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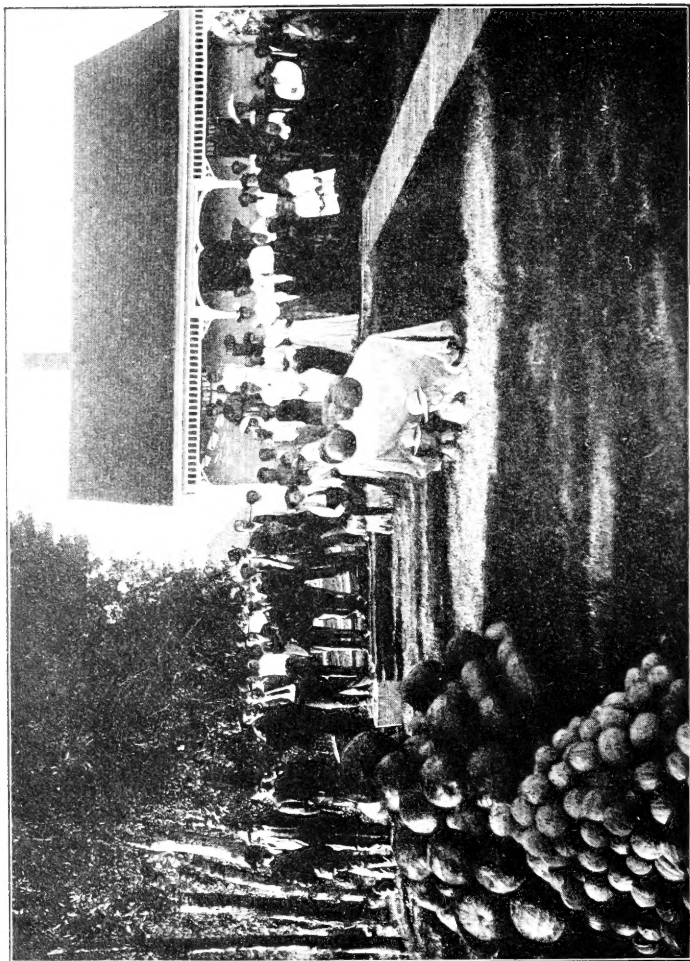
TEACHERS' MANUAL  
OF  
ELEMENTARY AGRICULTURE,  
NATURE STUDY, AND  
DOMESTIC SCIENCE

PREPARED UNDER THE DIRECTION OF  
THE COLORADO TEACHERS' ASSOCIATION

GINN & COMPANY  
BOSTON · NEW YORK · CHICAGO · LONDON







MELON DAY ON A COLORADO FARM

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# ELEMENTARY AGRICULTURE

## FOREWORD

BY PROFESSOR F. E. THOMPSON, STATE UNIVERSITY  
OF COLORADO

For several years there has been growing up in various quarters a suspicion that a part of our educational practice is merely ritualistic and of little use. We have had, and in most cases still have, great faith in our public schools, and now and then it is forced upon our attention that not by any means all those who have been through the school régime are wise, or righteous, or even competent—a lot of them have not even fair common sense. There is apparently not much more justice among our people than of old time, there seems to be about as much poverty, there is still much triviality, and there seems as much political inefficiency. We cannot yet dispense with jails, and poorhouses, and reform schools, but instead are each year engaged in building more of these. Our land is not yet a land of people engaged during “off hours” in reading great works, in admiring great pictures, in discussing masterpieces of sculpture or architecture. The slushy magazine and the villainous yellow newspaper are literature for most of the people; walls are still hung with chromos, and sculpture and architecture are often of the gingerbread variety. We have expected more of our education than it has provided.

Does the fault lie in expectations that were too large or in educating badly done? Probably in both. The world has been fed upon some very bad philosophy, and Americans have received their share; we have believed that any man could become a celebrity—have even supposed that our constitution made it possible. But constitutions can do no more than confer equal opportunities upon those who are equal. Men are never created free or equal. No two infants ever have equal capacities. No one is ever free from some hereditary limitation. But we have educated as if all could be made scholars, or all mathematicians, or all linguists, or all intellectual gentility. Or we have treated children as if they were made up of so many powers, each one of which is in need of only a certain amount of schooling to bring it out to its full perfection, when the child—a creature of developed powers—would be the efficient citizen demanded. So we drill, with much useless arithmetic, and much worse than useless grammar, and much unnecessary spelling and formal geography, and a lot more, until we drill all except the most docile of the children out of the schools. We have still to see that there are no powers except those possessed by people who have ideas that will work. We confer power when we confer ideas.

There is a movement in education now—not a big movement yet, but one that is gaining ground—for the teaching of ideas, of ideas about the world, the time, the place, the circumstances, in which we are actually living. And these ideas are not to be the vague things sometimes known under that name, but are to be clear and definite and to be practically always “plans of action.” The things which the vast majority think about are not to be *merely* such as are objects of beauty, or reverence, or adoration, but are to be things which can have something done to, or with, or about them.

We are, and most of us always must be, a practical people—a people who manipulate earth and air, and fire and water, and their combinations and products, to the end of a living and some luxury. The ideas of which we stand forever in need are ideas along these lines. These are the ideas that are fundamental, indispensable, for nine tenths of all our people, though, of course, there is no need that they be the only ideas. We are not to love artistic and cultural ideas *less*, but the most of us should love practical ideas *more*, or at least first. It ought to be an axiom that the foundation of every man's stock of ideas should be a group that he can, if necessary, turn to account in a practical, vocational way.

Though there has been a tremendous movement to the cities, and though that movement is still going on, it is nevertheless true that most of our people who honestly get a living, get it from the soil, and it is true that this must in the nature of things long continue to be so. The ideal which should become common among the rural population should be to make their land produce, through intelligent treatment, just as much as it will with the least expenditure upon it of time and labor. The farmer should not be a slave to middlemen, jobbers, transportation companies, or brokers, and he should not be a slave to his ignorance. He is often most pathetically the slave to this latter. He too often works unintelligently through long hours where intelligent effort rightly applied would accomplish far more in a few hours. The things missing from most farm equipments are clean-cut, practical ideas.

But there is another side to this matter of ideas. Men do not live by bread alone, even though it is true that without bread they do not live at all. It may be safely said that, all in all, man is happiest who makes his own living and who at the same time finds the biggest part of his joy in the

things from which that living comes. The doctor of medicine who *knows* the human body and its functions so well that every case he undertakes is an absorbingly interesting contest between disease and his skill, finds the practice of medicine a perpetual inspiration. The teacher who *knows* the human mind will gladly pay for a chance to teach. The artist who *knows* the laws of expression will sacrifice all things for time in which to paint. There is no occupation that has more of downright creation in it than has farming. There is no line of production where as many marvelous laws are in operation and coöperation. The farmer who clearly sees the processes by which his corn, or peas, or wheat, or cattle come to maturity has his mind filled with more beautiful things than are the part of any other man. A little real introduction to the wonders in which he lives will give to any normal farmer's boy lines of interest which will keep him growing in sanity, love of beauty, and efficiency as long as he lives.

Intelligent farming—farming that is an avocation as well as a vocation—is almost nowhere being done. Most farmers have by the hit-or-miss practices either of their parents or themselves stumbled upon methods that serve, after a fashion, especially when supplemented by an enormous amount of work. Some day, it is to be hoped, the farmer will be practically the superintendent of a lot of natural forces and processes which will prepare his crops, and, more than that, he will have those crops prepared in just the manner he wants. He will be a man with leisure for the employment of his powers and interests along other lines than those of his vocation, but he will still have many of his best powers employed in that occupation which gives him his support.

It is not our expectation that this bulletin will do much more than intimate or at least suggest some lines of work

that can be profitably undertaken in the country schools. It is not expected that it will revolutionize things—the best changes come through evolution. But the following outlines do indicate some of the more essential topics for study—some of the things which the intelligent, successful, happy farmer must know about. The ideal of those who are presenting this material is that it may become a part of the fabric of the minds of a host of our rural school boys and girls. We want minds full of these ideas. Nothing works in any age except ideas. The Greek world was what it was because of Greek ideas; the present world is what it is because of the ideas of those now living; a better world will come when men have better ideas. This bulletin presents outlines for some of these groups of ideas.

The worth-while teacher never teaches subjects—*she teaches children*; or, better, *she helps children to learn*. She must know what it is she would have them learn, what it is she would have them become. The materials suggested in the outlines are just mental foods which, under the teacher's direction, each child is to work into his particular mental tissue. If this teacher sees clearly what her pupils should become, she will find most of the special methods as she goes along. The following ideals, the writer believes, can be climbed to, in part at least by the way of such materials.

*First.* Each child now living in a rural community should be made more definitely a part of that community—an understander of its natural features and human activities, a sharer in its work. Each child should, for a part of his time, engage himself with pondering the problems of his neighborhood,—the soils, fertilizers, plants, pests, markets, etc. The teacher should raise the problems which the children themselves do not raise, and which are in the direction desired, and she should lead in the efforts at solution. And

this is as good a place as any to say that the teacher, to do this work successfully, need not herself know in advance a lot of agriculture. There is no great virtue in being an encyclopedia; students are made where learners associate with learners — the teacher should be a learner with the rest, the leader and inspirer. She should take the lead in discovering what the community's possibilities are. The particular community is to be differentiated from all others and its importance to the others shown, so that each child resident will feel himself a part of something that is significant.

*Second.* The teacher will help each pupil to realize that in the world of agriculture he can be a real maker of things — a creator. She is to help him to discover that there are certain natural laws which work together in the growth of things. Then she helps him discover that he can modify and complicate the action of these laws upon his undertakings in an almost endless variety of ways and with an almost endless variety of results. She has now led him to the most interesting human occupation, namely, that of working in view of hypotheses which grow out of one's facts. From now on he will not, as an agriculturist at least, be a believer in magic or in the influence of the moon. He will have been rescued from a life of making those motions his forefathers have made. He will now practice an art which is founded upon principles and will have dignity accordingly. It is this deeper intelligence that farmers stand in need of — not of more mere tricks.

*Third.* The teacher will use every opportunity to the end of evoking in her pupils *particular dispositions* on their parts *to the doing of things*. The public schools fail more lamentably right here than anywhere else. Our instruction does not emerge in strong, definite dispositions to specific employments. Our pupils do not become moral, efficient, because they do

not come to a focus. A man is not really a moral man until he is at least this — one who can specifically and well perform some part of the world's work. It may even be granted yet that the doing of one's share is the biggest and best part of morality. It is not being urged here that our rural or any other elementary teachers are to teach trades; but simply that teachers should inspire the most, or all, of their pupils with desires for specific occupations. True instruction is that which takes most any material and through its skillful representation and working over makes specific individuals want to express themselves in particular employments. "Where there is a will there is a way" is an old and faithful saying. Teachers should be busy producing "wills"; the boys and girls will find "ways" of learning trades.

Some one may object here that we do not want to make all rural children into farmers. I am inclined to believe we do want to do just that — at least in the beginning of their careers. It seems to be a commonplace of observation that the men who really amount to much have usually practiced several occupations. It is the man who early learns some line of work well that is most apt later on to change to some line in which he can exercise his largest powers. It is only the man who *waits* to discover what he is best adapted to, who is never well adapted to anything. A man's or a child's first duty is to *master* the occupation he finds nearest to him. Even though now and then a potentially good lawyer should remain a farmer, no great harm would be done. It is obviously true that the present system is making shyster lawyers and shyster everything else of boys who might otherwise have been efficient and honest farmers. Should our teachers work diligently for the attainment of the last aim mentioned, many of them would do less harm than they now do in creating discontent with the place and opportunity at hand.

*Fourth.* The teacher should have, as one of her aims, the helping of the child to discover the real dignity and significance of the farmer's occupation. Comparisons will not be odious here. Let each pupil discover that few occupations afford so good an opportunity for the exercise of the whole man, that few give a man the same independence of the domination of others, that few can be made mentally, morally, or physically so healthy. Let the pupil discover the age of the occupation. Let him learn how many of the world's great men have been and still are of the farming class. Do all this, and whether a boy remain a farmer or not, he will be one who will help to make for a better understanding among social and industrial classes.

*Fifth.* The teacher will aim to have each pupil get in the way of regarding himself as an authority on at least the line of work,—not only an authority but an investigator and experimenter as well. Nothing makes a boy respect himself, and strive for a fuller respect and recognition from others, as does the discovery that he is regarded as an authority. The rural schools are usually small enough to enable the teacher to do just this sort of individual work. Does anything else present so good an opportunity as does agriculture for the getting, by the boy, of this class of tangible results?

On the matter of methods a very few general principles may be in order.

1. The greatest consideration in all methods which have to do with the learning process is that each pupil shall actually be a participant. If this cannot be accomplished in the world of ideas, then there must be some sort of actual "doing"; if the teacher is sure of the pupil's notions, then talking and reading (on some topics) is enough, but where there is any doubt it should be cleared up with objects.



2. The mind does its work with percepts, images, concepts, ideas. All these are vitally related one to another. Ideas (clear ones), the goal of instruction, depend upon clear, vivid percepts, images, and concepts; and these are made clear and vivid by having them, and nothing else at the same time, under the full focus of attention. Whatever is to be used in a mental picture — is to be part of any idea — must be looked at singly and intently and repeatedly until fixed. Objects, pictures, word descriptions, maps, diagrams, models, — all these must be used to the end of clear notions.

3. Individual notions, percepts, images, concepts, must become associated into complexes which are *ideas*, or *plans of action*. The best of all ways to bring about these associations is to give pupils (and undertake with them) problems for the solution of which they have most of the data in the shape of notions, percepts, images, etc. Solving a problem means *constructing* in one's mind what I have called an idea. The problem itself gives part of the data, the teacher and pupils discover the rest, and so each mind that really participates, builds an *idea*.

4. The daily lesson, or the series of lessons, should be practically a series of problems of an increasing order of complexity, the later problems employing the earlier ones and their data in new ways. Some of the problems should be worked out in actual experiments.

5. In this (as in other content subjects) the teacher should be suspicious of words. She should make sure that they are not mere words,—that there are ideas behind them. American boys and girls are of too precious material to be made up into phonographs.

6. Teach agriculture as you would any other subject. Assign a lesson, see that pupils study it at home and in school, and make sure, by questioning during recitation period, that the pupils have learned the cardinal facts.

# SOILS

BY PROFESSOR T. S. PARSONS, PRINCIPAL DURANGO  
HIGH SCHOOL

In the home surroundings of the pupil we can find as well as anywhere else the best materials for the study of the soil. It is as necessary for the farmer boy to know about the soil upon which the family living principally depends as it is for him to know his other school subjects. In the teaching of any phase of nature we should begin at home, taking the environment of the child. We must build upon what has already become a part of his life. It is a wrong scheme of education which permits children to undertake the struggles of life entirely ignorant of the physical world with which they are in contact.

## SUGGESTIONS TO TEACHERS

The teacher need not be an authority upon the subject of soils in order to teach it. If the teacher knows a few fundamental principles that will make life on the farm more interesting, she can accomplish much. She will be making life brighter and at the same time will impart to the pupils knowledge of untold value which will aid them in life.

Lead the pupils upon excursions to the fields and woods. Study different soils, collect examples of each kind and put each in a small bottle and label it, and keep these in the schoolroom. Perform simple experiments before the pupils, and teach them how to make experiments and how to

observe for themselves. The teaching they receive direct from nature is the best teaching. They will not weary of observation and experiment. The young mind can easily grasp the concrete but soon wearies of the abstract.

**How Farmers first learn to till the Soil.** Read to pupils the story of Jethro Tull, — how he raised larger crops than his neighbors by tilling the soil better than they did. He used his brains as well as his hands in farming. We are finding out more and more that education is as useful on the farm as anywhere else.

**Origin of Soils.** Most soils come from the breaking down of rocks. The different colors are due to various minerals in the rocks. The rocks are broken up by the action of weathering, droughts, air, moisture, etc.; also by acids formed by the decay of fallen leaves and dead plants. Deep-rooted trees and shrubs help to break up rocks by forcing their roots between the layers.

The soil is distributed from place to place in various ways. Water carries and deposits it. Soil is formed in thin layers on the surfaces of rocks by the decay of the scanty vegetation growing there. The good soil along the river valley is that which has been brought down and deposited by the water.

**Plants need Soil.** Nearly all plants grow in soil; even water plants often send their roots down to the soil. Plants that grow on wood and rocks are of low order. If plants are deprived of soil they soon die.

**Kinds of Soil.** Sandy soil is composed largely of sand. The particles are hard and easily mixed; when moistened they cling together and can be molded into various shapes, but fall apart when dry. Sandstone is made up of particles of sand cemented together. Sand has many uses, such as in making glass, mortar, plaster, and cement. Read how the iron molder uses sand in making forms and patterns for castings.

**Experiments with Sand.** Scour a rusty knife with sand. Rub a piece of wood smooth with a piece of sandpaper. Try to dissolve a handful of sand in a glass of water. Does the water become clear when it stands for a while? Can the sand be easily separated from the water? Make some little balls and cubes of moist sand and let them dry and see what happens. Does sand hold water well?

**Clay Soils.** These are of various colors, — red, nearly white, and sometimes blue. When moist, clay can be easily molded into almost any shape, and when dry it does not fall apart like sand, but becomes very hard. When wet, it sticks to the boots, to the plow, and to the horses working in it. Clay is very useful to the artist in making models, and it is used also by the potter and brick maker. Adobe is a kind of clay used by Mexicans and others for plastering and making houses.

**Experiments with Clay.** Make some balls and cubes from moist clay as you did with the sand. Do they dry out as quickly as the sand? Do they retain their shape better when dry? If possible, visit a brick kiln and observe the manufacture of brick. Stir up a handful of clay in a glass of water. Does it color the water more than the sand? Does it settle and allow the water to become clear as quickly as the sand did? Can it be separated from the water as easily as the sand?

**Humus Soils.** These soils are dark in color, varying from light brown to black. They are usually formed in woods, swamps, and low meadows. Humus is made by the decay of vegetable matter. Traces of former plants always can be found in humus. This soil is light and easily worked, and holds water readily. Loam is a mixture of sand and clay with humus. This is the best soil for plants.

**Experiments.** Place a handful of swamp muck or leaf mold in an iron shovel and set it upon the burning coals in the

stove. Notice the change that takes place and the amount of ashes left. Try the same experiment with sand and clay and watch the result in each case. Put a handful of humus in a glass of water and stir it up. Notice the bits of sticks and leaves that float on the surface. Does the water clear as quickly as that with either the sand or clay in it? Pot three geraniums, one in sand, one in clay, and one in good humus, and see which requires the most watering and which makes the best growth, and note the condition of the soil in the three pots from time to time. Experiments in growing plants in different soils can be carried on very nicely during the winter months.

**Drainage of the Soil.** On the steepest part of a side hill there will be but little soil. Lower down we will find more, and near the bottom the soil will be very thick. Planting seeds in well-drained soils and wet soils will show us quickly which is best for crops. Water is not easily heated. A well-drained soil is heated by the sun's rays much quicker than a wet soil. A dish of soil will heat much quicker if it is placed on the stove above the fire than if it is placed below or beside the fire. The sun is the fire that warms up the soil in the field, and as the heat comes from above the effect is small. The surplus water must be got out of the soil so that the air can circulate freely and thus warm up quicker in the spring, so the seeds can sprout. Sandy soils usually drain themselves and are warmer. If the clay soil is not drained, it will be cold and is apt to bake on the surface.

The stickiness of clay can be overcome by the use of lime and humus. Shake up some sand in a glass of water and mix in a little finely powdered lime and notice its effect. Fill a deep bottle with clear water and drop a handful of soil into it. Stir it up and watch it settle. Notice how the heaviest particles settle to the bottom, the others arranging

themselves in layers above, according to their size. This shows that there is always more or less stony material in the soil. This stony material needs working over, and can be done best by tillage. Examine a little sand, clay, or loam under the magnifying glass. It looks like a little heap of stones. That is what all soil is. Thorough drainage and tillage do more than anything else to improve soils. The florist is able to grow very large plants in small pots because the soil is well drained and is kept loose so that plenty of air gets to the roots.

**Improving and Renewing the Soil.** If a crop is taken off the land every year and nothing put back, the land will soon produce little or no crop. It is as though you had a thousand dollars in the bank and drew out one hundred dollars a month and put no more in. We see a good crop on a certain field because the soil is good. The market gardener grows large crops on small pieces of ground because he keeps the soil in good condition. When a piece of woods is cleared the first few crops are very heavy because there is so much humus in the soil. If we keep the soil supplied with humus, we can always grow a good crop.

There are various ways of renewing the humus and plant food in the soil. One way is by the rotation of crops, i.e. following one kind of crop by another, as oats by clover, pasture by corn, etc. Most crops take from the soil more than they put in, so to keep the soil rich, crops must be grown from time to time that will put back the required materials.

**Weathering of the Soil.** Weathering affects the soil as well as rocks. A stick placed in the fire becomes charred. A stick buried in the soil is affected in the same way, except that the change takes place much more slowly. Oxygen causes the change. Oxygen and carbon in water form carbon dioxide. This acts like an acid and dissolves rocks very

rapidly, especially limestone. Vegetable soils are very easily crumbled between the fingers and contain but little sand or gravel. If a handful of such soil be shaken into a dish of water, it will color the water, as some of the minerals are dissolved in it. In order to get the vegetable material into soluble form it must be worked upon by the air; but air cannot get at the material unless the soil is well drained, so swampy soil should be drained in order to let in the air. Air also sweetens the soil. Vegetable soils that are wet are sour or acid, and plants will not grow in sour soil. A little lime sprinkled over the surface of the soil hastens the sweetening process.

Drainage is one of the best improvements ever made in agriculture. Drainage benefits the soil by deepening the top soil and removing the surplus water from between the soil particles. It benefits the subsoil and thus makes more plant food available. It also improves the texture of the soil and prevents washing.

Tile drains are the best and the cheapest. They are lasting and are out of the way of the plow. The effect of drainage may be shown by filling two tin cans with soil and planting seeds in them. Punch holes in the bottom of one can and not in the other. Give each the same amount of water, and observe in which can the seeds germinate and grow the best.

**Soil and Soil Water.** Water rises in the soil just as the oil in a lamp rises through the wick. The wick is full of little tubes called capillaries, and so is the soil, and the water rises through these. If a little kerosene or gasoline is put into a bottle and the bottle filled with soil, the oil will rise, and if lighted, will burn on the surface. When the water rises to the surface of the soil it evaporates. Evaporation is going on all the time when it is not raining. The soil soon dries out if something is not done to prevent it. Covering the soil with a light mulch prevents evaporation. Cultivating or loosening

the surface of the soil soon after a rain serves the same purpose. Cultivating breaks the small tubes, so that they are unable to bring the water to the surface.

A soil that contains much humus catches and holds more water than one that contains little. Such soil also holds moisture longer in dry weather. Plenty of barnyard manure applied to the soil helps to retain moisture, but commercial fertilizers are of little aid in retaining moisture.

Take two tall lamp chimneys and fill one with fine and the other with coarse soil. Set them in a dish of water so that the water just covers the base of the chimneys. The water will soon rise to the top of the fine soil, but rises in the coarse soil much more slowly. If there is a loose layer of rather coarse soil on the top, the water will rise through this much more slowly than through the fine soil beneath, so much soil water is saved.

**Fertilizing the Soil.** The plant gets some food from the air through its green leaves. The water of the plant comes from the rain that falls on the ground and is taken up by the roots. The mineral matter in the soil that is used by the plant is dissolved and taken up through the roots along with the water. There are about a dozen kinds of food needed by the plant, but three of these are frequently used up and have to be supplied artificially. These three are nitrogen, phosphorus, and potassium. Barnyard manure is applied to the soil because it contains these three foods, and organic matter. The manure also affects the texture of the soil. It supplies humus to the sand and makes it hold moisture and loosens up the clay so that it drains better. The same effects may be obtained by green manuring or the plowing under of green crops, but not so much plant food is supplied in this way.

Fallowing also benefits the soil by allowing it to rest a year without growing a crop. The weeds and plants that



come up are plowed under and the ground is harrowed from time to time so that the air can get through it easily; and then the drainage will be better, also. Fallowing puts nothing back into the soil, but puts the materials already there in a better condition to be used by the growing crops.

**Nitrification of the Soil.** The making of nitrates in the soil is called nitrification. Nitrogen is one of the most important plant foods and is often lacking in soils. Try the experiment of dissolving an ounce of nitrate of soda in a gallon of water and watering some plants with the solution. Notice how much faster the plants grow and how much greener and better they look. In order to be used by the plants the nitrates must be in soluble form. Humus contains nitrogen, and from it nitrates are made. In a good soil these minute forms of life are called bacteria. These are so small that they cannot be seen by the naked eye. Some of these little bodies grow upon the roots of certain plants, such as clover, alfalfa, and the like, forming little tubercles. In order to work well these small beings require warmth, air, and moisture. Other bacteria change organic matter into the nitrates. But these cannot work well in cold, damp soils, so good drainage and tillage help the formation of nitrates. Drainage and tillage put all of the plant foods in the soil in more soluble form.

**How Clover helps the Soil.** The intelligent farmer knows that clover is valuable, not only for pasture and hay, but that it is good for the soil as well, because of the nitrogen supplied by it. If we examine the roots of a clover plant, we will see little swellings or knobs on the larger ones. These knobs or tubercles are full of interest to the educated farmer. They are the little laboratories where the nitrogen is being taken from the air and stored in the soil.

The air is about four fifths nitrogen, but this cannot be used directly by the plant any more than the housewife can

make bread out of unground wheat. So the nitrogen must combine with other substances in the soil and become changed to nitrates before it can be used. The roots of clover and alfalfa penetrate far down into the soil and loosen it up more or less and thus aid in another way.

**Soil and Subsoil.** The farmer too often does not understand the value of a top soil. The subsoil is the foundation of the top soil. As a rule, it has less available plant food and humus than the top soil, so every care should be taken that the top soil is not removed from the field. Water often carries away the surface soil. This is why we often find good soil at the foot of a hill and poor soil near the top. Notice the difference in texture, color, and appearance of the top soil and subsoil. Dig a hole in a field through the top soil down to the subsoil. Also try germinating seeds in the top soil and subsoil.

The intelligent farmer plows along a slope instead of plowing up and down, and thus retards the loss of the top soil. Keeping the soil well covered with grass also prevents the loss of the top soil by washing. The soil on the hillside should not be worked during the seasons when denudations are likely to occur. The hilly land of the farm should be used for hay land or pasture instead of for cultivated crops.

**Soil needs to be packed around Seed.** Plant a few beans in a jar of moist soil and pack the soil down around them. In another jar plant a few beans in the same way, only do not pack the soil. Set the jars in a warm place and notice how the seeds germinate. You will probably find that the seeds germinate best in the packed soil. A seed must become filled with water before it can germinate, and since those seeds in the packed soil receive more moisture they germinate quicker. So we learn by packing the soil in a seed bed that we can cause seeds to germinate more quickly. This is why the good farmer often goes over his field with a roller after he has

sown his grain. A much better lawn will result if the soil is packed after the grass seed is sown.

Packing the soil also aids capillarity. The surface of the soil tends to dry out, and if seeds do not receive moisture at once in dry weather they will not germinate. Packing the soil brings moisture in close contact with the seeds and starts germination. Small seeds should be scattered over the ground or covered very lightly and then a board laid down and stepped on. This should be done over the whole bed in order to insure the germination of the seeds.

**Relation of the Soil to Plants.** Soil and plants have several important relations to each other. The soil holds the plant in place, supplies the plant food, acts as a reservoir for moisture, and serves as a storehouse for applied plant food or fertilizer. Some soils can act in all these capacities, while others can do so in one or two only. Early in the study of soils the teacher should take the pupils on excursions into the woods and fields where the different soils and their effects on plants can be studied at first hand.

The woods give us an example of a good soil. By digging here we can study all the different layers down to the sub-soil. In the worn-out field we see just the opposite. Here nature's lesson has been disregarded. Everything has been taken from the soil and nothing put back. The plant food has been used up, the drainage canals have been closed by the tramping of horses' feet. After the last crop was removed the land was left exposed to the winter rains and snows, which wash out much of the plant food, and after a few years of this treatment the field loses its fertility entirely.

Roots serve as holdfasts for the plant. They have also another important office: they get the food and moisture from the soil. Most trees have a very large root system in comparison to the spread of the tree. If we examine a large

forest tree that has been blown over by the wind, we shall see a large mass of soil pulled up by the many roots.

**How the Forests help the Soil.** The trees of the forest put more humus in the soil than any class of plants. The forest takes but little from the soil, but puts much into it. Every year the forest gives to the soil all the leaves grown during the season, and many limbs and branches that have died for the want of light. Many roots also die down in the ground. The leaves and twigs remain on the ground, and, as the ground is moist, decay goes on rapidly. This process goes on from year to year, and soon there is a thick blanket of vegetable matter all over the soil. The best soil for flowerpots and window boxes can be obtained in the forest because this soil is full of humus and holds water like a sponge, and therefore does not dry out quickly.

**Warmth is Necessary for Plant Growth.** If seeds are planted too early in the spring, before the soil is warm, they will not germinate, even though there is plenty of air and moisture. They must have warmth. Soil is slow to warm up in the spring because there is usually much moisture in it then and the sun's rays only come from above. Good drainage helps the soil to warm up.

The atmosphere is affected by temperature more easily than the soil. The warm spring rains bring some warmth into the soil. In the summer the soil becomes very warm and does not cool off as quickly as the air above it. The summer rains are cooler than the soil, and in passing through it they take up some of the heat. The color of the soil has much to do with the temperature. A dark colored soil is warmer than a light colored one. With a thermometer some interesting experiments can be made in determining the effect of color and moisture upon the temperature of the soil.

**What Plowing does for the Soil.** When the land is plowed

deep and the subsoil loosened, the farmer is sure of a good crop, other things being present. Land that is plowed to a depth of three or four inches cannot produce much. There is barely enough soil to cover the seed, and the little soil there is, is in danger of being washed away by the heavy rains. When the land is plowed to a depth of eight or nine inches, and the subsoil loose and open, the air and water can penetrate the soil and do their work. If we examine a hard road, a meadow, and a well-plowed field, immediately after a rain, we shall see why the field ought to be plowed. We find that the plowed field absorbs a much greater amount of water, and much less of the rainfall runs off. The best time to plow is when the soil is dry on the surface and moist just below. In plowing care should be taken that every particle of surface is turned under.

**The Story of the Buried Treasure.** There is a story of an old man who had three sons. When the time came for him to die, he called his three sons to his bedside and told them that there was a treasure buried in the field at the back of the house. As soon as the father was buried the three sons began to dig the field with spade, shovel, and pick. They left no corner of the field unturned, but they found no gold.

They were about to give up the search, when one of the sons said, "Let us not waste all this hard labor; let us sow the field to grain." So they planted the field, and such a harvest was produced as they had never seen. Then the one who had proposed the planting said, "Perhaps this is the treasure that our father meant was buried in the ground."

The story teaches that the soil must be tilled thoroughly and carefully if we would get a good crop. If the soil is well cared for, it will repay for all the work done upon it. The man who takes all he can get from the soil and never puts anything back is in one sense a robber. He is taking

something all the time and never giving anything in return. The farmer is dependent upon the soil for much of his living, and it is but fair that he should give something in return.

It is very necessary that the roots of the plants have comfortable homes in the soil. If a farmer has been plowing only four inches deep, he should plow an inch deeper each year. This gradual deepening will be good for the soil, and if proper cultivation and rotation of crops are carried on, the ground will become more fertile each succeeding year. If the seed bed be well prepared and the air admitted freely, paying crops will always be the rule.

## PLANT LIFE

BY PROFESSOR B. O. LONGYEAR, STATE AGRICULTURAL  
COLLEGE, FT. COLLINS

**Apparatus.** Pocket lens or dissecting stand, flowerpots or wooden boxes three to six inches deep, saucers or plates, trowel, spade, collecting box or vasculum. A market basket and a yard of table oilcloth. Any receptacle in which plants can be kept without wilting for a few hours may be used instead of the vasculum. If plants put into the box are sprinkled with water, they will remain fresh much longer, but are in danger of molding if left for more than a day.

A plant press, preferably made of narrow, thin wooden strips placed about one half inch apart and held by three cross pieces to which they are nailed. The ends of the cross pieces should project about one inch on either side of the press. The press should be in two parts and a little larger than the drying sheets, or about thirteen by eighteen inches. Sheets of carpet about twelve by seventeen inches for drying plants. Old newspapers may be cut the same length and twice as wide as the driers, and when folded are to hold the plants while being dried and when the driers are being changed.

Heavy white paper for mounting specimens of pressed plants. The standard size is about eleven and one half by sixteen inches. Smaller sheets may be used for the school herbarium.

Sheets of heavy manila paper, a little more than twice the size of the mounting sheets, are folded crosswise and form covers for the sheets of mounted specimens.

## AUTUMN STUDY WITH PLANTS — THE COTTONWOOD

Study the cottonwood trees of the neighborhood. In what situations do they grow as regards altitude, kind of soil, relation to water and alkali? Determine from these observations the most favorable situations for the cottonwood.

In the same relations study the conditions best suited to the following field and garden plants: wheat, oats, alfalfa, sugar beets, potatoes, peas, beans, asparagus. Note especially the behavior of each in fields where alkali is present, and determine the relative ability of each to withstand it. Grow seedlings of corn, beet, pea, bean, sunflower, and wheat of two or more varieties in flowerpots. When well started, water them with solutions of common salt of one, three, five, eight, ten per cent strengths. Make the ten-per-cent solution first by weight. Make the weaker solutions by diluting this with the proper measures of water. Keep a record of the effects and the different strengths required to kill the plants.

Study the leaves of the cottonwoods.

Parts of the cottonwood leaf	}	Stipules: are these present or have they fallen off and left scars?
		Petiole: length, shape in cross section near each end and in the middle, structure as seen under hand lens.
		Blade: midrib, veins, veinlets, apex, base, margin.

Are two leaves on the same branch or tree just alike in every way? Are two leaves ever just alike?

Study the leaves of the cottonwood while on the tree. What positions do they take on the same branch? Does the light seem to have anything to do with them? Note the motion of the leaves. Are they ever quiet? How is it that the cottonwood leaves are so restless?



Experiment with other kinds of plants, e.g. bean, pea, sugar beet, alfalfa, apple, plum, or cherry. In the case of root crops, as the best, the root with its crown of leaves, of a young plant, may be used as there are no twigs. Do some plants seem to require more water than others? In determining this it will be necessary to compute the total leaf surface of each specimen used.

Do the leaves on some cottonwood trees differ much in shape, size, length of petiole, and in other ways from those on others? Most of our common species of cottonwoods can be recognized by their leaves. How many species are there in the neighborhood, and what are they? Draw outlines of several leaves of each species to show their variations, or press them and mount on heavy paper or cardboard.

Try removing the leaves from an alfalfa plant or a half-grown sugar beet as fast as they grow out. What is the effect on the later leaves as they appear, and how long does the plant survive this treatment? Grow several seedlings of corn, bean, or pea in pots. Keep one pot in complete darkness by setting it in a tight box blackened inside to keep out all light. Note the effects of absence of light on the color of leaves and the vigor of the plant. This will indicate what shading does in influencing plant growth. After growing the plant in this manner for a time, cut a small hole in one side of the box. How does the plant behave toward the light that enters? How do plants grow in a window as compared with those which grow in the open where light comes from both sides?

**The Work of the Leaf.** By the following simple experiment show that leaves give off water. Cut a short twig bearing several leaves from a cottonwood tree or from a house geranium. Make a smooth hole through the cork of a narrow bottle or vial. Carefully insert the twig in this hole so that the

cut end will extend one or two inches into the bottle when the stopper is replaced. The twig should fit quite snugly, but, if air-tight, a narrow groove must be cut lengthwise along one side of the cork to allow air to enter the bottle. Fill the bottle to the top with water and replace the cork containing the twig. After a definite number of hours note how much water has been taken out of the vial and mark the place on a strip of paper pasted on the bottle. Remove all the leaves from the twig, refill the bottle with water, and insert the cork as before. At the end of the same period as before, note how much water has been used and compare the two results. It is evident that this experiment will indicate roughly the amount of water which must have been given off by the leaves.

Explain as simply as possible the work of the leaf in the manufacture of starch under the influence of sunlight. The starch thus formed is used by the growing parts of the plants or stored in some part for future use. Starvation of a plant may be accomplished by removing its leaves during the growing season, as often as any new ones grow out. The killing of such weeds as wild morning-glory, Canada thistle, and poverty weed may be accomplished in this way. As long as the plants are allowed to have any leaves above ground, however, they are able to manufacture enough starch to keep the underground parts alive.

Compare leaves of the following plants with those of the cottonwood and with each other: geranium, box elder or ash, woodbine, alfalfa, garden pea, clematis, yucca, a grass, prickly lettuce, Russian thistle, spruce, pine, and cedar. Note the following points:

1. Are some of the parts found in the cottonwood leaf wanting in the others?
2. Arrangement of the leaves on the stem.

3. Position of blade and length of petiole in relation to light. Examine after dark. Do any of the leaves assume a sleeping position at night?

4. The functions of the leaf or its part.

5. The veining of the blade: whether in the form of a network (netted veined) or of parallel fibers (parallel veined); whether the largest veins grow out along the sides of the midrib (pinnate), or branch out in several directions from the base of the blade (palmate).

6. The division of the blade: whether all in one piece (simple), or in several pieces or leaflets joined to a common stalk or petiole (compound).

7. What plants have no true leaves? (Most cacti. The prickly pears have very small leaves at first on the new joints.)

**Autumn Colors.** Note the autumn colors in leaves of different plants. Does the situation of the tree or other plant seem to affect the earliness of coloring? Autumn coloring may be taken as indicating the ripening or maturing of the leaves. Do the different species of cottonwoods differ in earliness of coloring? How does frost seem to affect this process? Do the leaves ever freeze to death before the autumn coloring appears?

**Seed Dispersal.** What benefits come to the plants from the dispersal of their seeds? Study the various means of seed dispersal as shown by the following:

1. Dispersed by wind: milkweed, dandelion, wild lettuce, clematis, box elder, ash, mountain mahogany, pine and spruce, Russian thistle, and other tumbleweeds.

2. Dispersed by water: giant and false ragweed, dock, clotbur, many grasses and other plants growing along ditches and streams. Remove the wings, hairs, and other parts from a number of such seeds and place the naked seeds in water. Do they float? Is there any benefit from the fact?

Dispersed by animals: fruits and seeds furnished with hooks, barbed spines, prickles or hairs, such as stick-seed, clotbur, sandbur, stick-tight, porcupine grass; fleshy or pulpy fruits that contain hard or bony seed, such as chokecherry, hawthorn, Virginia creeper or woodbine, raspberry and currant, poison ivy. These are largely eaten by birds and scattered in that manner.

Farm seeds form a common means through which seeds of many plants are scattered. In this way many of our worst weeds have been brought from Europe and other countries and sown on our farms. Samples of farm seeds may be examined for weed seeds that may be present.

A few plants, such as the sweet pea, wild geranium, and violet, shoot their seeds when ripe, usually by means of the sudden twisting or springing of some part holding the seeds when drying. The catapult fruits — skullcap, sage, wild bergamot — are usually sprung or operated by animals moving about among them, and by the movement of the plants in wind, while certain low, spreading plants reach far out along the ground and drop their seeds on new soil, as shown by the knotgrass and purslain common in gardens.

Collections of seeds and seed pods illustrating the different modes of seed dispersal may be made and mounted on cardboard. A brief description of how the process of dispersal takes place should be written on the card with the specimen, together with simple drawings which the pupils can make.

#### PREPARATION FOR WINTER

Plants get ready for winter in several ways, of which the following may be studied as among the most common.

1. **Fall of Leaves.** With a sharp knife cut lengthwise sections through cottonwood twigs so as to pass through the

base of a leafstalk. Under a lens note the line where the leaf will separate from the twig. This is called the separating layer, and when full formed causes the leaf to drop off easily. In what way does a sharp frost affect the fall of leaves? The shedding of their leaves enables many perennial plants to reduce their surface and thus largely avoid the severe drying effects of winter.

Study the fall of leaves in the woodbine, ash, box elder, and other trees and shrubs.

What plants do not drop their leaves? Do such leaves become highly colored in autumn? What plants hold their leaves all winter? When do such plants drop their leaves?

What becomes of the leaves after the plants are through with them?

2. **Seeds** form a means by which annual plants get through the winter.

Plant seeds of wild sunflower as soon as ripe; also others a year or two old. Which germinate? What advantage is this to the plant?

Try the same experiment with other seeds that ripen in late summer and autumn, using some wild and some cultivated plants. Do any of them germinate? Is the fact of special use to the different plants, and in what ways?

Examine and compare seeds of pea, bean, pumpkin, sunflower, corn, buckwheat, piñon pine, sugar beet, and others before and after they have been soaked several hours in water. Look for the scar or hilum, and the micropyle or little opening through the seed coat. The micropyle is often invisible even under the lens, but it is usually near the hilum. Its location is most readily and surely determined by the fact that the tip of the caulicle, the little stem of the embryo, lies close to the micropyle within the seed coats. Draw seeds of each species to show their shapes, scars, and other markings.

After removal of the seed coats or other coverings carefully examine the structure of the soaked seeds.

The little plant or embryo consists of:

*a.* Caulicle, a little stem.

*b.* Cotyledons or seed leaves. These vary in number, shape, size, and thickness in different plants. In the corn there is one (monocotyledonous); in the pea, bean, and others, two (dicotyledonous); while in the pines there are several (polycotyledonous).

*c.* Plumule, the little bud from which the shoot is to arise. The plumule is often too small to be seen readily.

Make drawings of the various embryos studied and name the parts.

In some seeds the embryo completely fills the seed coats, e.g. pea, bean, pumpkin, and sunflower. The cotyledons in such cases are rather large and thick and contain a supply of food material in the form of oily, starchy, or albuminous matter. Starch is readily detected by applying a very little tincture of iodine to the cut surface of the soaked cotyledons, when a bluish or purplish color will develop, becoming blackish if much starch is present. If albuminous matter alone is present, the color produced is yellow or brownish yellow. If starch is also present, a greenish color is often noticeable. Oily matter will give a greasy appearance if a seed containing it is crushed on paper. Seeds like the corn and buckwheat contain a quantity of starchy matter (endosperm) in which the embryo is imbedded.

Thus a seed consists of a little plant supplied with a small store of plant food and inclosed within a coat or shell.

**Fleshy Roots.** Roots of beet, turnip, carrot, and dandelion contain a store of plant food and possess a crown with buds which are capable of starting into growth the next season. Place a sugar beet, turnip, or carrot root in the top of a glass

jar containing water. The lower end only of the root should be in the water, which should be changed occasionally. Note the origin of the new growth showing where buds are located. The sugar in the roots furnishes mainly the material for the new growth.

**Leaf Rosettes.** Shepherd's purse, mullein, dandelion, and some primroses possess a circle of leaves which lie flat on the surface of the ground and are thus able to avoid to some extent the severe cold, especially when they are covered with



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snow. They usually possess a strong taproot supplied with a store of plant food, and are thereby able to start into vigorous growth early the next season.

**Underground Stems.** Golden-rod, wild aster, milkweed, blue stem and blue grass, and many others have underground stems which remain alive, although the parts above ground are killed in winter. In spring these send up new shoots from the buds. Tubers, like those of the potato, are very thick underground stems well stocked with starch. Bulbs are very short stems with fleshy scalelike or enwrapped leaf bases attached to them, as in the lily, onion, mariposa lily, hyacinth, and tulip. Plant tubers of potato whole. From

others cut pieces containing one eye, two eyes, and others without an eye. Plant in moist sand or sawdust and note from time to time the origin of the shoots that arise. Where do the roots start from? Do the pieces without an eye grow? Do these facts have a bearing on the growing of potatoes? Place hyacinth bulbs in the top of a jar or wide-necked bottle of water so that the base of the bulb just touches the water. Keep in a dark, warm closet or basement until roots have formed. Blossoms may come out in time from the terminal bud among the leaves.

Study branches of cottonwood in winter condition and interpret the various scars and marks to be found on them, according to the following classification.

*a.* Leaf scars, just below a bud.

*b.* Bud-scale scars, showing where the terminal bud stood the year before.

*c.* Lenticels (minute dots or swellings under the outer bark).

*d.* Flower-bud scars. These often occur on all but the last season's growth of branches from large trees. They stand just over a leaf scar and mark the position of the flower buds.

*e.* Branch scars formed by the dropping of twigs and branches that have become crowded or starved and are of no further use to the tree. Many of these discarded branchlets may be found in autumn and spring lying on the ground beneath a large cottonwood tree.

Other scars, due to hail, insects, or other injuries, may occur on the branches.

**Buds.** Study the position, size, shape, and other characteristics of the buds on the different species of cottonwoods of the neighborhood.

There are several kinds of buds: *terminal*, at the end of a twig; *lateral*, on the sides of a twig; *flower*, those which



contain a flower cluster; *branch*, those which contain a leafy branch; *dormant*. All buds on the cottonwood are dormant during one winter. Some of the very small ones at the lower part of the season's growth are usually latent, that is, remain dormant for several or many years.

Compare twigs and branches of box elder, ash, maple, apple, cherry, or plum, and other trees and shrubs to be obtained. Learn to read the history of a branch; of a fruit spur of the apple, cherry, or plum.

**Bark.** Study the bark characters of the trees of the region until the species can be recognized in winter as far as possible by this means. Small slabs, six by six inches, showing the bark on the trunks, may be mounted on thin boards or heavy pasteboard together with six-inch lengths of smaller branches which show the various characters of the bark.

**Wood.** Study in cross sections the stem of a sunflower plant and note the arrangement of the three parts, — bark, wood, pith. Compare with a section of cottonwood or other tree branch. The sunflower stem has only one ring of wood and a thin bark with no corky outer layer. The cottonwood has as many concentric rings of wood as the branch is years old, and the outer bark becomes thickened with a corky layer. What causes this outer layer to crack into ridges on old stems? Compare the part of the annual layer which is formed in spring with that produced later in the season.

The cambium layer, which lies between bark and wood, is the region of growth in such stems. Does the bark peel off easily in winter?

Compare the structure of the stem of Indian corn with that of the above stems. (The stem is here covered with a dense outer layer, the rind, which does not separate readily from the stem. The wood is represented by the threadlike strands which run lengthwise through the pith.) What is the character

of the leaf of the corn as compared with that of the cotton-wood? Draw diagrams showing the structure of the three stems above mentioned.

### SPRING STUDY WITH PLANTS

With the approach of spring comes the season of renewed activity in the living things of nature. Much of the winter's work has been done in the class room, but as plant growth begins out of doors the interest may be gradually transferred again to the outside world.

**Seed Germination.** Plant seeds of pea, bean, squash or pumpkin, corn, buckwheat or castor bean, and box elder in boxes of sand or sandy soil, and study their behavior during germination. Note how the different parts of the embryo behave and how they get out of the seed coats. What part first appears above ground? Examine at different stages of sprouting and make drawings and notes of each. Plant seeds at different depths and note their behavior in germination.

Gather a little soil from a garden, ditch bank, open prairie, and mountain side, and place in dishes for germination of any seeds that may be present. Note the number of kinds that appear; also what kinds, so far as possible.

Note how the various plants begin to grow. Study the unfolding of leaves in trees and shrubs and other hardy plants. Observe which buds are the first to open; also if the plants of the same kind differ in the time of leafing out.

Examine opening leaf buds of different species of cottonwoods, cutting the buds crosswise with a sharp knife. Note how the leaves are rolled or folded within the shell of bud scales. Notice the color and odor of the balsam with which all parts are coated. What differences are discoverable in the buds of the different species? Draw enlarged diagrams of cross sections of the opening buds.

Watch for the earliest flowers. What is the character of the plants that bloom earliest, and how is it that they are able to appear so early? What relation does the appearance of flowers bear to that of leaves? Make cuttings from six inches to one foot long from the last year's growth of willow and cottonwood. Insert the lower end in moist sand in pots, kept in a moderately warm place. Plant others out of doors in a moist soil. Examine at intervals of a few days to note the process of rooting. Make cuttings from geraniums and other house plants and insert them in clean sand in the bottom of a box covered with a pane of glass. Keep in a warm place until roots form. Examine from time to time to follow the process.

When the leaves are coming out note how the bark of cottonwood, willow, and other shrubs slips off readily. This is due to the softening of the cambium layer as growth begins. This is the time to make willow whistles, also to do grafting on the apple and pear. Study grafting as done in the orchard at this time. Budding consists of inserting a bud, and a bit of the bark to which it is fastened, under the bark of another tree of the same or closely related kind. It is performed in midsummer or early fall, and is adapted to the cherry, peach, plum, and apple.

Watch the blooming of the cottonwoods. Do all of them bear the same kind of flowers? Gather branches bearing opening flower clusters (catkins) and place in vases or jars of water in the schoolroom where they can be watched. The flowers of the cottonwoods are as simple in structure as any to be found. On one tree each little flower may consist of a tiny bunch of purple stamens fastened to a small stalked disk, each disk in the cluster or catkin coming out from under a fringed scale. With the lens note the structure of the stamens. Each consists of a threadlike stalk, the *filament*, which bears

a four-celled pod, the *anther*. The anther soon opens and discharges a yellow powder, the *pollen*.

Tie or closely pin several small paper sacks over the ends of twigs of a pistillate-flowered cottonwood so as to inclose several catkins in each sack. This must be done just as the catkins are coming out of the buds which contain them, and before the pollen from other trees has touched them. When the trees are in full bloom remove part of the paper sacks, bring a branch from a staminate flowered tree of the same species, and shake some of the pollen powder upon the pistil flowers. Replace the sacks and leave them on until the trees are entirely through blooming, or for several weeks.

When the cottonwood is nearly ready to shed cotton, untie the sacks and compare those twigs that were covered all the time with the others. What do you conclude to be the office of the pollen?

On another tree each little flower may consist of a small egg-shaped body fastened to a stalked disk, while from its apex three earlike objects grow out. This whole thing consists of the pistil, the egg-shaped part being the *ovary* and the earlike objects the *stigmas*. Carefully open the ovary and with the lens note the tiny seedlike objects, *ovules*, that grow inside. Make enlarged drawings of each flower and its parts. Study in like manner the flowers of other trees and shrubs of the region.

As they come on examine the structure of the flowers of some of the following plants: wild onion, sand lily, mariposa lily, pasque flower or anemone, loco, beardtongue, cucumber, squash or pumpkin, cherry or plum, apple, corn, oat, wheat, or barley. In most of these the stamens and pistils are together in the same flower and are inclosed in the bud by some more or less showy parts, the floral envelopes. Where these are in two sets, the outer is the calyx, the inner the corolla.

Floral diagrams showing the positions of the parts in the flower bud may be drawn by the oldest pupils.

**Pollination of Flowers.** This may be taken up by the older pupils, to some extent, in connection with their study of floral structure. The various agents by which pollen is carried from stamens to stigma in the same flower (close or self-pollination) or from stamens of one flower to stigmas of another flower of the same species of plant (cross pollination) should be noted. How is the structure of the flower and the arrangement of its parts adapted to each agent? In the case of the cottonwood the separation of the flowers, each kind being on separate trees, necessitates cross pollination, the wind being the agent. Indian corn has the staminate flowers in the tassel at the top of the plant, while the pistillate flowers are on the ear. What part does the silk represent? How is pollination effected?

#### COLLECTED PLANTS FOR SPECIMENS

A collection of the commonest plants of the neighborhood may be made during spring and autumn months of the school year. Some pupils may be interested enough to carry this work through the summer vacation.

If not too large, the whole plant should be taken — root, stem, and leaf. In large plants twigs or small branches must do. Strive to get as many different stages of bloom as possible on one specimen. It is often necessary to collect specimens from the same plants, at different times in the season, in order to get flowers, leaves, and fruit. Such plants as grow from small bulbs, tubers, or rootstocks should be carefully dug up so as to get all or part of the underground portions.

The specimens should not be allowed to wilt before being put into the drying press. To press the plants, lay a drying

sheet on one part of the press, and on this place a sheet of old newspaper or other thin paper, on which carefully spread the plant. Some parts may need breaking or cutting off, others can be doubled back to make them come between the driers. On top of this place another drier and another sheet of thin paper with a specimen on top. Continue this until the plants are all used or until the pile is not more than six inches high. On top of all place another drier and the upper half of the press. Twenty or thirty pounds of weights may now be placed on top of the press; or, preferably, a strong, heavy cord may be wound about the projecting ends of the cross pieces of the press in such a way as to draw the top and bottom parts together.

The driers should be replaced with dry ones once a day for several days, or until the plants feel dry to the touch. The first time this is done the leaves and other parts that are crumpled may be straightened out. The process of drying may be hastened by keeping the press in the sun or near the heat of a stove. A record of the date, the locality, and the character of the soil should be kept for each plant, together with the name of the collector. As far as possible the plants should be identified soon after they are collected, as they are most easily studied then. Good dried specimens, however, can be quite readily identified by a botanist at any time by softening a flower or other part in hot water.

Specimens of fleshy fruits, when nearly full grown, may be gathered and preserved in a four-per-cent solution, in water, of commercial formalin or formaldehyde. Large-mouthed bottles or fruit jars are suitable for holding such material. Flowers of many kinds may also be kept well, so far as structure is concerned, in this way. The specimens should be soaked in water for half an hour or more before being used for study.

In this way flower buds, flowers, young fruit, and nearly mature fruits of such plants as cherry or plum, apple, strawberry, raspberry, and others may be kept ready for use, and the teacher will thus be able to show their various stages of development without waiting for the season to bring them around.

# SCHOOL GARDENING AND IMPROVING THE SCHOOL GROUNDS

BY PROFESSOR H. W. HOCHBAUM, COLORADO STATE  
NORMAL SCHOOL

**Introduction.** The effect of beautiful rural school and home grounds is a great one, making the country child content with the country, stimulating the love for nature and the beautiful, and making for better culture, better ideals, better homes, better farms, and better, broader, fuller, and richer lives.

The indifference of farmers as a class to the appearance of rural school grounds is the one great factor that accounts for our bleak, bare, cheerless, rural school grounds the country over. Generally the poorest piece of land in the district is chosen as a site for the schoolhouse. Good farmers, who give their every care and attention to the welfare of their cattle, are careless and neglectful of the place where their children go to school. School grounds without trees, grass, or flowers, usually untidy and ill kept, are not the best environment for the impressionable child. Beautiful school grounds are great educators, and their influence should be recognized.

This should inspire every teacher to work for the betterment of every school. She, more than the parents or her pupils, is responsible for the present conditions. She will have to start this improvement work, for she is the leader. To be sure, she may lack training and experience in such work, but given enthusiasm and perseverance, much can be done, even under the most unfavorable conditions. Enthusiasm and perseverance are more important than mere knowledge



of garden handicraft, for there are prejudices to overcome, as it is more than likely that the people of the particular rural community will resent the introduction of a "fad." To overcome this the teacher will have to talk gardening at every opportunity. She will have to work for some immediate improvement of the school grounds, and thus show her earnestness in the cause. This immediate improvement, secured with the aid of the children, who will clean litter, rubbish, and trash from the grounds, and perhaps repair fences and buildings, will win other helpers from the community. After this "sprucing up," the further improvement, that is, the planting, may be planned.

The handicaps to improvement work in this state may seem great. Many schoolhouses are located in non-irrigated districts, some may not even have wells on the premises. Others, again, are in high-altitude districts, where the season is short and the winters especially severe. Yet these handicaps should not deter the teacher from attempting some improvement work. The greater will be your glory if success is yours. There are comparatively many species of shrubs, trees, and flowers, both native and introduced, that will succeed even under the most adverse conditions. Only make the attempt to improve and you will be surprised to see how richly your efforts will be repaid.

**Cleaning up the School Grounds.** The first step in the improvement of the school-ground area should be a cleaning-up process. This must, of course, be accomplished by some development of local pride. Get the pride of your pupils so aroused that they will help clean up the grounds and keep them in good condition. Try to have more attractive grounds than the "Cottonwood Draw School," your nearest neighbor. Institute a cleaning-up campaign. Adopt "Clear up and Clean up" as your motto. Have one wood pile in some convenient

place instead of several scattered all over the area. Repair the broken fences and gates. Rake up and burn all rubbish. Clear stones from the land. Cut down all weeds and burn them. Cut off small inequalities of surface and fill up all holes, so as to have a fairly level surface. Clean up around the corral and horse sheds, and keep clean. Perhaps you will need some new hitching posts or other renewals and repairs. Clear the weeds from the roadsides.

**Planning the School Grounds.** In considering the planting of the school grounds a plan is essential. Without some plan, however simple, one cannot come to a finished, beautiful,



MAKING A SCHOOL GARDEN

coherent composition. Such a plan should concern itself with the general arrangement of the area, considering walks, playground areas, gardens, and plantings. These are the fundamentals and we should consider them before worrying about the details. As the builder first considers size and general

arrangement in planning a house, before concerning himself with the color of the paint, so must we in planning the school grounds consider, first, general arrangement, before worrying about the proper depth to plant sweet peas, or what kinds of morning-glories we are going to plant.

We consider first, then, the general arrangement of the grounds with reference to the buildings. The schoolhouse is to be the center of the picture we are making. Most schoolhouses are situated only a short distance from the highway. The entrance walks and drives should therefore be as direct as possible, straight rather than curved, laid out to afford the most convenient access.

In ordinary school-ground areas we may concern ourselves with three divisions of the property, viz :

1. The front area, — between the main building and the road.

2. The playground area, — at the sides or rear of the building.

3. A service portion, — comprising the extreme rear area for sheds, corrals, wood piles, and outbuildings.

In the arrangement of these areas we should strive to keep the centers open; that is, all the plantings should be thrown to the sides or to the rear. These plantings serve to frame the picture, to screen some buildings, to hide objectionable features, to protect and shade the schoolhouse and make it part of the picture, and to afford shelter from the prevailing winds.

The front area should preferably be sown to grass. Here, especially, all plantings should be placed at the sides and against the building. This is the dress portion of the grounds, and should be made the most attractive, since it is the part of which most is seen. The trees along the highway may be planted in line. All other planting should be informal,

natural, massed. Nature never plants things in line. Most amateurs make the mistake of planting things in line, or scattering shrubs and trees all over the area, in a hit-or-miss way. A much stronger effect is secured if the planting is massed, the centers being kept open. Attention is thereby focused, in the same way that the artist focuses attention by massing, rather than distracting it by scattering his subjects all over the canvas. Furthermore, the plants make a better growth, can be given better care and need less care, if planted in masses, in beds of well-cultivated soil, than if placed into holes cut in the ground. Massed plantings appear more natural, and we should strive to imitate nature as closely as possible in most landscape improvement work. This front area may be screened from the rear portions by shrub masses.

The playground areas should be separated for boys and girls. These may be placed at the sides or rear of the building. They need not be sodded, but should be kept in good condition, — level, clean, and neat.

The gardens should be so situated as to be convenient of access from the schoolhouse. Plantings of trees and shrubs will protect them. They should be screened from the service portion of the grounds, since there we may expect to find the more unsightly features of the area. The gardens should be fairly level, yet slope somewhat to facilitate irrigation.

The service portion should be screened from the other parts of the grounds. This must also be of convenient access from the road, yet must not be too far from the schoolhouse. The buildings and fences that are a part of this area ought to be well screened by vines and shrubs.

Many teachers will no doubt think that the above ideal will be difficult to carry out, especially where the conditions are so trying as they are in the higher and more arid portions of the state. This ideal of greensward, massed shrubbery, and

trees may seem afar off. Yet, under the most adverse conditions, much improvement can be made. Have the conditions peculiar to the region well in mind. Do not attempt to do too much the first year. Improve a little at a time until your experience allows you to plant everything the means permit. Where you cannot purchase lawn seed for a greensward, or where this may not succeed, a substitute may be found in the native flowering plants of the arid plains. These can be transplanted to the school grounds with success, provided reasonable care is given them. Perhaps the native bunch grass of the arid plains may be used. Seed of this can be collected easily, and if sown early in spring, a stand of grass may be secured. There are also many plants, trees, and shrubs, native and introduced, that are very hardy. As has been said, many of these will thrive under the most adverse conditions. I am aware that it will take a great many trees and shrubs to fill the grounds and shrubbery beds. Yet given a few cottonwoods, box elders, maples, dogwoods, Virginia creepers, the average teacher can in a few years propagate enough plants to fill all requirements. Some teachers may be in wooded districts, where they can draw on nature's vast stores, the native shrubs and trees of the mountains and foot hills, far more beautiful than introduced species and far more satisfactory. These can be transplanted with little effort, and, given ordinary care, will thrive and make a garden beautiful. I know that it can be done, for we are doing the very thing here. Even sagebrush, that homely, characteristic plant of the plains of Colorado, is beautiful when growing at the edge of a shrubbery bed or planted along a fence or the base of a building. It may seem odd to think of planting sage brush, yet Eastern people, with all their wealth of ornamental plants, use sage as a decorative plant in their garden. I have seen in parks and

gardens of the East far more inconspicuous plants used for the same purpose. Our native yucca, or, if you will have it, soapweed, is far more beautiful than the cultivated, cherished yuccas of Eastern gardens. It is characteristic, natural, beautiful.

**What to Plant and How to Plant it.** This refers to the plant material to be used in the decoration of the school-ground area. In choosing plants for this purpose always choose the cheaper kinds, for, all things being equal, these are hardier and more satisfactory than the higher-priced ones. Whenever possible, plant native trees, shrubs, and flowering plants. These are far more interesting than the introduced kinds, since they carry with them something of the spirit of the country and region. Their name is legion. Colorado has a wealth of native plants suitable for ornamental planting.

In selecting plants do not choose for beauty of flower alone. Plant for foliage as well as for bloom. Plan to have some color in your garden the year round, be it color of bark, foliage, flower, or fruit. Plan to have some evergreen trees and shrubs, as well as the deciduous sorts, for they are cheery in winter, when all else is sere and brown. Plant with an eye to the future and not alone for immediate effect. Plant large masses of the same or closely related kinds, and plant these in irregular masses, the natural way. In massing, plant the taller growing kinds at the rear of the beds, the smaller kinds in front.

In massing, furthermore, have the beds well prepared by deeply cultivating and fining the soil. In these beds dig the holes for the plants a little larger and deeper than the spread of roots appears to demand. Fill the spare immediately about the roots with good, rich soil, well compacted, so that the plants will at once take hold and grow. Especially is this to be advised where the less fertile subsoil lies near the surface. Water well immediately after planting, to settle the soil

around the roots and to keep life going. Water well all the time, particularly the first season when the plants are making every effort to reestablish themselves. After the plants are watered, prune back at least one half. This restores the balance of root and top, disturbed by the loss of root surface occasioned in removing the plants from the woods or nursery.

Where water is scarce, success in transplanting may be attained by following the principles of the dry farmer. Prepare the land well in the fall by deep plowing to increase the water-holding capacity of the soil. This deep plowing enables the soil to hold more of the moisture precipitated in fall snows and rains. Once taken up by the soil, this moisture may be retained to a large extent by cultivating the surface occasionally during the winter. In early spring, when the ground is still moist, the transplanting may be done. Spread out the roots well and firm the soil about them. Reduce the evaporating surface of the plant by pruning back severely one half or more. After planting, cultivate the surface or put on a thick mulch of manure or litter.

**Planting for Early Crops.** The market or truck gardener roughly classifies vegetables thus: (1) vegetables that may be transplanted; (2) vegetables that may not be transplanted.

By planting seeds of the vegetables of the first class in the hotbed early in spring, he secures plants which may be set out in the open ground when all danger of frost is over. These naturally have the start over plants grown from seed planted directly outdoors; consequently, he gains time in the maturing of a crop. This is a matter of some profit, since the earliest vegetables always pay best.

The same method can be practiced by school gardeners. Because of the time gained, the garden will show some results before the close of school in late spring. In regions where the season is short, as in high altitudes, this method must be

resorted to in many cases to get any crop at all. Especially is this true of such crops as tomatoes, egg plant, and peppers. These plants are easily injured by light frosts. If we wait until all danger of frost is past and sow the seeds of these plants directly outdoors, the plants will not mature in time to escape the early frosts of autumn.

**Preparing the Garden for Planting.** Garden soil must be in the very best condition as respects textures and fertility. Fertility means productivity. The plant food in the soil must be in such condition that the plants can use it immediately. It must be available. The texture must be such as to most easily facilitate the operations of the garden and afford most congenial quarters for the plants. If the soil is loose, open, friable, and well drained, we say that the texture is good. A garden soil must, furthermore, be early; that is, it must become warm and must dry out early in spring, so that seeds and plants may grow.

Such a soil may be obtained by careful and consistent working; that is, by plowing and cultivation, by admitting manure and vegetable matter, and, in the case of wet heavy soils, by drainage. Medium loams are the best garden soils. Heavy soils are too wet, cold, and late. Such soils bake and are ever hard to manage. Light sandy soils dry out too rapidly, and, where there is much wind, are blown away.

In the fall, when the soil of the school garden is still moist, plow or dig it up as deep as possible, turning under in this operation any manure you may have been able to secure. After every rainfall or snowfall, as soon as the ground is dry enough to work, the surface should be cultivated to aid in retaining the moisture. Land thus prepared will be in fine condition for sowing in the spring. Then it may again be turned over, stone and litter removed by thorough raking, and the beds and walks laid out.



It is quite essential that the garden be dug or plowed to a considerable depth. The soil is thereby loosened up. New plant food is unlocked, as new surfaces are exposed to the weathering influences of sun, air, and moisture. The storage reservoir for water is also deepened, while the feeding area for the roots is greatly increased, for the tender rootlets and feeding root hairs can then more easily penetrate the soil. Ask any farmer of the importance of this deep plowing and thorough fitting of the land, especially for such crops as potatoes and beets, and he will tell you that it is more important than any subsequent operations necessary in the growing of the crop. Unless this thorough fitting of the land is well attended to, dwarfed, gnarled, misshapen potatoes, beets, carrots, parsnips, and turnips will be yours to harvest.

**The Garden Record.** A garden notebook will prove of great benefit in the garden work. A class notebook, kept where every one can get to it, will do, but individual notebooks are better. In this notebook the following items may be recorded. Their record ought to prove of great value in governing the garden operations from year to year.

1. Date of sowing and planting the various crops.
2. Date of harvesting the first crops.
3. Date of harvesting the main season crops.
4. Date of last killing frost in spring.
5. Date of first killing frost in fall.
6. General weather observations and records of effect on the various crops of the garden.
7. Temperature records; amount of sunshine; amount of rainfall; total precipitation.
8. Records of the varieties and kinds grown; their yield, when ripe; suitability for the region.

Do not insist on too much detail. Spend more time in the garden than in writing up notebooks.

**Laying out the Laboratory School Garden.** The size and scope of the laboratory school garden, the place where the children are to dig and plant, depends upon local conditions, such as the amount of water, character of the soil, knowledge of handicraft, length of school session, etc. Every effort should be made to give every child in the grades above the second, some plot of ground which he may call his own, where he may plant and care for the plants he is interested in. For the first two primary grades, a common garden is better than one with individual plots. As the age and experience of the child permit, larger plots may be assigned. A bed six feet by ten feet will suffice for ordinary purposes. Here the child may plant parsnips and peas, peanuts, maybe, or daisies and daffodils. It is better to practice flood irrigation. This will work to better advantage than inter-row irrigation, for with these short beds the rows will be short and unevenly spaced, and they are bound to be crooked. Have one large walk, with smaller lateral walks connecting the garden plats. These walks should be large enough to prevent crowding, say three to four feet. Smaller walks should be laid out between all the individual plots. Have enough walks so that the children will not have to jump over garden plats at the risk of trampling growing crops. The garden operations are also greatly facilitated by having enough space for walks.

As soon as the condition of the soil allows, dig up the garden and get it into condition for planting, as outlined above. Then lay out the main walks and the lateral ones. The beds assigned may next be laid out, as well as the walks between. Do not raise the beds above the walks. The main walks should have gutters to carry the water of irrigation.

**Sowing the Garden.** Transplanting is not always successful in the arid West. The winds are drying and the sun is hot. Unless cool, cloudy days favor the planter, and unless the

ground is moist, fine, and rich, transplanting may be a failure with even the hardier plants. Yet I would advise every gardener to try transplanting, for much time is gained. Here at Greeley the young gardeners were quite successful with such crops as lettuce, cabbage, muskmelons, parsley, onions, tomatoes, peppers, and other hardy crops.

There are always certain crops that cannot be transplanted, and which must be sown where they are to grow in the garden, and thinned to the proper distances as they crowd. You will find some of these in the list below, others in the Planting Table. All the root crops, for example, are best sown where they are to stand.

In sowing seeds care must be taken not to sow too deep or too shallow. If too shallow, the seeds and young plants will be washed out, or bake under the hot sun. If sown too deep, the seeds will be late in germinating and coming up, or, perhaps, will not come up at all. In general, sow a little deeper than books advise for Eastern conditions. The size of the seed governs the depth of sowing. Small light seeds must be barely covered, or planted very shallow. Unless they are protected by some shade, they will bake. Try, therefore, in sowing small light seeds to protect where possible with some light covering, as light brush or dry, clean straw. The heavier seeds may be planted deeper. Peas, for example, may be planted three inches deep.

Do not crowd the seeds in the row or drill. You will have to thin the young plants anyway. Why waste seed? After sowing, firm the earth on top of the seeds with the foot or hand. This restores capillary action, so that the soil will be moist near the seeds, and will thus enable them to sprout and grow. If the soil is very dry, do not sow. Water the soil well first, leave over night, and then sow the next day. Especially is this advised for light seeds, for if you water

immediately after sowing, and the ground is very dry, the small seeds will wash away. Always try to sow in moist soil.

After the seedlings are up and when they show character, they may be thinned out to spaces sufficient for the best development of the plant. Sometimes two or three thinnings must be made. In some cases these thinnings may be eaten. Beet thinnings make the most delicious spring greens.

**Garden Flowers.** Many of our most beautiful garden flowers are annuals. There are many kinds suitable for planting. Many may be grown from seeds sown in the cold frame or in the house, and thus time in blooming is gained. Good stocky plants should be grown, and care must be used in transplanting some of the tenderer sorts. Others will grow almost under any conditions. Some poppies cannot be transplanted and must be sown where they are to stand. These should, of course, be thinned to the proper distances as they crowd. Only the common kinds are given here. These are cheapest and best. They can often be purchased for a cent or two a package, and fifty cents' worth will make a great showing in the garden. Often the children will bring seeds saved from flowers grown in their home gardens. It is always better to try only the hardier and more common sorts of vegetables and flowers, at least at the start. As one's knowledge of handicraft increases, the more difficultly grown kinds may be tried.

#### LIST OF COMMON GARDEN ANNUALS<sup>1</sup>

**ASTER. H.** Endless varieties of these pleasing garden flowers may be grown. There are red, pink, purple, blue, and white varieties in different shapes and kinds of flowers. They grow from one foot to three feet high, blooming in late summer. They are fine for cut flowers and last a long time in water.

<sup>1</sup> The letters H., Hh., and T., refer to hardy, half hardy, and tender, respectively. P. = perennial. All others are annual.

Sow outdoors in April, and indoors in the hotbed or house in March, transplanting as soon as the weather permits. Asters are likely to be small and dwarfed unless plenty of water is supplied them.

**AGERATUM.** Hh. A small plant about nine inches high. Blue flowers. Sow outdoors when danger of frost is past, or indoors in March, transplanting outdoors as soon as the weather permits. Space plants six to nine inches apart.

**BLANKET FLOWERS** (*Gaillardia*). H.P. Beautiful early flowering perennials for shrubby beds or garden. Red, orange, and variegated. The native species are also beautiful. Sow seeds indoors in February and transplant to permanent quarters as soon as weather permits, or sow outdoors in August and protect the seedlings over winter with straw and litter. Thin to twelve inches apart.

**CANDYTUFT.** H. A well-known garden annual. The white and carmine shades are best. Grow about one foot high. Sow indoors in March, or outdoors when danger of heavy frost is past. Transplant to ten inches.

**MORNING-GLORY.** H. A free-flowering twiner. Sow as early as possible in spring, in a warm sunny place. Sometimes a nuisance, as it is likely to self-sow and grow where it is not wanted. Not to be planted with shrubs.

**MIGNONETTE.** H. Sow outdoors as soon as the ground is ready, or indoors in March and transplant. Space twelve to eighteen inches apart. Mignonette is a fragrant and very desirable garden annual. It likes a cool situation and plenty of water.

**NASTURTIUM.** Hh. Dwarf and twining. These delightful annuals flourish in the hottest sun and in the poorest soil. They are of all colors, — red, orange, yellow, cream, striped, maroon, pink, and scarlet. The flowers are borne in great profusion. Sow in the spring as soon as the weather is settled.

**PANSY.** H. This well-known flower demands a cool, shady, moist location for its best growth. It is very hardy and thrives in a low temperature. Sow the seeds in a sheltered place outdoors in early fall, and thin to three inches as the plants crowd. Protect with straw over winter and transplant to place where wanted in early spring.

**PETUNIA.** H. White and magenta shaded flowers that delight us the whole summer long. They are very good for massing in beds or for edging walks. Sow indoors in early spring, or outdoors as soon as the weather permits. Thin to eighteen inches apart.

The most expensive seeds are the best. Do not buy cheap seeds of this species.

**PHLOX** (*Drummondii*). H. Brilliantly colored flowers, — red, maroon, white, pink, scarlet, and variegated. The dwarf varieties are best. Sow in the open ground in May and thin to ten inches apart.

**POPPY**. H. Poppies do not transplant well and the seed must be sown where the plants are to stand. When the seedlings crowd they may be thinned to twelve inches. For continuous bloom prevent the formation of seed pods. Some varieties are brilliantly colored. The Shirley poppy is a distinct type and is very good.

**SWEET ALYSSUM**. H. One of the most satisfactory garden annuals, blooming from early spring until late fall. The flowers are white and very fragrant. The plants grow about eight inches tall and are excellent for lining walks or garden beds. Sow the seeds outdoors in April, thinning to eight inches as the plants crowd, or sow indoors in March and transplant outdoors as soon as the weather permits.

**SWEET PEAS**. H. For the best effects with these old garden favorites, plant the colors separate. Large fragrant bunches of flowers all of one color may then be picked and a better bouquet obtained than when mixed colors are planted together. The seeds are very cheap, as twenty cents will purchase four ounces. Sow the seed in fall for early spring bloom and protect the plants over winter. Sow the seed about four inches deep in well-prepared rich soil. If you wish to sow in spring, sow outdoors about the twentieth of March, sowing seeds about three inches deep in moist soil. After planting, stir the surface soil and then place over the row brush or chicken fence wire for a support.

**STOCKS**. H. These fragrant garden flowers come in many colors, and I recommend them to every one. The flowers, while not large or gayly colored, are very fragrant. The characteristic gray foliage of the plant reminds us of some of our native plants. Sow the seed indoors early in spring and transplant to fifteen inches outdoors when the weather is settled, or sow outdoors in April and thin as the plants crowd. The most expensive seed gives a larger percentage of double flowers.

**VERBENA**. H. Verbenas demand good rich soil. For the best results sow the seeds indoors in February and transplant to the garden in April or May, setting the plants ten inches apart. If separate colors are wanted, plants from seed cannot be depended upon. It is better in that case to purchase young plants, or cuttings of known color.

**ZINNIA. H.** This old favorite of grandmother's garden succeeds anywhere, blooming all summer until frost. The flowers are very brightly and oddly colored. Sow outdoors when danger of frost is past and thin to fifteen inches. The dwarf varieties are interesting. The scarlet tints are brilliant and fine.

**CALIFORNIA POPPY. H.** Flowers all summer. Red, white, orange, and yellow varieties can be had. The plant is very hardy and drought-resistant and seems to grow well anywhere. Sow early in spring and thin to twelve inches.

### *Climbers*

**DOLICHOS BEAN. T.** Ten to twenty feet. The flowers are borne in clusters. Purple and white are the two colors to be had. The foliage is beautiful and the plant is useful where a large screen is desired. Sow like morning-glories after danger of frost is past. Also known as the hyacinth bean.

**JAPANESE HOP. T.** This is one of our most rapid annual climbing plants, twining from fifteen to twenty feet in a season. The leaves are prettily variegated. Sow early in spring in pots in the house or hotbed, or outdoors when danger of frost is past. Rich, well-tilled, moist soil is appreciated by the plant.

**COMMON HOP (Humulus lupulus). H.P.** A very beautiful and efficient screen. Makes a good growth every year, once it is established. The young plants are cheap, and every school yard ought to boast three or four plants of this species.

**CLEMATIS PANICULATA. H.P.** This is one of the best perennial climbers. The leaves are a rich glossy green. The white flowers, borne on beautiful long sprays, grace the porch or wall in September. A support of some kind is appreciated by the plant.

**VIRGINIA CREEPER (Woodbine). H.** This is the best all-around vine for covering fences, sheds, and screens. The large green leaves turn to brilliant red, orange, and yellow in early fall, and then this plant is beautiful indeed, especially so if it bears at the same time deep purple, grapelike fruit. This has escaped from cultivation and can be collected from stream banks in some localities of the state. A support of some kind will help it to more quickly serve its object, namely, to screen fences, buildings, and undesirable vistas. Trained to twine about a large ash, its gay colors contrast well with the glossy green leaves of this tree in early fall.

**HONEYSUCKLES.** H. There are several kinds of twining honeysuckles. Hall's, the Chinese, and varieties of these are very beautiful and should be in every garden. They are hardy and easily cared for.

**TRUMPET CREEPER.** H. A tropical old-fashioned favorite. The plant is hardy and succeeds well nearly everywhere. It is grateful, however, if given a somewhat sheltered position.

**DUTCHMAN'S PIPE.** H. Another interesting climber. I fancy that in this climate it will appreciate a somewhat sheltered shaded position. The plant is a rapid grower. Its large leaves and curious flowers make it an interesting and useful addition to most gardens.

**The Problem Garden.** In your garden set aside some plot of ground, no matter how small, for a problem garden. This problem garden may be made, in a large measure, the laboratory of your older pupils, a laboratory where many interesting and helpful problems and experiments may be carried on. Here, for example, experiments in tilling and cultivating may be made, or experiments that will bring home the great importance of thorough fitting of the land, conservation of the soil moisture, and the effect of tillage on the texture and fertility of the soil.

Here seed tests may be made, and you may show what a good effect selection of seed has on the vigor and yield of a crop. New varieties may be tested here, and prove their worth for general planting in your garden beautiful. Many other garden and farm problems may be worked out in this problem garden. I will suggest that part of it be made a place where varieties of fruits can be tested. Find out by actual test how many kinds and varieties are suited to your region. Such experiments will be of great benefit to the entire state, for these are a few of the things of which the rural people of this state need to know more.

**Irrigating and Watering the Garden.** Floor irrigation is better than inter-row irrigation for all gardens except the home



vegetable garden. In the small garden plots the rows are short and crooked and made up of plants of different sizes. Inter-row irrigation will be found to be impracticable because of these factors. Floor the beds from the small ditches placed along the lateral walks. The waste water may be utilized in flooding the plots below, or may be allowed to run in the shrubby beds. Care must be exercised on irrigating thus, not to wash out the small seeds and plants, so it is dangerous to use a large head of water. But when you water, be it with bucket, hose, or by ditch, soak the ground. Do not be content to merely wet the surface. Have the soil so well tilled that the water will soak in readily. Test the depth of penetration by thrusting the finger in the soil. If you can easily push this down in wet soil for three inches, you may know that you are soaking the ground somewhere near the roots of the plants. After each watering, as soon as the ground permits, restore the surface blanket of loose soil to conserve moisture. How often you will have to water depends upon the locality, the amount of water, the kinds of plants, the soil, etc. Depend more on cultivation to conserve moisture than on watering.

**Flowers in Winter.** By planting the bulbs of hyacinths, tulips, and narcissus in fall, blooms may be had in mid-winter. A blooming plant greatly cheers during the dark winter days, and because flowers are so easily obtained from bulbs, every one should plant a few in the fall. These bulbs can be purchased at a very reasonable price. They should be ordered early in the fall, to have them on hand before heavy frosts come, and should be planted before the end of September. The secret of success in getting bulbs to bloom in winter is to secure good root growth before the plants are taken in the house. If the following directions are observed, every one can succeed.

All bulbs require well-drained soil, free from fresh vegetable matter. Fill pots three fourths full of garden soil of this kind, and then place three or four bulbs of a kind in this soil, pressing them down. Now fill the pot even full with soil, and firm this down with the hands to within a half inch of the top. This leaves a space for water. Sprinkle a little chaff over the top of the pots, and after labeling them, water and place outdoors in a sheltered position. Then cover the pots with a foot of soil.

Any time after the middle of January these pots may be removed to the schoolroom. A mild day should be chosen, lest the tips of the bulbs freeze. If the soil is frozen, thaw it out gradually by placing the pots in a room where the temperature is not too warm. Then the pots may be watered and placed in the schoolroom windows. The chaff that is placed on top of the soil in the pots enables one to separate the soil cover from them.

After blooming, the pots may be stored in the cellar. In the spring the bulbs should be taken from the pots, cleaned, and stored in dry sand, in a cool, dry, dark place. The following fall the bulbs may be replanted in pots, though it is better to plant them outdoors in the shrubbery beds.

**A Window Garden.** If you cannot have bulbs for winter bloom, or if the schoolhouse is too cold over Saturdays and Sundays, by resorting to some of the following devices you may still be able to have a little green or perhaps a little bloom to cheer up the schoolroom. Have something green, some growing thing in the schoolroom, no matter how common or simple it may be. Plant a beet or a carrot in a pot or can. To be sure, these are commonplace, but under the conditions they will prove interesting.

Early in spring, as the weather gets warmer and the temperature of the room does not go below freezing, a window

box containing some of the following common, hardy plants may prove very successful. Make a box large enough to fill the window-bench space and about five inches deep. Drainage must be provided for by boring a few holes in the bottom or by leaving a crack. A coating of paint will greatly improve the appearance of the box. Cover the drainage holes with pot crocks or a layer of cinders, and fill the box with good garden soil and plant therein plants or seeds of those varieties with which you are familiar.

## FIELD CROPS

BY PROFESSOR W. H. OLIN, COLORADO STATE AGRICULTURAL COLLEGE

**Introduction.** Let the child be led to find out the truth *for himself*. Curiosity is inborn in every child, and the true teacher makes use of this fact and so plans the work that the child is, by logical steps, led from the known to the unknown. In this way nearly every child will take a keen pleasure and deep interest in the practical study of that which in the majority of cases is his life work.

Amplify each lesson in your own way, stamping it with your personality. The bibliography names books which you will find helpful in working up these lessons in Field Crops.

**A Lesson on Seeds.** In our study of plant life we have learned that plants have a number of ways of propagation or of reproduction. The crops we grow in the field are reproduced by seeds.

A seed is a rudimentary plant with sufficient stored-up food to nourish it until it can obtain its supply from soil and air. When the seed has been matured the mission of the plant has been accomplished.

In most instances, leaves, stalks, and roots die, but the plant lives in each vital seed which it has brought into existence, as wheat, oats, barley, corn, etc. Some plants, like the sugar beet, require two seasons to mature seed; and some, like alfalfa, will mature seed each season, but the plants will live on for many years.

The normal seed has that mysterious, indefinable something which we call *life*, giving it the power of growth and

development. It is a vital force which we may in a measure influence, control, or even destroy, but which, when once destroyed, we cannot restore.

The great object of cultivation is to provide that environment, supply those conditions, which will enable economic plants of great commercial value to produce the best and most vital seeds.

In a healthy, vigorous growth of these plants lies our greatest profit. How very important then for us to study the nature and character, in fact, the life history, of the plants we cultivate in our fields.

Luther Burbank, the great student of plant life, who lives in California, said some years ago :

The student of plant life who adds one more kernel of corn to each ear, one additional grain to each wheat head, oat panicle, or barley spike, one more potato in a hill, would add to the nation's output of these important field crops as follows :

1 extra kernel of corn to each ear,	5,200,000 bushels
1 " " " wheat to each head,	15,000,000 "
1 " " " oats to each panicle,	20,000,000 "
1 " " " barley to each head,	15,000,000 "
1 " potato in each hill,	21,000,000 "

The farmer of to-day seeks to increase his acre yield rather than the number of yielding acres.

**School Collection of Seeds.** Heat a seed until it will not grow, and freeze a seed until it will not grow, and plant both with a normal seed in a soil box and give an object lesson on *life* as a vital force.

Have children get a school collection of seeds from the school district. Place in uniform-sized, screw-capped bottles two or three inches in height. Schools should not gather seeds from the nation by correspondence in English class work. Have all classified and named. Send to the United States

Department of Agriculture for a collection of classified weed seeds, and have the class determine how many grow in the district by bringing in samples.

Make as complete a collection as possible of seeds of field crops from crop-growing regions of the United States.



HARVESTING THE POTATO CROP

The children will delight to do this work under your directions.

Classify all seed bottles by name of seed and state where grown.

**Germination.** Germination is that first stage of growth when the plant depends upon the seed for its nourishment.

#### OUTLINE

1. Parts of a seed.
2. Essential factors of germination.
  - a. Vitality.
  - b. Moisture.
  - c. Heat.
  - d. Oxygen.
3. Circumstances which influence vitality.
  - a. Maturity.

- b. Heredity.
  - c. Age of seed.
  - d. Size of seed.
  - e. Climatic conditions.
4. Testing farm seeds.
- a. Soil-box test.
  - b. Sand test.
  - c. Plate test.
  - d. Cigar-box test.
  - e. Some original plan of germination test devised by student.
5. Plan for germination card.

Name _____	Date _____																								
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; text-align: left;">Class</th> <th style="width: 15%; text-align: left;">{ Number of seeds }</th> <th style="width: 45%; text-align: left;">No. germinated days.</th> <th style="width: 30%; text-align: left;">Total per cent germination.</th> </tr> <tr> <td></td> <td></td> <td style="text-align: center;">1-2-3-4-5-6-7-8-9-10-11-12-13-14-15</td> <td></td> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>		Class	{ Number of seeds }	No. germinated days.	Total per cent germination.			1-2-3-4-5-6-7-8-9-10-11-12-13-14-15																	
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REMARKS.																									

### Germination (*continued*).

1. Classes of Seeds :
  - a. Monocotyledons.
  - b. Dicotyledons.
2. Depth to plant seeds :
  - a. Varies with nature of soil.
  - b. " " climate.
  - c. " " character of season.
  - d. " " size of seed.
  - e. " " character of seed.

3. Have students partition a cracker box. These boxes are usually at least fifteen inches or more deep. Place in one division pure sand, in another pure clay, in another sandy loam soil, etc., until all kinds of soil in the neighborhood are fairly well represented. Now place ten seeds of the following plants at the depths of one, two, three, four, five, six, seven, eight, nine, ten inches respectively: alfalfa, or red clover; wheat; barley; oats; corn; pumpkin; flax; sugar beet, and such other seeds as neighborhood interests may indicate.

Have normal temperature and moisture conditions so students can be led to determine why monocotyledons can be planted at lower depths than dicotyledons, and what would seem to be the best depths for each kind of plant in each kind of soil.

4. Require a written lesson in English giving facts learned from studies in germination.

**Classification of Field Crops.** Under the head of Field Crops are considered those crops which are generally cultivated on an extensive scale under Field Conditions. We usually consider any crop which is grown on an area of ten or more acres as a field crop, even if given intensive or garden methods.

The following groups of field crops are presented for our present study: (1) cereal, (2) legume, (3) tuber root, (4) grass, (5) forage, (6) sugar producing, (7) fiber, (8) melon, (9) clover, (10) miscellaneous.

The United States is the greatest agricultural nation in the world, and on some of its five and three-quarters million farms all of the above-named crops are grown.

The total area in field and garden crops in our nation by the last census was found to be in round numbers 289,000,000 acres. The total area of improved or cultivated land in the nation at that time (1900) was 415,000,000 acres. The remaining portion of this cultivated area not in crop (126,000,000 acres) is in orchards, woodlands, meadows, and pastures.

Describe each crop group and name some region in our nation where each is grown. This lesson can be used in the geography work most advantageously.



**A Cereal Story.** All cereals belong to the grass family. Those grasses which are grown principally for their fruits or edible grains are called cereals.

The six great cereals of the world are wheat, rye, barley, corn, oats, and rice.

**Wheat.** Wheat is grown from the subpolar to the subtropical region in both Orient and Occident. Corn, the world's greatest cereal, is found in a comparatively limited area. Wheat is a native of Asia, but was brought to South America in the sixteenth century. From there it has followed civilization to all the Americas.

We can trace this grain in its origin to Asia, yet here we fail to find when or where it first furnished man with bread, his "staff of life."

While its origin is thus shrouded in obscurity, yet, we know it to be the greatest *world grain* grown, and we may properly consider it a safe barometer of the world's civilization, since it has been used as a seed plant for forty-six centuries. Egypt, the northern nation of antiquity, Greece, and Rome, all cultivated and prized it above all the fruits of the field.

One of the first findings in the excavated ruins of Pompeii, Herculaneum, and Stabiei, the three cities buried by Italy's remarkable volcano in 79 A.D., was charred loaves of bread on tables in the homes of these cities.

The nation raising the most wheat and transferring it into bread for its people has ever been a leader in progressive civilization.

The world's average annual cereal crop is supplied by the following nine nations, named in order of production: (1) United States, (2) Russia, (3) France, (4) British India, (5) Austria, (6) Italy, (7) Germany, (8) Argentina, (9) Spain.

The most important wheat consumers are here given, with the average amount per capita consumed annually:

1. French . . .	467 lb.	6. Yankee (U.S.) . . .	240 lb.
2. Canadians . . .	360 "	7. Dutch . . . .	240 "
3. Italians . . .	307 "	8. Germans . . .	180 "
4. English . . .	250 "	9. Russians . . .	93 "
5. Austrians . . .	250 "	10. Japanese . . .	22 "

Wheat is now raised in forty-three of Uncle Sam's states and territories. In 1850 the total wheat crop of our nation was but little more than what Kansas raises alone in a good year — 100,000,000 bushels. The nation's wheat exports that year amounted to 1,000,000 bushels of wheat and 2,000,000 barrels of flour.

In 1859 a United States geological survey revealed the remarkable fact that Iowa and Wisconsin could never be permanently first-rate wheat lands; and one year later Klippart wrote that Ohio marked the western limit of profitable wheat growing, stating that the Far West was mostly a *desert* incapable of producing *anything*, much less good wheat crops.

It is not too bad to spoil the official report on Iowa and Wisconsin by stating that now these two states raise 30,000,000 bushels of wheat annually; while almost in the center of Klippart's dream of desert, incapable of raising good wheat, is situated the greatest wheat state in our nation.

The average yield of the important wheat countries is as follows:

Argentine . . .	6 bu. per A.	Hungary . . .	17 bu. per A.
India . . . .	10 " " "	France . . . .	28 " " "
Russia . . . .	10 " " "	N.W. Canada	25 " " "
Romania . . .	17 " " "	U.S. . . . .	14.8 " " "
England . . .	30 " " "		

The greatest bread basket of the world is beyond the extreme limits of successful wheat growing as set by Klippart in 1860. The great Northwest of our nation and Canada are

now, and will continue to be, the greatest wheat-producing regions in all the wheat-growing world. In the central and northern portion spring-wheat varieties are raised, and in the southern portion, including Nebraska, Kansas, and Oklahoma, winter wheat seems well adapted to both soil and climate.

Before the opening of the wheat region in the Northwest, Rochester, New York, was the flour city of the Union; to-day



EXPERIMENTAL PLOTS AT THE COLORADO EXPERIMENTAL STATION

Minneapolis, in the very heart of the great Northwest, is the flour city of the world. Rochester has lost her big mills, but claims the honor of still being our nation's flour center, although she now spells it "flower." Minneapolis alone produces fifteen and a half million barrels of flour annually, besides 400,000 tons of feed. While only 30 per cent of the flour is exported, yet if the exported product of the mills of this city were laid in a line, it would reach from New York to Honolulu.

The one state of Minnesota makes over 118,000 barrels of flour daily.

The opening of the Middle West and the Northwest gave an impetus to the European export trade, and the large freight steamers now being built for Pacific commerce bid fair to make the Orient — the original home of wheat — our most important buyer of wheat and flour. The opening of the Panama Canal will be a great factor in this development. To-day the world's mills grind out 361,000,000 barrels of flour for the 510,000,000 bread eaters, but since the number of bread eaters is constantly increasing we must now seek to make each acre sown to wheat produce its maximum crop.

For this reason we need to carefully study the seed we sow, that we may secure for planting a quality that shall produce its kind with the greatest vigor. For this reason permit me to call your attention to the classes of wheat we should consider and the grades made by our grain inspectors.

I wish to take this opportunity of taking you through a large flouring mill and showing you how wheat is ground into flour and feed products.

The wheat is first cleaned, tempered, tested, and, if approved by the tester, it is ground by the gradual reduction method, which is a process of granulation rather than pulverization, as is the case of the upper and nether millstone. In this process it goes through six different sets of machines called *breaks*. This is the roller-mill process. The first break slightly crushes the wheat kernel when it goes to the scalper or sieve. Here the middlings, or grits, are separated. The residue is sent to another break, where it is crushed still more, carried to the scalper again, and more middlings sifted out. The wheat goes through six sets of breaks and a scalper each time, the rolls in each break being closer and closer together, and the middlings obtained in each instance being finer and finer.

This gives six different grades in size of particles. The finest and purest is selected for the best grade of flour, run through purifiers, where impurities are removed by suction and sifting. Dirt and dust are caught in a dust collector made of flannel tubes, when the residue is ground into flour, which is sometimes spoken of as bolting. Something like one hundred and fifty separations are made from the time the wheat is turned into the hopper until it comes out in the sack labeled with the trade-mark of the particular mill grinding it.

Complete the story by having bottled samples of the product of each break, the different grades of flour made, and the feed products produced in the flour-making process. State the number of pounds of flour made from one hundred pounds of wheat.

1. Botany of wheat:
  - a. Name and species.
  - b. Tilling or stooling.
  - c. Fertilization.
  - d. Composition of grain and parts of kernel.
2. Culture methods:
  - a. Preparation of seed bed.
  - b. Seeding time, method, amount of seed per acre.
  - c. Cultivation after seeding.
  - d. Irrigation.
  - e. Harvesting.
3. Fungous diseases. (See Professor Longyear's "Plant Life.")
4. Insect enemies. (See Professor Johnson's "Insect Studies.")
5. Uses of wheat.
6. Marketing of wheat.
  - a. Commercial grades.
  - b. Elevators; terminal; country elevators.
  - c. Wheat centers of nation; of world.
7. Statistics.
  - a. World's production.
  - b. Ten great wheat-producing nations.
  - c. Ten wheat states of our nation.
  - d. Exportation of wheat by customs districts.

- (1) Atlantic ports.
- (2) Gulf ports.
- (3) Mexican-border ports.
- (4) Pacific ports.
- (5) Northern border and lake ports.

8. Judging samples of wheat.

**A Corn Study.** Corn is believed to be a native plant of America, being found here by Columbus. Evidence points to the fact that the ancient Peruvians cultivated corn centuries ago in the Inca Empire. The Montezumas are known to have grown the plant in Mexico, while the North American Indian carried it with him in his nomadic wandering over what is now the United States.

The primitive corn of the early days seems to have had ears from four to six inches long, each individual kernel being enveloped in a husk, and the whole surrounded with an outer husk covering. From this peculiar wild corn all our cultivated species are believed to have been developed.

This crop has become the most important crop of our nation. Here in the United States is grown eighty per cent of the world's corn.

The leading corn states of our nation are here given in order of average and yield for 1906.

	ACRES	YIELD IN BUSHELS
Iowa . . . . .	9,450,000	373,275,000
Illinois . . . . .	9,610,000	347,169,000
Nebraska . . . . .	7,320,000	249,782,000
Wisconsin . . . . .	5,050,000	228,522,000
Kansas . . . . .	6,750,000	195,075,000
Indiana . . . . .	4,640,000	183,893,000
Texas . . . . .	6,920,000	155,804,000
Ohio . . . . .	3,320,000	141,645,000
Tennessee . . . . .	3,070,000	86,428,000
Indian Territory . . . . .	2,030,000	68,493,000

Let us load the corn of these ten states on wagons, forty bushels to the load. We will place the wagons and teams so that the noses of the horses come just to the tailboard of the preceding wagon. If it were possible for this line of march to cover the land and sea, an average year's crop would make a complete belt of corn wagons from Denver, our capital city, six times around the world. If placed in a straight line, the first wagon would be nearly three hundred thousand miles from the last one. If our nation's corn crop for 1907 be placed in wagons holding forty bushels each, starting from our nation's capital city as a center, it would make a line of golden grain for our President to review that would number over seventy-three million wagons, sufficient to encircle the globe sixteen times. Place this crop of corn in freight cars holding five hundred bushels each and we will have over five and three-quarters million car loads. This would be sufficient to make a corn train entirely round the world, with cars reaching from Boston to Seattle waiting to get in line.

We may now begin to comprehend why, in the list of the nation's cereals, corn stands first in average yield and value.

It is estimated that seventy-five per cent of the corn now grown in the United States is used on the farm as food for the various forms of live stock; fifteen per cent is used as glucose, starch, spirits, breakfast foods, and other forms for human consumption; ten per cent is exported.

The area where corn can be grown is circumscribed by soil and climatic conditions. The growing demand for corn can only be met by more intensive methods of corn raising. We must make an acre produce more corn than it does at present. The average for the nation in 1906 was but little more than thirty bushels per acre, and for the banner state (Illinois) thirty-six bushels.

To the question, How much corn is it possible to raise on a measured acre? permit us to say that in 1889 the *American Agriculturist*, a farm paper published in New York, offered a prize to the farmer who would raise the greatest number of bushels of corn on a measured acre. Forty-five farmers in the corn-growing states competed for this prize. The average yield of these forty-five corn fields at harvest time was one hundred and four bushels. The highest yield was two hundred and fifty-five bushels. This was grown by Mr. Z. J. Drake of Marlborough County, South Carolina. This is the highest yield ever known. It seems abnormally large to us, and we will not attempt to approach it in actual work, but it shows us the possible yield as eight hundred and thirty per cent above our present average national yield.

By studying the character and growing habits of the corn plant as it grows in the field, the nature and structure of the developed grain, and the best methods of selecting and storing seed ears, it would seem possible for us to get more vigorous and prepotent seed for planting, and, with a more perfect stand, to secure a greatly increased yield.

The importance of the corn crop cannot be overestimated. The Mississippi valley is a vast territory, the richest on the continent. It is this valley which we call the "Corn Belt," where this crop is, and perhaps always will be, the money crop for the farmer to grow.

#### OUTLINE STUDY FOR CORN

1. Botany of corn.
  - a. Name and species.
  - b. Fertilization.
  - c. Ear and number of rows of kernels.
  - d. Composition of grain and parts of kernel.
2. Cultural methods.
  - a. Preparation of seed bed.
  - b. Seeding — time, method, and of seed per acre.



- c.* Cultivation after seeding.
  - d.* Harvesting.
  - 3. Selection and testing of seed ears.
    - a.* Methods of testing germination.
  - 4. Fungous diseases.
  - 5. Insect enemies.
  - 6. Uses of corn plant.
  - 7. History of plant.
  - 8. Marketing corn.
    - a.* Commercial grades.
    - b.* Corn centers of nation.
  - 9. Statistics.
    - a.* World's production.
    - b.* Five largest corn-producing nations.
    - c.* Ten corn states of our nation.
    - d.* Colorado's corn production.
      - (1) Why not grown more generally in the irrigated lands.
    - e.* Our corn commerce is with what nations principally?
  - 10. Judging samples of corn.
- Oats and Barley.** Follow a similar plan for oats and barley.

#### OUTLINE FOR STUDY OF RICE

For rice the following plan may be followed :

- 1. Botany of rice.
  - a.* Name of species.
  - b.* Character of growth.
  - c.* Composition of grain.
- 2. Climate requirements.
- 3. Soil needs.
- 4. Cultural methods.
  - a.* Preparation of seed bed.
  - b.* Seeding.
  - c.* Application of water.
  - d.* Cultivation.
- 5. Harvesting.
  - a.* Time.
  - b.* Method.
- 6. Uses.
- 7. Statistical data.

**The Legume Group.** Beans and peas have been grown for many centuries, and have, until modern times, been gathered by hand. Hence they became known as legumes, from the Latin word *lego* meaning "I gather."

All plants which resemble peas and beans in their botanical nature, having seeds formed in pods or legumes and with similar blossom, leaf, and root habits, are called members of the legume family (Leguminosæ).

The following are the principal members of this family :

1. Cultivated for seed.
  - a.* Common field and garden pea.
  - b.* Common field and garden bean.
  - c.* Horse or Windsor bean.
  - d.* Lentils.
  - e.* Lupines.
  - f.* Peanut.
2. Cultivated for forage more than seed.
  - a.* Alfalfa.
  - b.* Clover family.
    - (1) White or Dutch.
    - (2) Alsike or Swedish.
    - (3) Common red.
    - (4) Crimson or scarlet.
    - (5) Mammoth.
    - (6) Japan or Lespedeza.
    - (7) Vetch or tares.
    - (8) Velvet beans.
3. Cultivated for both seed and forage.
  - a.* Soy bean.
  - b.* Cowpea.

The economic importance of legumes is tersely stated by Professor James of Ontario as follows :

1. They have many leaves and are good for fodder.
2. Their seeds are very rich in food materials.
3. Their roots are generally long ; therefore they are deep feeders.

4. They take up free nitrogen from the air, and are therefore easier on the soil than are cereals of root crops.

Secure bottle samples of seeds of all members of this plant group and such native examples as can be found in the district. Lead students to decide what member or members are best adapted for growing in the school district. Have definite reasons given.

#### OUTLINE

1. Botanical name and description.
2. Crown and stem growth.
3. Root growth — root tubercles.
4. Inflorescence.
5. Seed information.
6. Importance of good seed.
7. Seed-bed preparation.
8. Seeding alfalfa.
9. Cultural treatment the first season.
10. Cultural treatment the second season.
11. Cultural treatment the third and successive seasons.
12. Rules to observe in curing alfalfa.
13. Harvesting for seed — suggestions.
14. Alfalfa the basis for a crop rotation.
  - a. Five essentials as a soil improver.
  - b. Plowing up alfalfa: how to do it; when to do it.
15. Coburn's "Quartette of Alfalfa Vexations."
16. Smith's "Alfalfa *Musts* and *Don'ts*."
17. Uses and value of alfalfa to the farm and the farmer.
18. Research work — test of viability and purity of seed used in neighborhood. Determine different leaf and stem types in a given area of a field of alfalfa three or more years old. Determine average number of stems on crowns one year old; two years old; three years old; four years old; five years old. Can a crown be found in the district with three hundred or more stems? Find length of root under normal conditions of one-year-old plant, two-year-old plant, three-year-old plant. Determine what is now being done by plant breeders to improve this plant. Are honeybees desirable in alfalfa fields?

**Crop Rotation.** The preceding lessons on field crops will suggest a general plan for studying all crops of special interest to the school. It is very important to call attention to rotation of crops, and a brief outline is here given to be used after work on the special crops is completed.



THE RESULTS WHEN EDUCATION IS APPLIED TO FARMING

#### OUTLINE

1. Reasons for crop rotation.
2. Planning a rotation.
3. Choice of crops and rotation.
  - a. Things which must be considered.
    - (1) Adaptation to locality.
    - (2) Yield or producing power.
    - (3) Quality.
    - (4) Market condition for crop grown.

All plans for farm rotations should include some feed crops which can be fed upon the farm to some form of live stock, and the barnyard compost hauled back to the fields to renew the stock of plant food.

- b. All rotations should have at least one legume crop. Why?
- c. All rotations should have at least one cash or money crop.

4. Length of rotation.

*a.* Differs with size of farm.

*b.* Differs with kind of farming practiced.

5. Plan a practical rotation for the home farm and bring into class for general discussion.

In all this work let the idea prevail that a rotation must keep up soil fertility and at the same time equalize farm work, seeking to distribute to best advantage throughout the year.

## INSECTS AND BIRDS

BY PROFESSOR S. ARTHUR JOHNSON, COLORADO STATE  
AGRICULTURAL COLLEGE

**Introductory.** The way to begin nature study and agriculture is to begin. The material to be used is that which is at hand. What this will be in a given locality no one can foretell, and probably it will not be the same two years in succession.

The view to be kept constantly in mind is this: that which ultimately will be of greatest value to those whose business it is to come in close contact with the soil. Nature study has a very close relation to all agricultural pursuits, for it is the laws of life that we wish to discover, and he who enters most keenly and sympathetically into these pursuits is best equipped to so control them that he may obtain the best results.

**Equipment.** 1. *Hand lens.* The first article of importance will be a good hand lens of rather high power. The Bausch and Lomb lens, No. 6, costs seventy-five cents, and will serve for most purposes.

2. *Insect Net.* The next in importance is an insect net. This can be made or purchased from dealers. To make the net, take a stout wire about four feet long and bend it into a circle about a foot in diameter, leaving four inches or more of each end free to bend down by the sides of the handle. Cut a groove across one end of the handle and a few inches down each side. Lay the wire ring in the groove across the top and fasten it down with small staples. Then bend the ends of the wire down and fasten firmly in the grooves at

the sides of the handle. The net is made from some sort of light material. Bobbinet or linen scrim is the best, but cheese cloth or other material will serve very well. The net should be nearly twice as deep as is the diameter of the ring, and made round at the bottom. Nets may be purchased from dealers at from one to three dollars each.

3. *Collecting Bottle.* The collecting bottle is made by taking any wide-mouthed bottle, putting a piece of cyanide of potassium in the bottom, covering this with sawdust, and pouring soft plaster of Paris over the top. It is well to fit a piece of blotting paper over the plaster of Paris, and keep some pieces in the bottle to take up excess of moisture. The cyanide of potassium is one of the most violent poisons known, and the bottle must be labeled POISON, and care taken that the fumes are not breathed.

4. *Insect Boxes.* Cigar boxes serve very well for retaining collections temporarily, but are not sufficiently tight to make permanent receptacles.

5. *Notebooks.* Records of some kind should be made of these lessons, both for the purpose of impressing them and for the educational value of the work. Sketches should be made of the different stages in the insects' lives, and accounts written of the habits, characteristics, and other points discovered. These might have been indicated in the outlines, but it is better to trust to the teacher's judgment to select the times and occasions. Ordinary composition books will answer every purpose.

#### STUDYING INSECTS

**The Cabbage Butterfly.** This common garden pest will furnish a series of lessons which will be typical of a whole group of insects, the moths and butterflies. Each kind of

insect has its own life history, of course, but each stage in the life of the cabbage butterfly will be duplicated in a more or less general way by any one of this great order of insects.

The larvæ can usually be found in abundance in any cabbage patch. They are not true worms, like the earthworm, but caterpillars. They are commonly called worms, but the children should be taught the distinction. Worms never develop into more highly organized animals. They are almost the exact shade of green of the cabbage leaf, and when full-grown are a little over an inch in length. They will be found of all sizes, and more abundant, on the lower sides of the leaves than on the upper. A large number of these should be collected and brought to the schoolroom, where they may be kept in "breeding cages," which are nothing more or less than jelly glasses, or other suitable receptacles, preferably of glass.

In caring for the caterpillars do not put more than three or four in each cage, and supply them with fresh food each day. Place a thin piece of muslin over the top of the glass, and fasten it on with a rubber band. On Friday, when the cages must be left till Monday, they should be covered with tin covers to keep the leaves fresh.

But to return, the search over the cabbage plants should not be confined to securing caterpillars alone. Careful scrutiny will almost surely reveal the eggs of the butterflies. These are tiny yellow objects firmly attached by one end to the surface of the leaf, more often beneath than above. These little objects are perhaps three times as long as broad, and dome-shaped, being pointed at the free end. With a good hand lens tiny ridges may be seen running from the base to the top, and between these, are little dashes running crosswise.

The eggs will hatch within a few days and the baby caterpillars be an object of wonder. Observe the large size of the



caterpillar compared with the egg, the relatively large size of the head, the color, and tiny hairs which cover the body.

With the large larvæ taken on the plants make out the general shape and ground color. Are there any markings? Describe them. Note the hairs which cover the body. Into how many segments, or rings, is the body divided? How does the head compare with the size of the rest of the body? Has it eyes? Where are they situated? How does the larva eat? Which way do the jaws move? How does it walk? Do the feet move in the same way as those of the horse or dog? Count the legs. How many kinds? What differences in shape? The first six are called true legs, the others prop legs. To what part of the body are the true legs attached? Do they have any relation to the body rings?

To which segments (counting from the head) are the prop legs attached? (Four pairs on successive segments, and the pair on the last segment, make up the ten.) The front legs are called true legs because they are replaced later by the legs of the butterfly; the prop legs disappear. Examine the place where the caterpillar rests on the leaf. See if you can find the bed of fine silken threads under it. With a hand lens examine the sides of the larger worms. On each segment is a little dark ring. This marks the place where the air holes enter the body. The insect breathes through these little holes and the air is carried by tiny tubes to all parts of the body.

Many of the larger caterpillars will go into pupation soon, perhaps within a day or two. Usually they come to the top of the breeding cage and spin a silk bed on which to rest. The hind prop legs are firmly secured in a tuft of silk, and a beautiful silk loop is spun, which passes over the back. A caterpillar in this condition should be passed about the class so that all may observe what has been done.

Within the next twenty-four hours the last skin will be shed and the pupa revealed. The old cast skin will be found attached to the posterior end of the pupa. It is very frail and much crumpled, but the head shield retains its shape very well. The pupa of the insect, of course, is not made suddenly out of the caterpillar, but the changes have been going on inside for some time, though hidden by the outer skin. The skeleton of an insect is really on the outside and cannot grow as rapidly as the insect, so it is necessary, from time to time, to throw off the old skeleton, in order to get a new one. These changes are called molts, and usually occur several times during the insect's life.

Note the form of the pupa; also the relation of its color to its surroundings. By careful examination the wings of the future butterfly, and other parts of the body, may be seen beneath the delicate cuticle. See the way the pupa is attached and hung by the silk.

The adult butterfly will probably emerge in the warm schoolroom within two weeks unless the worms were collected so late that the winter brood has been taken, in which case they will probably not appear until the following spring.

The butterflies are white, marked with black. The males have one round black spot on the front wing, the females, two. The adults may be kept in confinement in the schoolroom for observation. Often they may be induced to sip a little sweetened water from the fingers or a drop in a convenient place. Call attention to the parts of the insect's body: the head; the thorax, or middle part; and the abdomen. Insects as a class have three parts to the body and get their name from this character, for *insect* means "cut into." They are characterized, too, by having six legs, and are called technically *Hexapoda*, which means six feet. How many wings? To what part of the body are they attached? How

many legs? Where are they found? What differences between the front and hind wings? Notice the knobbed feelers attached to the head. How does the butterfly eat? What does it do with its long sucking tube when not eating?

If desired, the adults may be killed in the cyanide bottle for further study, but it will be better to collect specimens out of doors for this purpose. The scholars become attached to their pets, and it is better to give the butterflies their liberty.

**Other Larvæ.** If requested, the pupils will bring in other larvæ that they find on plants or wandering about at this season of the year. These may be kept in cages. If they are found on plants, they should be fed with leaves of the kind of plant from which they were taken. Most of those found wandering about will be full fed; that is, they will eat no more, but are seeking a place to pupate. The larvæ of moths will, perhaps, spin cocoons or bury themselves in the moist sand which should be provided in the bottom of the cage.

Hairy caterpillars called woolly bears are quite common. They are of two kinds, — those with a thick coat of hair, brown in the middle part of the body and black at both ends, and others with mixed hair over the entire body. The former transforms into the *bella* moth, but will not spin a cocoon until the next spring. They cannot be easily kept over in the warm schoolroom. The latter will spin cocoons the coming fall, weaving the hair of the body in with the silk. Watch this process. Certain large caterpillars with horns or spikes on the posterior end of the body are the larvæ of the humming-bird moths and change to the pupa form in the ground. Fill the cage half full of moist (not wet) sand, and after these larvæ have disappeared in this a few days, carefully dig them out and show the chrysalids to

the pupils. Larvæ of the codling moth may be taken under bands on apple trees; the boll worms in ears of corn; the hop merchants on hops; the cotton worm on cotton; the fall army worm on grains and grasses.

The group of insects which have practically the stages described in this brief outline belong to the order called *Lepidoptera*. All moths and butterflies come under this head. The next insect that we study will belong to another order.

**The Squash Bug.** Another common pest which is often available for insect study is the squash bug. Almost any garden or field where pumpkins or squashes are growing, will produce specimens for study. The only disagreeable feature in this work is the offensive odor which the insects emit. Numbers of them should be collected and killed in the cyanide bottle. They may be exposed in the open air for half a day before the study is to begin.

These insects are true bugs, rusty black in color and about half an inch in length when full-grown. The adults are ovoid in form with flat backs. Find the three regions of the body as in the butterfly. What is the shape of the head? Note the long feelers attached. How many joints in them? Find the compound eyes. Examine the mouth parts. Note the long sucking tube which extends back between the fore legs when not in use. The children will have to be informed as to the way in which these insects get their living. Within the tube under the head are four long bristles which are thrust into the tissues of the plant, causing the sap to flow. With the sucking tube, or beak, this sap is drawn up by the insect. Compare with the biting mouth parts of the cabbage caterpillar. It is very important to draw out this information, for on it rests the use of two great classes of remedies for combating insect pests. For insects which chew their

food, like the cabbage caterpillar, we may often put some poison on the leaves which they will eat. For the insects which suck their food we cannot use such a poison because they will put their beaks through it and suck the juice unharmed. Therefore we must use something which will kill the insects when put on their bodies, called a contact poison.

Examine the wings. How many pairs? Note how they are laid over each other on the back. Remove the upper wing for examination. Is it the same texture throughout? From which part of the body do the wings and legs come? Compare with the butterfly. Note that the legs and body generally are made up of joints or rings. The young of these insects hatch from eggs laid by the parents and get their living in exactly the same way. They are gray in color and have the abdomen more rounded than the adults and are devoid of wings. During their lives they shed the outer skin a number of times.

If squash bugs are not to be had, there are a great many others which may be substituted. Among them are the box-elder bug, stink bugs, etc.

The order to which the bugs belong is called *Hemiptera* because of this double structure of the wing. It includes all those insects which have mouth parts built upon the plan of the squash bug. Besides those already mentioned, there are chinch bugs, green-plant bugs, cicadas or harvest flies, plant lice, and water striders. The so-called "green bug" on wheat is a plant louse. Plant lice are to be found on all plants, and many of them cause great damage. Among such are the corn-rust louse, apple louse, hop louse, and lice of different kinds on house plants. Leaf hoppers of many kinds are injurious to grapes, cotton, and many other plants.

**Other Work.** Many kinds of bugs may be collected and shown to the pupils until they have the order firmly fixed in mind.

**Hornets.** The hornets and wasps belong to an order of insects which, in many respects, are the most wonderful in the world, and to which we owe more of the beauty of the earth in which we live than to any other group. Here come the bees, tame and wild, the ants, the hornets, the wasps, the sawflies, and a very large proportion of the parasites on other insects.

The fact that hornets sting will deter some from the study, but if the directions here given are followed, the danger will be greatly lessened, if not altogether obviated.

The first step will be to interview the boys and find out where a hornet's nest is located. If one can be found which hangs from the limb of a tree within reach of the ground, the labor and risk will be greatly lessened.

**Capture of the Nest.** After dark, preferably on a cool night, the party should start out armed with a little cotton, a tight paper bag large enough to inclose the nest, and a lantern. The party halts some distance from the nest so as not to disturb the watchful colony. The lantern is held in such a way that sufficient light is thrown on the nest to work by. One of the party slips cautiously forward and quickly slips a wad of cotton about the size of one's thumb into the hole at the bottom of the nest. The paper bag is then drawn quickly over the nest and crumpled tightly about the limb above. Cut the limb away and the entire colony is captured.

The insects may be killed in a number of ways. A little opening may be made in one corner of the bag and this thrust in the mouth of the cyanide bottle. The hornets will rush out at this opening and be captured. Gasoline, carbon bisulphide, or chloroform may be poured into the bag on the nest and the inmates killed in this way. Some one may be stung during this operation, but that is part of the game.

**Study of the Hornets.** When the hornets are killed they should be carefully separated into three groups according to

the forms. In the early fall three forms, or, as they are sometimes improperly called, "sexes," will be found. The smaller, and usually the most numerous kind, are the workers. The largest and most robust ones are the young queens, while the ones intermediate in size, which are slender and have long antennæ, are the males. The males may be distinguished from those of the other groups because they have one more segment in the abdomen and one more in the antennæ. One good nest will furnish plenty of specimens for the whole class to study. Provide each pupil with one or more.

See if this insect has the three parts to the body that the others studied had. Note the colors of the body. Examine the head. Where are the eyes? Note the large ones at the sides of the head. Examine the top of the head with a lens to discover three small simple eyes, — ocelli. Examine the mouth parts. Are they made for biting or sucking? How many wings? What is their texture? See the heavy lines (veins) in them. Note that the fore wings fold lengthwise when the insect is at rest. How is the abdomen joined to the thorax? What is its shape? Compare the different parts of this insect with the others studied.

The order to which the hornet belongs is called *Hymenoptera*, which means "clear wings." The groups which come in this order have already been named.

**Study of the Nest.** Note the outer form of the nest, — how the layers are put on, and the texture of the "paper" of which they are composed. The hornets gather substances with which to make the paper by scraping fibers from weatherbeaten wood, dead trees, boards of houses, fences, etc., with their jaws, or mandibles, and carry them to the nest in round balls the size of a small pea. Arriving at the nest, the pulp is worked over with the mandibles and mixed with saliva which makes it stick. Careful examination of the surface of the nest will

show where each one of these pellets has been put on in a tiny strip. With a pair of scissors cut through the paper envelope around the middle of the nest, beginning at the hole at the bottom. Remove the paper from half of the nest. Note the layers of paper and the way in which they are put together. Note the layers of combs. What is the shape of the cells? Do they extend in the same direction as those of the honeybee? How are the combs held together? Examine the cells to see what they contain. Doubtless there will be plenty of larvæ. These may be drawn out with a pair of forceps for examination. Note the color, shape, head. Compare with the larvæ of the cabbage butterfly. Examine cells for eggs. Study them. Many cells doubtless have white caps over them. These caps were spun by the larvæ, like the cocoons of moths. Remove some of the caps and draw out the inhabitants. These are the pupæ of future adults. Compare with adults. Now note that this insect has the same stages in life as the cabbage butterfly, — egg, larva, pupa, adult. These changes that come in an insect's life are called metamorphosis. An insect which has all four is said to have a complete metamorphosis. The metamorphosis of the squash bug is said to be incomplete because it has no inactive pupa state when feed is not taken.

**History of the Nest.** A hornet's nest is used but one year. The young queens found in the nest will go out when cold weather comes and find places where they may hide during the winter. The others, both drones and workers, die in the fall. In the spring each queen that has lived through will start a new nest. At first she does all of the work herself and raises a brood of workers. After that she does nothing but attend to the work of egg laying, the workers making the cells and nest and feeding the larvæ. The drones and young queens are only produced in the fall of



the year, so that the queens may live over winter to produce new nests again.

**Other Work.** If a hornet's nest is not available, other insects in this order may be selected. The common wasps, with their nests, may usually be easily secured. Often the adults may be found on the schoolroom windows and captured in the cyanide bottle. Honeybees may be secured in sufficient numbers for study from the homes of scholars where bees are kept. A piece of comb, especially that which contains brood larvæ, will illustrate the points which are to be brought out in the life history. In using the honeybee it will be well to read up on the subject or visit an apiary and ask questions. Follow the outlines given here for the hornet as a general guide. The following points may be added. Note that the bee is clothed with dense hairs. On the hind legs it may be noticed that one joint has a fringe of curved hairs. This is a pollen basket. The pollen gathered in this is carried to the hive and used for the food of young bees. Gather all the information possible from scholars living in homes where bees are kept. The currant worms have a very different life history from that of the bees and wasps, but the adults look very much like them, and they belong to the same order.

**Ground Beetles.** Large beetles may commonly be found under boards and stones, and killed in the cyanide bottle. The larger forms will be most valuable for study. Sometimes there is danger of confusing these with the darkling beetles. The ground beetles have larger mouth parts and are much more active than the other kind.

Having collected a good number of these, go over the anatomy that has been learned from the other insects. Note that there are two pairs of wings. The outer pair are shell-like and meet in a line down the middle of the back. This

characteristic is the one that separates this order from the others. All beetles are called *Coleoptera*, which means "sheath wing." Of what use are the hard wing covers to the insect? The Coleoptera belong to a very large order, one of the most important economically. Here are found the potato beetles, the ladybirds, the cottonwood-leaf beetles, May beetles, and many others. Lift the upper wings and find the thin membranous ones underneath. See how they are folded. Note how different in texture they are from the strong upper ones. (It is quite possible that the teacher will find forms in which the lower wings are not present.) In flying, the insect uses only the under pair, the upper pair being held out stiffly at the sides, serving, perhaps, as parachutes.

Now examine the mouth parts. If the specimens are fresh, these may be separated out with a pin. In front of the mouth is the upper lip, or labrum, which runs as a narrow strip across the lower edge of the face. Below this are the quite prominent jaws, or mandibles. Notice their shape. Which way do they move? To what part of the head are they attached? Just below the mandibles is to be found a second pair, the maxillæ, moving the same way as the mandibles. Note their shape and the jointed appendages attached to them. Still under these is the tiny lower lip, or labium. Does it have jointed appendages also?

The teacher should go over these points in private in order to be able to help the pupils in their study.

Examine the beetles carefully and note that the legs are made up of joints resembling those of a stovepipe. Note that the body itself is made up of rings. What about the antennæ? Are there any animals other than insects which have the bodies made up of joints? Compare with spiders. Crabs, crayfish, and lobsters are formed in the same way. How about centipedes? Because all of these animals have this peculiar

characteristic, they are put into one great group and are called *Arthropoda*, which means "jointed foot." The ground beetles live upon insects and other small animals, and are therefore very beneficial to mankind.

**Life History of Beetles.** The life history of beetles is best studied by following some leaf-eating species, such as the potato beetle. The eggs of this beetle are laid in clusters on the food plants. The larvæ are reddish brown, stout grubs, which eat the leaves. They molt several times and pupate in the ground. All beetles have complete metamorphosis. The larvæ of ground beetles are long white grubs, which are capable of moving about quite rapidly and live chiefly in the ground.

**Other Work.** Collect numbers of beetles of as many varieties as possible and compare with regard to form, color, etc.

**Studies of Common Birds.** Bird study is undoubtedly the most popular branch of animal nature work. The reasons for this are many. Birds are more numerous than any other available group of vertebrates. They are also more in evidence than the others, for with their ability to fly they are less fearful of exposing themselves to view; in fact, that phase of their lives must make them conspicuous at times, whether they will or no. Add to these the features of song, nesting habits, companionableness, and peculiar habits, such as flocking and migration, and there is sufficient to attract the attention of all.

**Outline for Bird Observation in the Field.**<sup>1</sup> A notebook should be made ready by preparing each page with the numbered words in capitals in the following outline. The part included in parentheses should be committed to memory so as to aid in taking notes. As the bird is observed, the note should be made opposite the appropriate place on the page.

<sup>1</sup> Anna Botsford Comstock, in "Home Nature Study" Course.

NAME \_\_\_\_\_ DATE \_\_\_\_\_

- I. SIZE. (Compared with the English sparrow, robin, crow.)
- II. COLORS. (Bright, dull.)
- III. MARKINGS :
  1. TOP OF HEAD.
  2. BACK.
  3. BREAST.
  4. WINGS.
  5. TAIL.
- IV. SHAPE :
  1. BODY. (Long and slender, short and stocky.)
  2. BILL. (Short and stout, long and slender, long and heavy, hooked, curved.)
  3. TAIL. (Forked, notched, square, fan-shaped.)
- V. MOVEMENTS. (Hop, walk, creep up trees, bob head and wag tail, twitch tail from side to side.)
- VI. FLIGHT :
  1. FAST. (Direct, abrupt and zigzag, smooth and circling.)
  2. SLOW. (Flapping, sailing or soaring, flapping and sailing alternately.)
- VII. LOCALITIES FREQUENTED. (Gardens, orchards, roadsides, fences, meadows, thickets, woods, rivers, lakes, and marshes.)
- VIII. FOOD AND MANNER OF OBTAINING IT.
- IX. SONG :
  1. MANNER AND TIME OF SINGING. (From perch, in the air.)
  2. CHARACTER OF SONG. (Plaintive, happy, long, short.)
  3. CALL NOTES. (Signal, warning, anger, fear, pain, protest.)

**Winter Care of Birds.** The winter months offer, in many respects, admirable opportunities for the study of birds, if for no other reason than the paucity of other life at this season.

In severe spells of weather, when food is largely covered with snow, the strenuousness of the lives of these feathered beings may be greatly lessened by thoughtful care in feeding. Birds may be attracted to the school grounds and kept

there for study until warm weather calls them away to their summer homes.

The food of a bird must be suited to its needs, of course, and a variety of kinds will attract a variety of guests. Crumbs from the dinner pail scattered on the snow will draw many of the smaller varieties, such as sparrows, juncos, chickadees, and others. Most of the woodpeckers will take meat from the limbs of trees and similar places. Tie lumps of suet securely to the under sides of limbs of trees. The limbs selected should be those which extend upward at an angle of at least forty-five degrees, otherwise the meat will be too difficult for the birds to reach. Nuthatches sometimes carry away lumps of this to hide. In order to prevent such wholesale methods, some people wrap the meat with wire in such a way that only small bits can be pecked off. Large bones which contain marrow can be split and fastened to trees or posts in a similar manner. A great many sparrows and finches are fond of seeds. Their wants may be supplied by seeds of hemp, sunflower, box elder, and others. The teacher is wise who stores up the seeds of plants and trees in the season when they may be had in quantities.

A good plan is to provide a feeding box on the top of a post or the limb of a tree. If this box can be protected by a roof, it will be more serviceable to both man and bird. We should always remember that the feeding of the birds should be as regular as possible, and when once begun, should be continued as long as it is necessary for the good of our charges.

There are many things to learn about the bird visitors, and one of the first is the names of the common kinds. To know every kind of bird at sight is expert work, and is only acquired after long study and experience, but any one may know those that are most common. The chief groups of birds are given in another part of this outline, so that the

student may learn something of the way in which the naturalist arranges them. Common names often cover a multitude of sins. The little brown and slate-colored birds which we know as snowbirds are juncos. There are so many kinds of them so nearly alike that few people know the differences. Junco is the only name that most of us need to know. The horned larks that stay with us in winter are a different kind from those that nest here. The former come from the far North, while those that are here in summer seek a warmer country in which to spend the winter. Among other birds that we are apt to see are the jays, grouse, flicker, crow, blackbird, waxwing, and robin.

Note the actions of the birds as much as possible, manner of flight, call notes, manner of taking food, method of using the feet in walking, hopping, perching, etc. Note the individual characteristics of the birds, temperament, sociability, flocking habits. Other items will suggest themselves as the study proceeds.

**Grasshoppers.** During the spring months insect life appears on the stage in ever-increasing abundance until it reaches its gala day in midsummer. Among the first insects to be found in the spring are some of the beetles and grasshoppers. Most kinds of grasshoppers die in the fall of the year after the egg-laying season is over, but some live until spring in the half-or full-grown state. Individuals may be found as soon as the warm days appear, and should be killed in the cyanide bottle for study.

The grasshopper is one of the classical insects for study of anatomy in biology, because its generalized form gives a fair idea of the whole class of insects and because its large size permits of easy manipulation.

After the grasshoppers have been in the bottle for several hours they will be ready for study. Have the pupils place

them on the table with the back uppermost and the head from them. Note the three parts of the body. Examine the head as with the beetle. Note the long antennæ and compound eyes. The mouth parts may be worked out and glued to pieces of paper on which the names may be written, or the older pupils may make sketches of them.

The thorax and wings should be thoroughly examined. What is their shape? texture? structure? Note how the lower pair are folded when the insect is at rest. The adult grasshoppers differ from the young in that the wings of the former are fully developed. In the young they are represented by wing pads which are not sufficiently developed for use.

The life history of grasshoppers will prove interesting material. The eggs are laid, most commonly in the fall, in patches of dry ground, such as paths, ditch banks, etc. The mother grasshopper makes a hole in the ground with her abdomen, and then lines it with a fluid which makes it practically water-tight. In this neat little package twenty or thirty eggs may be laid. The top is then sealed over and the whole covered with loose earth. By digging the loose earth in the places indicated, these "pods" of eggs, as they are called, may often be disclosed. If the eggs are laid in the fall, they will hatch in the following spring. The young resemble the adults, but differ from them in being wingless and having very large heads in proportion to the rest of the body. There are about four molts and the metamorphosis is incomplete.

The grasshopper belongs to a different order of insects from any that we have studied before. Because of the straight upper wings they are called *Orthoptera*. In this order are also found katydids, crickets, and some others.

**Other Work.** Watch from March on for the coming of new birds in their migrations to the north.

The coming of the frogs from their winter quarters may be looked for in March.

**Cutworms.** The seedlings and other plants in the garden are often injured during this and the next month by cutworms. These are grayish or brownish caterpillars which hide by day and eat by night. The evidence of their presence is often the cut-off plants of the garden. The culprits may usually be found in the loose earth within a few inches of the place where the injury is done. They bury themselves to the depth of an inch or two after dragging in some of the vegetation that they have cut off as food. Look under pieces of board, clods of earth, and other protected places in the field for these caterpillars. When disturbed they have the habit of curling up and playing "possum," whereby they may usually be distinguished from others.

These caterpillars may be kept in a breeding cage in which a little earth is put. They may be fed on green vegetation of almost any kind, but prefer clover or lettuce leaves. They will pupate in the ground about the last of May or the first of June, and the moths will appear about two weeks later. The cutworms are among the most injurious insects that we have. The damage is done chiefly in the spring, when they cut off young plants of many kinds.

**Other Work.** The bluebirds, robins, and meadow larks will be abundant during April and should be studied. This and the next month will be the best for the study of bird songs. For general bird study, follow the outline given for bird study during the winter months.

**Bees and Flowers.** Teachers are all familiar with the fact that many flowers depend upon insects for fertilization. To make this study valuable it should follow a study of flowers which will acquaint the scholar with the parts and their uses. They should know the meaning of fertilization and its



use to the plant. Having proceeded thus far, it will be well to call attention to the different kinds of pollen. Some pollen is dry and dusty, such as that of the flowers of the maple, and may be blown from tree to tree. The other kind, like that found in peas and most conspicuous flowers, is sticky and must be carried by some other means. Collect some bees over flowers and note the pollen which clings to the hairs over the body and may sometimes be found in lumps on the legs and abdomen. Watch the bees collect it. What do they do with it? (Store it in the nests or feed it to the young.) What may happen when a bee with pollen from one flower clinging to it goes to another? Study the flowers for the adaptations that they have for securing cross fertilization. This is one of the most interesting subjects that we have, and the literature is abundant. Space here prevents going into detail. Other insects than bees are engaged in the work of cross fertilization. The butterflies, many flies, and some beetles help to accomplish this. Many flowers depend almost entirely on insects for this office.

**Other Work.** Continue the study of the different groups of insects and their life histories.

The birds will be nesting in May, many of them about the houses of the children. Watch this process. See how much time is consumed in building a nest. How is it made? Of what material? Note the difference between the inside and outside of the nest, its shape, location, when the eggs are laid, how many, how long before hatching, how the young are fed, upon what. In short, gain all the information possible along these lines.

# LIVE STOCK

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**Introduction.** In our present educational system in the rural sections the one great difficulty lies in getting boys and girls from the farm to see the points of contact between their studies and their future life work. There is altogether too large a percentage of the young people from the country districts who leave school between the fifth and eighth grades simply because they cannot see what value their study is to be to them in their future life work on the farm. This outline is substituted with the idea that it will tend to interest these young people in advanced education along live-stock lines. The subjects for the lessons are briefly outlined and may be elaborated to almost any extent in the judgment of the teacher.

**What the Human Family gets from Live Stock.** I. From cattle: milk, butter, cheese, beef, veal, tallow, and hides for leather.

2. From sheep: wool for clothing, mutton, and soft leather for gloves, etc.

3. From swine: pork, such as ham and bacon, lard and sausage.

4. From poultry: eggs, and meat products such as chicken, turkey, goose, and duck.

A brief outline of the characteristics and qualities of the various meat products should be given, calling attention to such products as eggs, milk, butter, and lard in the daily menu of the human race.

For the older pupils, a study of the statistics of the classes, types, and breeds of the various kinds, with their estimated value taken from the census reports for state and county, will be interesting and valuable.

**Importance of Horses in Our Civilization.** Dwell upon our dependence upon this animal for field labor—in producing crops, fruits, and vegetables, and their transportation to market, etc. An outline of the early history of the horse and its association with mankind from the origin of history to the present time will be valuable and helpful to the student not only in many phases of his work in history but in his life work as well.

**Types and Breeds of Draft Horses.** Particular reference should be given to the prevailing climatic and other conditions constituting the environment of the various types and breeds in their native countries. Trace the effect of environment, both natural and artificial, on the characteristics of the various breeds. The characteristics and utility of the different breeds should be taught.

**Breeds of Light Horses.** These may be made very interesting lessons by tracing the early history of the Arabian horse through the Thoroughbred, and down through the American trotter and the American saddle horse to our present types as we find them in the United States. Reference may also be made to the various breeds of light horses and the extent to which the Arabian blood has improved and developed them.

**Types and Breeds of Beef Cattle.** These lessons may follow the same general outline as is given for beef cattle, noting how the demand of any particular interest of a people has changed and modified the type and utility of the animals they have developed.

**Types of Sheep.** Wild sheep are found in Asia and North America, the latter being called Rocky Mountain sheep.

From the wild sheep of Asia are descended our breeds of domesticated sheep. Early biblical history speaks of Cain as the first shepherd, so undoubtedly flocks of sheep were herded as a source of profit centuries before history was written. Woolen goods were manufactured in Asia two thousand years before the Christian era, and the fine wools of Italy were greatly improved while Rome was still a republic. Prior to the Christian era fine-wooled sheep existed in Spain, and these were improved by the introduction of fine-wooled sheep from Italy.

The breeds of sheep of to-day are classified as follows :

1. Fine-wooled sheep.
2. Mutton sheep.
  - a. Medium-wooled.
  - b. Long- or coarse-wooled.

**Fine-Wooled Sheep.** These are descendants of the Spanish sheep, and have been improved greatly in Spain, France, Germany, and North America. They are bred chiefly for the value of their fleece, and are not well adapted for meat production, being light in weight and hard to fatten. You have learned that the finer and longer the fiber of wool, the greater its value. But extreme fineness and great length are hard to get in combination, so that the fleeces of fine-wooled sheep are short, compared with the fleeces of coarse-wooled sheep. The fine fleeces also contain more yolk or oil than coarse fleeces, and on that account there is a less percentage of scoured wool to unscoured or raw wool.

The Spaniards introduced sheep into North America soon after Columbus landed here. From these are descended the flocks of so-called "Mexican" sheep in Mexico, New Mexico, and Arizona.

There are three types of fine-wooled sheep, — the wrinkly, Delaine, and smooth-bodied types.

The wrinkly type are the smallest Merinos, with very fine, greasy fleeces, and wrinkles or folds of skin over the entire body. They are represented by the American Merino breed.

The Delaine type has wrinkles only on the neck and flank, and is larger-bodied, with longer, drier wool. The wool is also somewhat coarser. All of the breeds of this type are called Delaine Merinos.

The smooth-bodied type is free from wrinkles or has them only on the neck. They are the largest-bodied Merinos, and the wool is still longer, coarser, and drier than in the Delaine Merinos. There is only one breed of this type, namely the Rambouillet (pronounced Ram'buch lay).

The Merinos are all very hardy because of their dense fleeces, and consequently are used more in the range industry than any other type.

**Mutton Sheep.** It is not known just what was the origin of the sheep native to Great Britain. Undoubtedly they are from the continent of Europe. But regardless of the source of their stock, the British have given to the world nearly all of the improved breeds of mutton sheep, both medium-wooled and coarse-wooled.

**Medium-Wooled Sheep.** Some of the medium-wooled sheep of England were raised in the hills, or "downs," as the hills are called, and so have taken the name of "down" breeds. These all have black or brown faces, and so are also sometimes called "black faces." They are the Southdown, Suffolk Down, Hampshire Down, and Oxford Down.

The other medium-wooled breeds are the Cheviot (a Scotch breed), the Dorset Horn, and the Tunis (an African breed). The Cheviot and the Dorset Horn both have white faces, and the Tunis a golden-brown face.

All of these sheep have broader, deeper bodies than the fine-wooled sheep, have straighter backs and rumps, and are

much more easily fattened. Most of them are heavier breeds than the Merinos. They are, therefore, much better than Merinos for the production of mutton, but their fleeces are not nearly so dense, and consequently they are not so well adapted for range use the year round. They are used extensively, however, for producing lambs, which are sold the same summer they are born. Colorado lamb-feeding districts fatten many lambs of this type.

**Long- or Coarse-Wooled Sheep.** The best known breeds of this type are the Lincoln, Cotswold, and Leicester, all English breeds. The Black Faced Highland is a Scotch breed, and is small in body, while the other three are the largest-bodied sheep in common use in America. All the long-wooled sheep are distinguished by the fact that the wool hangs in long curls or spirals, and parts on the back. The wool on fine-wooled and medium-wooled sheep stands straight out from the body like bristles in a brush.

The long-wooled sheep clip good heavy fleeces, and so are valuable for both mutton and wool; they are used for running on the range the year round, as well as for producing mutton lambs. The long-wooled fleeces contain less oil or grease than any other class of wool.

**The Breeds and Types of Swine.** Follow the same general outline as noted in the beef-cattle lessons, dwelling particularly on the fact that the American people have developed more and better types and breeds of this class of stock than of any other, which is due very largely to the fact that swine reach maturity much earlier in life, and it requires less time and patience to effect improvement than in any of the other classes of live stock.

**Breeds and Types of Poultry.** Give an idea of the amount and extent of the poultry interests in America, and of the comparative value of the poultry products produced in the

United States as compared with the other products, such as grains, beef, hay, etc. The breeds and types may be studied and the interest stimulated in this very important branch of our live-stock industry, which may be made particularly interesting to boys and girls from the fact that all of them may very easily secure some of this stock to study and experiment with.

**Development and Importance of the Dairy Industry in America.**

The value of cleanliness, the transmission of disease through milk products, and the relation between the diseases of animals and human beings, as in tuberculosis, typhoid fever, etc., explain how readily these diseases may be transmitted through meat and milk.

Let the teacher enlarge on the following :

Milk as a human food : its source of supply ; its importance and various methods of handling, bringing out the importance of cleanliness and freedom from taint and odors.

Butter : its value, method of manufacturing, etc.

Cheese : its value as a food ; its importance ; varieties and methods of manufacture.

In presenting the foregoing the teacher should not attempt to go into details too deeply. Some general information is what is desired, merely to stimulate the interest of the student in the everyday things with which he is constantly coming in contact, with the object in view of creating in him a thirst for more information which he should get later on in his college course.

## DOMESTIC SCIENCE

BY PROFESSOR MARY F. RAUSCH, COLORADO STATE  
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**Introduction.** Sometimes domestic science in the rural schools has been opposed on the ground that an expensive building and equipment are necessary, but much good may be done without them. In many schools in different parts of the country the total cost of equipment has not exceeded twenty dollars, and in some instances it has not exceeded five dollars. In some cases a room in the basement has been secured, in others the end of a hall, and it is a common thing to find one end of a class room fitted up for the work.

Often the boys are able to build a small cupboard for food and utensils, or even to put some shelves in a dry-goods box. The girls hem muslin for curtains. A small oil stove may be procured for three dollars, and some housekeeper is usually willing to donate one iron, so that the children may have a lesson in washing and ironing dish towels and napkins. Different farmers furnish fuel at stated times.

If the teacher is enthusiastic, she will have no trouble in getting the parents to donate a saucepan, cups, spoons, a bowl, a teakettle, a frying pan, knives and forks and plates, a dish pan, a draining pan, towels, and soap. A small table is necessary, and in emergency a dry-goods box covered with white oil cloth will do very well. Parents are glad to send milk, eggs, butter, flour, and whatever else is necessary. A very small quantity of food stuffs is needed, as it is the principle which is shown at school; the pupils practice at home.



Sometimes the children give an entertainment and use the proceeds to furnish the equipment.

**Industrial Training not in Homes To-day.** The homes of to-day do not furnish industrial training. Formerly candles, carpets, clothing, and many other necessities which now are purchased at the stores were made in the homes. Industrial home training of a generation ago trained the brain as well as the hand, and made fine men and women. Times are changed for the better in many ways, but the love of house-keeping seems to be lost. It is the aim of domestic science to create a love and respect for the work of the hand, to teach habits of neatness and economy, and to fit a girl to be a good mother and housekeeper.

Each girl who leaves the rural school should be able to take charge of the work in a small home—to know how to buy wisely, to prepare good food, to be clean, and to keep the home neat, to take care of the mending, to dress well, and with good taste.

In class work the older pupils may assist the teacher. In many schools in Virginia the teacher gives instruction in practical cookery, housekeeping, and sewing, and conducts at the same time regular class-room recitations.

The study of various kinds of food, where and how they are grown, forms a very important part of nature study and should be correlated with reading, writing, and language lessons. Let the pupil write an essay on wheat,—where it grows, what it costs, what a good cheap food it is, and how many things may be made from it.

**Some Suggestive Lessons.** The following suggestive lessons may be given by any teacher to pupils of any age. It has been found that young children in New York, Wisconsin, and other states are able to do this work intelligently and to put it in practice in their own homes.

These lessons may be varied to suit the teacher. In nearly every case in which the work had been tried, the superintendents have been so pleased that they have been willing to set aside from one to two hours every Friday afternoon for this work. The teachers who have tried it say that the children are so enthusiastic about it that, if permitted, they stay until six o'clock. In every case the pupils that have taken work in domestic science have done better work in their other studies.

It is advisable to let the children give an exhibit once a year, and to let them bring loaves of bread, cookies, cakes, pillowcases, and aprons which they have made. The mothers and fathers will all come. Increased interest will be taken in the schools.

Prizes are often given for the best exhibit of any kind. This year, in a bread-making contest, a little girl of eight received the first prize. These lessons may also be used for older pupils, and may be given without any equipment. It is often desirable, and very much appreciated, if the mothers are invited to attend the classes.

#### PERSONAL CLEANLINESS

*Care of the Body.* 1. Hands. 2. Teeth. 3. Finger nails. 4. Hair and head. 5. Clean body. 6. Clean clothing.

*Personal Habits.* 1. Keep face and hands clean. 2. Neatness in dress. 3. Buttons on clothing and shoes. 4. Not to spit on floor or slate. 5. Not to "swap chewing gum." 6. Not to pick nose. 7. Turn face aside when coughing. 8. Keep mouth closed. 9. Pencil should not be put in mouth.

NOTE. Mouth is for eating and speaking, and should be closed when not in use.

*Sleeping Rooms.* 1. Sleep with windows open. 2. Have plenty of bed covering. 3. Don't sleep in clothes worn during the day. 4. Ten hours' sleep necessary for children under twelve. 5. Take clothes off bed; put on chair in front of window. 6. Air sleeping rooms.

## MEASUREMENTS

*Mental Drill.* 1. How many ounces in one cup of sugar? 2. How many ounces in one-half cup butter? 3. How many tablespoons in one cup butter? 4. How much will five cups of flour weigh? 5. How much will two cups of granulated sugar weigh?

*Abbreviations, Level Measurements.* 1. Cup — liquid and solid. 2. Spoon.

NOTE. To measure a cupful, fill cup and level with knife for good accurate results. Cup of butter is packed solid. Cup of liquid, all the cup will hold.

## CARE OF THE KITCHEN

*Fire.* 1. How to make fire. 2. Drafts. 3. Care of fire and stove.

*Kitchen.* 1. Care of floor, sweeping and dusting. 2. Sink. 3. Windows. 4. Faucets, zinc, and nickel. 5. Brooms and brushes. 6. Sink strainer. 7. Garbage.

NOTE. Make a sink strainer out of a tomato can. Scrub strainer and garbage pail with hot soapy water. Do not throw parings or coffee grounds into the sink.

## DISH WASHING

1. How to scrape dishes clean. 2. Dishes piled and washed in the following order: glasses, silver, dishes, saucepans. 3. Dish water. — pan of hot soapy water for washing, clean hot water for rinsing. Dish pan. Dish cloths.

NOTE. Wash dish pan inside and out. Dry thoroughly. Wash out dish cloth and towels. They must be washed and boiled and hung in the sun at least once a week.

## WATER

1. Source of water. 2. Care of water. 3. Use of water in health and disease. 4. Danger of bad water. 5. Water good to carry away waste products of the body. 6. Difference between hard and soft water.

*Water for Drinking Purposes.* 1. Value. 2. Making of tea and coffee.

## FRUIT

1. Value of fruit because it contains water and mineral. 2. Danger of underripe fruit. 3. Danger of overripe fruit. 4. Dried fruit cooked.

Baked apples, steamed prunes, apple sauce, dried apricots. Stale bread thoroughly dried out and used with fruit for puddings. Apple Betty.

NOTE. Soak dried fruit twenty-four hours before cooking, and cook slowly. Prunes need no sugar. With other fruit add sugar just before taking from the fire, because then it takes less.

## CEREALS

1. Kinds of cereals. 2. Let children get lists of breakfast foods from stores and catalogues. 3. Methods of cooking.

Oatmeal, corn meal, cream of wheat with dates, farina. Rice as vegetable and dessert. Potatoes.

NOTE. Foods containing starch must be carefully and thoroughly cooked.

## MILK

1. Value of milk as a food. 2. Danger in bad milk. 3. Use of milk, sour milk. 4. Boiled milk indigestible. Making of cottage cheese, custard, slices of bread baked with cheese and milk.

NOTE. Milk must be taken slowly, not a whole glassful at one swallow.

## EGGS

1. How to know a fresh egg. 2. How to keep eggs for winter use. 3. Eggs and milk as food. 4. How to cook eggs: hard- and soft-boiled eggs; poached; scrambled; baked; sponge cakes.

NOTE. An egg sinks to the bottom of a cup of water if fresh.

## MEATS

1. How to select good meat. 2. Which cuts to buy. 3. How to fry beefsteak without fat. 4. How to cook meat slowly. 5. How to cook pork thoroughly. Cooking stews, roasts, steak, bacon. Left-over dishes.

NOTE. Cheap meats are just as good if properly cooked.

## SOUPS

1. Made from meat.
2. Made from milk.
3. Made from vegetables.
4. Made from dried peas and beans.

NOTE. Milk soup is nourishing. Clear beef soup is not nourishing, but good for the stomach before a meal.

## BREAD

1. Why bread is good for us.
  2. Different kinds of flour.
  3. How to select good flour.
  4. How to make good bread.
  5. How to bake it well.
- Muffins and gingerbread.

NOTE. Clear directions for bread making should be given and children allowed to try it at home.

## SETTING THE TABLE

1. Table in center of room.
2. Silence cloth of old clean blanket for quietness and protection.
3. Even tablecloth.
4. Centerpiece in the center.
5. Flowers on the table.
6. Position of napkin, plates, knives, forks, spoons, and water glasses : first five same distance from edge ; fork on left side with tines turned up ; knife with sharp edge toward plate ; water glass at tip of knife ; napkin folded square and placed at left side.

NOTE. A clean tin can with geranium in it and clean white paper pinned around it may be used for center of table. Be sure that table linen is clean.

## LAUNDRY WORK

1. Necessity of washing once a week for cleanliness and health.
2. How to mend clothing before washing.
3. How to take out stains before washing—coffee, tea, fruit, and medicine.
4. Sorting and order of washing.
5. How to hang clothes on the line.
6. How to damp, fold, and iron.

NOTE. Washing and boiling sets the stains. Wash flannels in lukewarm water, rinse in lukewarm water. Overalls or dirty coarse clothing rubbed with a brush. Wash dish cloth and towel. Clothing used in sickness must be washed separately.

Rub and keep irons clean with sapolio and water. Wash and iron handkerchief and napkin.

## BED MAKING

How to make a bed: sheet over mattress to protect it; tuck sheet in all around nice and smooth; tuck the clothes in at the foot; stand the pillow up straight; turn the mattress every week; air the bed.

**ILLUSTRATION.** Give a doll a bath and put in bed in comfortable position. Dress doll in night clothes without underwear.

**NOTE.** Doll's bed or bed made of boxes may be used; mattress of cheese cloth filled with straw; sheet of cheese cloth.

## SEWING

1. How to sit properly. 2. How to hold scissors. 3. How to use the thimble. 4. How to thread needle. 5. Basting. 6. Folding hem on paper. 7. Running stitches. 8. Backstitching. 9. Overcasting. 10. Gathering. 11. Cutting a straight line. 12. Making buttonholes. 13. Sewing on tapes. 14. Hooks and buttons. 15. Darning woolen, cotton, linen.

How to spell terms used in sewing. Hem duster. Make holder, sleevelets, gingham apron, pillowcase, plain featherstitching.

**NOTE.** This may be started in school and done at home.

## DRESSING WELL

*Colors.* 1. Quiet colors. 2. Colors that harmonize. 3. Certain colors with certain complexions. *Material.* 1. Kinds that wear well. 2. Suitable material for dresses. 3. Stripes for short people.

*Clothing.* Comfortable clothing. Warm underwear in winter. Rubbers in damp weather. Dresses suitable for school, church, and parties. Care of one's clothes.

## HOW TO FURNISH A HOUSE

Simplicity: plain things, very little bric-a-brac. Good material. Plain washable curtains; no plush curtains. Iron beds. Furniture that won't catch dust. Plain floor with rugs that can be lifted. Quiet colors in furnishings. Good books and good pictures.

**NOTE.** Use linoleum for the kitchen.

## PLANNING A MEAL

Cooking and serving. Meat balls. Tomato sauce. Muffins and cocoa

## THE LAST LESSON

For the last lesson let the children bring in an exhibit of work they have done at home. Invite all the mothers and friends to be present. Let the children make and serve cocoa and sandwiches.

## A SAMPLE LESSON: SETTING THE TABLE

1. The table should be in the center of the room, the tablecloth on straight and smooth over a blanket or heavy cloth.

The centerpiece, if used, must be exactly in the center of the table; fruits or flowers in the center of the centerpiece. The napkin should be folded square and laid at the left of the plate next to the fork. The open corner should be placed at the lower left-hand corner of fork.

2. The knife must be placed at the right of plate with the sharp edge turned toward the plate. The spoons are always placed at the right of knife with the bowls turned up. The forks should be placed at the left of the plate with tines turned up. The plate should always be placed between the knife and fork, right side up. The handles of knives, forks, and spoons should be placed one-fourth inch from edge of table. The glasses should be placed at the upper right hand and at the point of the knife. They should be filled three fourths full before the meal is announced.

3. Cold food should be served in cold dishes.

4. Hot food should be served in hot dishes.

5. Dishes which permit of choice should be passed from the left. Plates must be removed from the right and food put down from the right.

6. Soiled dishes must be removed first, then the food, then the clean dishes, then the crumbs.





## BIBLIOGRAPHY FOR AGRICULTURE AND NATURE-STUDY WORK

The following named books will be found most helpful to the rural teacher in preparing lessons which the manual outlines. Encourage the district board to place in the district library such books as you think will be of greatest value for reading and reference use.

- A Primer of Forestry, G. Pinchot. Bull. Nos. 1 and 11, Bureau of Forestry, U. S. Dept. of Agriculture.
- Agriculture for Beginners, Burkett, Stevens, and Hill. Ginn & Company. 75 cents.
- Agriculture in the Common Schools, F. G. Adams. U. S. Dept. of Agriculture Bulletin.
- Agriculture through Laboratory and School Garden, Jackson and Daugherty. Orange Judd Co. \$1.25.
- Among Country Schools, O. J. Kern (Supt. Schools, Winnebago County, Ill.). Ginn & Company. \$1.25.
- Animal Studies, Jordan, Kellog, and Heath. D. Appleton & Co. \$1.25.
- Bacteria, Yeasts, and Molds in the Home, H. W. Conn. Ginn & Company. \$1.00.
- Birds of a Maryland Farm, U. S. Dept. of Agriculture.
- Book of Alfalfa, F. D. Coburn. Orange Judd Co. \$2.00.
- Botany, L. H. Bailey. The Macmillan Company. \$1.10.
- Bulletins from the states growing field crops (address State Experiment Station).
- Bulletins of State Agricultural College, Fort Collins, Colo.
- Care of Children (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 3 cents each.
- Cereals of America, Thomas F. Hunt. Orange Judd Co. \$1.50.
- Citizen Bird, Mabel Osgood Wright. The Macmillan Company. \$1.50.

- Colds (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 2 cents each.
- Colorado State Experiment Station Bulletins.
- Colored Plates of Vegetables, Fish, etc. Whitcomb & Barrows, Boston, Mass. 2 cents each.
- Cornell Nature Study Leaflets, Cornell University, Ithaca, N.Y.
- Course in Cooking (Hartford Public Schools, Hartford, Conn.). Free.
- Course of Lessons in Domestic Science (Seventh Grade, Public Schools, Grand Rapids, Mich.), Fuller. Whitcomb & Barrows, Boston, Mass. Free.
- Economic Entomology, J. B. Smith. J. B. Lippincott Co.
- Elements of Botany with Rocky Mountain Flora, J. Y. Bergen. Ginn & Company. \$1.50.
- Elements of the Theory and Practice of Cookery, Williams and Fisher. \$1.10.
- Experiments with Plants, Osterhout. The Macmillan Company.
- Farm Grasses of the United States, W. J. Spillman. Orange Judd Co. \$1.00.
- Farm Poultry, George C. Watson. The Macmillan Company.
- Farmers' Bulletins. U. S. Dept. of Agriculture.
- First Book of Forestry, F. Roth. Ginn & Company. 75 cents.
- First Steps in Food and Diet, Ellen H. Richards. Whitcomb & Barrows, Boston, Mass. 40 cents.
- First Steps to Scientific Knowledge, Paul Bent. J. R. Holcomb & Co., Cleveland, Ohio. \$1.25.
- First Studies of Plant Life, George F. Atkinson. Ginn & Company. 60 cents.
- Forage and Fiber Crops, Thomas F. Hunt. Orange Judd Co. \$1.50.
- Forage Crops, E. B. Voorhees. The Macmillan Company. \$1.50.
- Forage Crops, Shaw. Orange Judd Co. \$1.25.
- Fur-Bearing Animals, John Burroughs. Houghton, Mifflin & Co. \$1.10.
- Garden Making, L. H. Bailey. The Macmillan Company. \$1.00.
- Good Luncheon for Rural Schools without a Kitchen, Ellen H. Richards. Whitcomb & Barrows, Boston, Mass. 10 cents.
- Handbook of Colorado, Thomas Tonge (Denver, Colo.). 50 cents.
- Healthful Farmhouse, Helen Dodd. Whitcomb & Barrows, Boston, Mass. 60 cents.
- Healthful Homes (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 3 cents.

- Hints for Health in Hot Weather (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 2 cents.
- Home and School Sewing, Francis Patton. Whitcomb & Barrows, Boston, Mass. 68 cents.
- Home Studies (Series No. 2, University of Nebraska, Lincoln, Nebr.). Whitcomb & Barrows, Boston, Mass.
- How We Are Clothed, J. F. Chamberlain. Whitcomb & Barrows, Boston, Mass. 48 cents.
- How We Are Fed, J. F. Chamberlain. Whitcomb & Barrows, Boston, Mass. 48 cents.
- How We Are Sheltered, J. F. Chamberlain. Whitcomb & Barrows, Boston, Mass. 48 cents.
- Insect Enemies of Shade Trees. Farmer's Bull. No. 99, U. S. Dept. of Agriculture.
- Insect Life, J. S. Hunter.
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- Insects Injurious to Stored Grain. Farmer's Bull. No. 45, U. S. Dept. of Agriculture.
- Irrigation in Field and Garden. Farmer's Bull. No. 138, U. S. Dept. of Agriculture.
- Judging Live Stock, John A. Craig. San Antonio, Tex. \$2.50.
- Key to Rocky Mountain Flora, A. Nelson. D. Appleton & Co. 50 cents.
- Landscape Gardening, F. A. Waugh. Orange Judd Co. \$1.00.
- Laundry Manual. Proctor & Gamble, Cincinnati, Ohio. Free.
- Lessons with Plants, L. H. Bailey. The Macmillan Company. \$1.50.
- Life Histories of American Insects, C. M. Weed. The Macmillan Company. \$1.50.
- Meat and Drink (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 3 cents.
- Milk (Health Education League Booklets). Whitcomb & Barrows, Boston, Mass. 3 cents.
- Milk and its Products, H. H. Wing. The Macmillan Company. \$1.25.
- Nature Studies on the Farm, W. A. Keffer. American Book Company. 50 cents.
- Nature Study and Life, C. F. Hodge. Ginn & Company. \$1.50.
- Our Domestic Animals, C. W. Burkett. Ginn & Company. \$3.50.

- Outlines of Lessons in Cookery (St. Louis Public Schools). Free.
- Plague of Mosquitoes and Flies (Health Education League Booklets).  
Whitcomb & Barrows, Boston, Mass. 2 cents.
- Plant Life on the Farm, Dr. M. T. Masters. Orange Judd Co.  
50 cents.
- Plants as a Factor in Home Adornment (Reprint from 1902 Year-  
book). U. S. Dept. of Agriculture.
- Principles of Breeding, E. Davenport. Ginn & Company. \$2.50.
- Profitable Home Farming, Yoeman. Cassell & Co.
- Reading Course Bulletins prepared by Cornell University (School of  
Agriculture, Ithaca, N.Y.).
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- Seed Dispersal, W. J. Beal. Ginn & Company. 35 cents.
- Sheep Farming in America. Sanders Publishing Co., Chicago, Ill.  
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- The Farmer's Interest in Good Seed. Farmers' Bull. No. 111, U. S.  
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of Agriculture.
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culture.

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