experiments can be made with such crops as alfalfa, corn or wheat. Garden or flower seeds may be obtained free by any teacher from the Department of Agriculture, Washington, D. C.

It is suggested that something definite be done each year in the way of beautifying the school grounds. The planting of flowers, shrubs, vines and trees in a definite natural way is known as landscape gardening. Trees and shrubs may be set out either in the fall or in the spring. For ornamental purposes it is not best to set trees in rows and especially upon school grounds. Shrubs should be placed near the building or in masses along the walks. Catalogues should be procured from seed houses and from nurserymen. Among the nurserymen that may be mentioned are:

Swain Nelson Co.....	Chicago, Ill.
A. M. Augustine.....	Normal, Ill.
Wm. A. Peterson.....	Chicago, Ill.
C. H. Webster.....	Centralia, Ill.

Below is a list of shrubs. (In many places wild shrubs may be set out on the school grounds.)

dog wood	choke berry
elder	viburnum
arrow wood	dwarf blue berry
sumach	

The arbor and bird day book of 1914 contains many suggestions as to planting shrubs. It may be obtained free by addressing State Superintendent F. G. Blair, Springfield, Ill.

FREE BULLETINS.

Forestry in Nature Study.....	Bulletin 468, Dept., of Agri., Washington, D. C.
Insect Enemies of Shade Trees..	Bulletin 99, Dept. of Agri., Washington, D. C.
School Gardening	Bulletin 218, Dept. of Agri., Washington, D. C.
Testing Seeds	Bulletin 428, Dept. of Agri., Washington, D. C.
Arbor Day	Bulletin 96, Dept. of Agri., Washington, D. C.
Tree Planting	Bulletin 134, Dept. of Agri., Washington, D. C.

DIGESTIBLE NUTRIENTS IN ONE TON OF FEED STUFFS.

Kind of Feed.	Digestible Nutrients.		
	Dry Matter.	Protein.	Carbohydrates.
Alfalfa hay	1832	220	864
Sugar beets	270	22	208
Buckwheat bran	1790	148	694
Buckwheat grain	1748	154	1066
Carrots	228	16	166
Clover hay	1694	136	792
Corn and Cob Meal	1698	88	1330
Corn fodder, green	414	20	250
Corn, grain	1782	158	1528
Corn silage	418	18	258
Corn fodder, dry	1156	50	746

Cowpeas	1704	366	1134
Gluten meal	1836	516	1362
Cotton seed meal	1836	744	888
Whole milk	256	72	264
Skim milk (gravity)	192	62	130
Skim milk (centrifugal)	198	58	118
Buttermilk	198	78	130
Oat Straw	1816	24	808
Oats, grain	1780	184	1136
Rye, grain	1765	198	1402
Rye straw	1858	12	830
Soy beans	1784	592	1094
Wheat, grain	1790	204	1460
Wheat bran	1762	244	906
Wheat straw	1808	8	744
Timothy hay	1736	56	932

STANDARD FEEDING RATIONS.
(Wolff-Lehmann.)

Showing approximate amounts of nutrients required per 1,000 pounds live weight for a day's feeding:

Animal.

	Total Dry Matter, lbs.	Protein, lbs.	Carbohydrates, lbs.	Fat, lbs.	Fuel Value, Calories.	Nutritive Rates.
Fattening Swine:						
First period	36	4.5	25.0	0.7	57,800	1: 5.9
Second period	32	4.0	24.0	0.5	54,000	1: 6.3
Third period	25	2.7	18.0	0.4	40,200	1: 7.0
Oxen:						
At rest in stall	18	0.7	8.0	0.1	16,600	1:11.7
At medium work	25	2.0	11.5	0.5	27,200	1: 6.3
At heavy work	28	2.8	13.0	0.8	32,755	1: 5.3
Fattening Cattle:						
First period	30	2.5	15.0	0.5	34,650	1: 6.4
Second period	30	3.0	14.5	0.7	35,000	1: 5.4
Third period	26	2.7	15.0	0.7	35,900	1: 6.1
Milch Cows:						
Giving 11 lbs. milk a day....	25	1.6	10.0	0.3	22,850	1: 6.7
Giving 16½ lbs. milk a day..	27	2.0	11.0	0.4	25,850	1: 6.0
Giving 22 lbs. milk a day....	29	2.5	13.0	0.5	30,950	1: 5.6
Giving 27½ lbs. milk a day..	32	3.3	13.0	0.8	33,700	1: 4.5
Sheep:						
Coarse wool	20	1.2	10.5	0.2	22,600	1: 9.2
Fine wool	23	1.5	12.0	0.3	26,400	1: 8.5
Breeding ewes, with lambs..	25	2.9	15.0	0.5	35,400	1: 5.5
Fattening Sheep:						
First period	30	3.0	15.0	0.5	35,600	1: 5.4
Second period	28	3.5	14.5	0.6	36,000	1: 4.5
Horses:						
Light work	20	1.5	9.5	0.4	22,150	1: 6.9
Medium work	24	2.0	11.0	0.6	26,700	1: 6.2
Heavy work	26	2.5	13.3	0.8	32,750	1: 6.0
Brood Sows	22	2.5	15.5	0.4	35,170	1: 6.6

LEGAL WEIGHT PER BUSHEL.

Barley	48 lbs.
Beans	60 lbs.
Blue Grass Seed	14 lbs.
Bran	20 lbs.
Buckwheat	52 lbs.
Clover Seed	60 lbs.
Corn in ear, husked	70 lbs.
Corn (shelled)	56 lbs.
Corn Meal	48 lbs.
Oats .....I.....	32 lbs.
Onions	57 lbs.
Sweet Potatoes	50 lbs.
Irish Potatoes	60 lbs.
Rye	56 lbs.
Fine Salt	55 lbs.
Coarse Salt	50 lbs.
Timothy Seed	45 lbs.
Turnips	55 lbs.
Wheat	60 lbs.

QUANTITY OF SEED NEEDED FOR AN ACRE.

Alfalfa	25 lbs.
Blue Grass	25 lbs.
Brown Corn	35 lbs.
Cabbage	1 lbs.
Red Clover	16 lbs.
Cowpeas	75 lbs.
Oats	80 lbs.
Red Top	14 lbs.
Soy Beans	80 lbs.
Timothy	20 lbs.
Wheat	80 lbs.

FARM PAPERS.

(There should be a farm paper on the library table of both rural and city schools.)

Prairie Farmer	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Indiana Farmer	Indianapolis, Ind.
Wallace's Farmer	Des Moines, Iowa
Farm and Fireside	Springfield, Ohio
Orange Judd Farmer	Chicago, Ill.
Farmer's Review	Chicago, Ill.
Farmer's Wife	Minneapolis, Minn.
The Farm Home	Springfield, Ill.
Country Gentleman	Philadelphia, Pa.
Successful Farming	Des Moines, Iowa
Farmer's Wife	St. Paul, Minn.
Missouri Valley Farmer	Topeka, Kans.
Breeders' Gazette	Chicago, Ill.
Wisconsin Agriculturist	Racine, Wis.
Ohio Farmer	Cleveland, Ohio
Iowa Homestead	Des Moines, Ia.
Colman's Rural World	St. Louis, Mo.

P D 47.7

Units that should be memorized so that they may be used on a moment's notice:

- 486=number of cents in an English pound.
- .866=altitude of 1 ft. equilateral triangle.
- $1\frac{1}{2}$ =di. of a silver dollar in inches.
- 412 $\frac{1}{2}$ =weight of a silver dollar in grains.
- 25.8=weight of a gold dollar.
- 13.6=specific gravity of mercury.
- 22 $\frac{1}{2}$ =No. of bricks for a cu. ft.
- 128=cu. ft. in a cord.
- $1\frac{1}{4}$ =cu. ft. in a bushel of small grain.
- 1 4/9=cu. ft. in a bushel of ear corn.
- 18 $\frac{1}{2}$ =di. in inches of a bushel measure.
- .7854=No. used in finding area of circle.
- 2150.4=No. of cu. in. in a bu. of small grain.
- 3888=No. of cu. in. in a bu. of ear corn.
- 2067=value in cents of an ounce of gold.
- 31 $\frac{1}{2}$ =gallons in a barrel.
- 100=links in chain.
- 640=acres in section.
- 5760=grain in 1 lb. Av.
- 5760=grains in 1 lb. Troy.
- 16 $\frac{1}{2}$ =ft. in a rod.
- 30 $\frac{1}{4}$ =sq. yd. in a sq. rd.
- 7.92=in. in a link.
- 4=inches in a hand.
- 62 $\frac{1}{2}$ =pounds in a cu. ft. of water.
- 1.4142=diagonal of a 1 ft. square.
- 231=cu. in. in a gallon.
- 1.732=diagonal of a 1 ft. cube.
- 43560=sq. ft. in 1 acre.
- 100=cu. ft. in cord of stone.
- 7 $\frac{1}{2}$ =gallons in 1 cu. ft.
- 550=cu. ft. in 1 ton loose clover hay.
- 400=cu. ft. in 1 ton mixed hay that is settled.
- 343=cu. ft. in 1 ton compact hay.
- 3.1416=circumference of a 1 ft. circle.
- 9=sq. ft. in 1 sq. yd.
- 27=cu. ft. in 1 cu. yd.
- 2240=No. of lbs. in a large ton.
- $\frac{1}{2}$ =the area of an inscribed square is $\frac{1}{2}$ of a circumscribed square.
- 9=No. of shingles to a sq. ft. when laid 4 in. to weather.
- 22 $\frac{1}{2}$ =No. of brick to a cu. ft.
- 24=a roll of paper is 24 ft. by $1\frac{1}{2}$ ft.
- 18 $\frac{1}{2}$ =diameter of a cylindrical bu. measure.
- .7071=line parallel to base of triangle and dividing it into 2 equal parts.
- 268.8=cu. in. in a dry gallon.
- 19.36=specific gravity of gold.

LIST OF BOOKS.

1. Elementary Principles of Agriculture—Ferguson and Lewis—Ferguson Pub. Co., Chicago.
2. Beginnings in Agriculture—Mann—The Macmillan Co., Chicago.
3. Elements of Agriculture—Warren—The Macmillan Co., Chicago.
4. Productive Farming—Davis—J. B. Lippincott & Co., Philadelphia.
5. Agriculture for Beginners—Burkett, Stevens & Hill—Ginn & Co., Chicago.
6. Elementary Agriculture—Nida—A. Flanagan & Co., Chicago.
7. Practical Agriculture—James—D. Appleton & Co., Chicago.
8. One Hundred Lessons in Agriculture—Nolan—Row, Peterson & Co., Chicago.
9. I. C. S. Farmer's Handbook—International Text Book Co., Scranton, Pa.
10. Soil Fertility and Permanent Agriculture—Hopkins—Ginn & Co., Chicago.
11. Elementary Agriculture—Hatch & Haselwood—Row, Peterson & Co., Chicago.
12. Farm Friends and Farm Foes—Weed—Ginn & Co., Chicago.
13. First Principles of Agriculture—Goff & Mayne—American Book Co., Chicago.
14. Fungous Diseases of Plants—Duggar—Ginn & Co., Chicago.
15. Types and Breeds of Farm Animals—Plumb—Ginn & Co., Chicago.
16. The Principles of Breeding—E. Davenport—Ginn & Co., Chicago.
17. Cyclopedia of American Agriculture (4 volumes)—L. H. Bailey—The Macmillan Co., Chicago.
18. Physics of Agriculture—King—F. H. King, Madison, Wis.
19. How to Keep Hens for Profit—Valentine—The Macmillan Co., Chicago.
20. Practical Nature-Study and Elementary Agriculture—Coulter & Patterson—D. Appleton & Co.
21. Eleven Studies in Horticulture—Blair. Twelve Studies in Farm Animals—E. Davenport. Twelve Studies in Agriculture—E. Davenport—C. M. Parker, Taylorville, Ill.
22. Story of the Soil—Hopkins—Gorham Press, Boston.
23. Our Native Trees and How to Identify Them—Keeler—Charles Scribner's Sons.
24. Trees that Every Child Should Know—Rogers—Doubleday, Page & Co.
25. Grasshopper Green's Garden—Schwartz—Little, Brown & Co., Boston.
26. How to Know the Wild Flowers—Dana—Charles Scribner's Sons.
27. Flyaways and Other Seed Travelers—Fultz—Public School Pub. Co., Bloomington.
28. Garden-Making—Bailey—The Macmillan Co.
29. The Farm and the Dairy—Sheldon—The Macmillan Co.
30. Milk and Its Products—Wing—The Macmillan Co.
31. The Diseases of Animals—Mays—The Macmillan Co.
32. Forage Crops—Voorhees—The Macmillan Co.
33. Plant Diseases—Massee—The Macmillan Co.
34. Diseases of Plants—Ward—The Macmillan Co.
35. Farm Machinery—Davidson & Chase—Orange Judd Co., Chicago.
36. The Book of Alfalfa—Coburn—Orange Judd Co., Chicago.
37. Plants and Animals Under Domestication—Darwin—D. Appleton Co., Chicago.
38. Corn Plants—Sargent—The Macmillan Co.
39. The Potato—Fraser—The Macmillan Co.
40. An Introduction to Agriculture—Upham—D. Appleton & Co., Chicago.
41. Principles of Agriculture—Bailey—Macmillan Co.
42. How to Make School Gardens—Hemenway—Doubleday, Page & Co.
43. Nature Study and Life—Hodge—Ginn & Co.
44. The Study of Nature—Schmucker—J. B. Lippincott & Co.
45. Special Methods in Elementary Science—C. A. McMurry—Macmillan Co.
46. Corn Plants: Their Uses and Ways of Life—Sargent—Houghton, Mifflin & Co.
47. Feeds and Feeding—W. A. Henry—Madison, Wis.
48. Poultry Craft—Robinson—Farm Poultry Publishing Co., Boston.

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