

Lessons on Farm Crops For 4-H Club Members

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PREFACE

These lessons are intended for the use of study groups in 4-H and other agricultural clubs in Kentucky. As a rule, such groups meet but once a week, and each lesson, with a few exceptions, is intended as a weekly study assignment. However, it may be desirable to spend more time on the study of certain crops — tobacco, for example — in which the group is particularly interested, and less time on crops not important in the community. It is usually impossible to cover the lessons fully at the weekly meetings, and the leader should go over each lesson carefully in advance and select for discussion the most important points.

This edition has been revised and made more complete than previous editions. Considerable information on plants and plant activities has been added (Lesson 1). This is information that 4-H club members should have, especially those interested in plant breeding or the production of farm seeds. For younger groups of students the more difficult portions of the lesson may be omitted. The lessons on tobacco should be particularly useful because this crop is not discussed fully in most textbooks on crops.

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102 LESSONS ON FARM CROPS FOR 4-H CLUB MEMBERS

106 By E. J. KINNEY

LESSON I

112 **The Importance of Plants.** Man is entirely dependent upon
plant life for his food supply. His diet consists partly of animal
118 products but the animals which furnish these products feed on
plants or on other animals which subsist on plants. Plants are not
only the primary source of our food but, directly or indirectly, they
furnish most of our clothing and the fuel necessary to warm our
houses, cook our food and develop power. Much of the material
from which houses and other buildings are constructed and from
123 which thousands of articles indispensable to civilized people are
made, are products of plant life. Clearly man's existence would be
very brief indeed if plants were to suddenly disappear from the
earth.

130 **Variety in Plants.** Plant life is exceedingly varied. There are
thousands of forms so small that individual plants can be seen only
by the aid of powerful microscopes. At the other extreme are the
great trees of the forest. Between the two extremes there is endless
138 variation in size and structure. Plants differ not only in size and
structure but in the kind of food they are able to use. Those which
contain chlorophyll, the green pigment which gives leaves and
stems or other plant parts their green color, obtain their food from
simple chemical compounds taken from the air and soil. From
145 these simple compounds are manufactured the complex compounds
—the foods—necessary to sustain life. The other group of plants
consists of those which lack chlorophyll and as a result are unable
to manufacture food. They are either parasites dependent upon
living plants for their food supply or saprophytes which obtain
154 their food only from products of plants and animals. Some utilize
both sources. Among parasites are the rusts and smuts of grain
crops, mildews, the blights and wilts affecting various crops and
hundreds of other organisms which cause disease in plants and

164 * This circular is intended to take the place of Kentucky Extension Circular 56, Lessons
on Farm Crops.

animals. The best known of the saprophytes are the common toadstools, and the yeasts. In addition are the numerous kinds of bacteria decomposing organic matter. The latter are of great value for as a result of decomposition by different forms there are produced finally the simple nitrogen and mineral compounds which are the food of the chlorophyll-forming plants.

Photosynthesis. The staple food from which green plants build their tissues and obtain energy for the plant activities is starch. Starch is manufactured in the leaves or other green parts of the plant as a result of a process known as photosynthesis, which means "building with the aid of light." The materials from which starch is made are carbon dioxide (CO_2), a compound of 12 parts (1 atom) of carbon with 32 parts (2 atoms) of oxygen, and water (H_2O), which is composed of two parts (2 atoms) of hydrogen and 16 parts (1 atom) of oxygen. The carbon dioxide which is present in small amount in the air enters the leaves thru tiny openings known as stomata. In the plant cells the carbon is united with the hydrogen and oxygen of water to form starch. The energy necessary to bring about this chemical change is the energy of light. The chlorophyll enables the plant cells to use this energy. It is important to remember that photosynthesis takes place only in the presence of light and only in plants supplied with chlorophyll.

The Growth of Plants.* As explained, the starch manufactured in the leaves is the all-important building material of plants. However, it is insoluble, and only soluble material can be transferred to the various parts of the plant where it is needed. Plants have the remarkable ability, however, of changing starch into sugar and other related materials and back again into starch. Since sugar is soluble, it is easily transferred and is used as the basic material for building the other compounds produced by the plant—cellulose, protein, fats, and mineral compounds. Protein compounds contain sulfur and nitrogen taken from the soil, and the mineral compounds also come from the soil. All the food manufactured from the simple compounds taken from air and soil is first used in the growth of the plant. Later, as it approaches maturity, the energies of the plant are devoted more and more largely to reproduction. In seed-bearing plants, blossoms develop, followed by the fruits and seeds. Within

* Unless otherwise stated, seed-bearing plants are referred to in the discussion following.

each seed is an embryo plant around which is stored concentrated food material—starches, sugars, proteins, fats, and mineral compounds. This food supply supports the young plant which develops from the seed until it becomes established and is able to manufacture its own food supply. It is the concentrated food material in seeds that makes them such a valuable source of animal food.

Species and Varieties of Plants. The term *species* as used by botanists means a distinct or special kind of plant. For example, red clover, Kentucky bluegrass, corn, black locust, common ragweed, the cocklebur and the potato; each is a species. The individuals in a species are all very much alike in appearance. They interbreed or can be interbred, and their offspring differ from the parents only in minor respects, as a rule. No two plants, even in the same species, are exactly alike, however, and sometimes forms appear which are quite different from the common form, particularly in size, color of blossoms or other parts, and length of life. Under natural conditions these variant forms interbreed with the common forms and are not perpetuated in many instances. When one appears in a cultivated species, however, it may be noticed, and if it seems to have some superior qualities the seed is saved and the new form is perpetuated. Such new forms are known as *varieties* or, to botanists, generally as *subspecies*. In many of our cultivated crops there are hundreds of varieties, and sometimes these varieties are quite different in appearance. They interbreed, however, or can be interbred, and are obviously all one kind or species of plant. A good example of a species in which there are numerous varieties is corn. Corn varieties differ in color of the seed and other plant parts, in height, in length of time required to mature, and in many other respects. We also have many varieties of wheat, oats, beans, soybeans, cowpeas, and in fact of nearly all our important crops except the grasses. Recently plant breeders have produced a few varieties of several of our cultivated grasses.

Botanical Classification of Plants. By grouping or classifying plants according to their likenesses and differences, we are able to get a comprehensive picture of the plant world as a whole and to see the relationships among the thousands of different kinds or species. The branch of botany which has to do with classification is known as systematic botany.

A species, as we have learned, consists of similar individuals

which interbreed and produce similar individuals, so that each individual is the link of a chain. Most species have one or, more often, a number of close relatives as indicated by the fact that all essential parts—for example, the flowers, leaves and stems—are constructed on the same plan. Such a group is known as a genus (plural genera). A genus, then, is a group of closely related species. Red clover, white clover, crimson clover and alsike clover are species of the clover genus. Similarly, the different kinds or species of maple form the maple genus; the various species of oak the oak genus; and the dozen or more different kinds of dock form the dock, or sorrell, genus.

Genera that have certain plant characteristics in common form a *family*. The genera which comprise a family may be quite unlike in many respects, but on close examination the similarity of various plants can be easily observed. The grasses, which comprise one of the largest botanical families, vary in height from a few inches to fifty feet, or more as in case of the bamboo, the largest grass. Some varieties of corn, also a grass, reach a height of fifteen to twenty feet. However, all the grasses have the same type of leaf, jointed stems, and flower parts similar in arrangement and structure. In the mustard family all genera have a certain kind of flower, and the juice has a sharp or pungent taste. The members of the legume family, so important in agriculture, all bear their seeds in a pod, and most of them have butterfly-shaped flowers.

Groups of families which have certain characters in common are known as *orders*, and groups of orders form *classes*. Finally, the plant kingdom is divided into four great divisions. These are (1) the Thallophytes, in which are included the bacteria, fungi and algae, all very simple plants, most of them microscopic in size; (2) the Bryophytes, which include the mosses and related species; (3) the Pteridophytes, the most prominent members of which are the ferns; and (4) the Spermatophytes, which includes all plants which bear seeds. The spermatophytes are the common conspicuous plants of field and forest, and nearly all cultivated crops are included in this division. They are by far the most numerous and highly developed of all groups. There are two *classes* of spermatophytes—the *gymnosperms* and the *angiosperms*. In the former the seeds are naked; while in the angiosperms they are covered—borne in a sac. The most important of the gymnosperms are the pines, cedars and

other cone-bearing plants. There are only about 450 species of gymnosperms. Practically all our common plants, including cultivated crops, are angiosperms. The number of species in the angiosperm group is approximately 125,000.

Plant Names. All botanical names are either Latin or Latinized names from some other language. Words are Latinized by giving them Latin terminations, or endings. For example, the name Jefferson is Latinized into Jeffersonia, and Clayton into Claytonia. The name of a plant—the so-called scientific name—is the name of its genus followed by the name of the species. The name of the genus corresponds to the family name of a person, and the name of the species to the given name. The names of genera are always capitalized; those of species are not, even when derived from a proper name. A few examples will make the system of naming clear. The clover genus is named *Trifolium* (three leaves). *Trifolium pratense* is red clover; *Trifolium incarnatum* is crimson clover; *Trifolium repens* is white clover. The oak genus is called *Quercus*. White oak is *Quercus alba*; red oak, *Quercus rubra*; and black oak, *Quercus nigra*. Kentucky bluegrass is a member of a genus known as *Poa*, and the scientific name of this grass is *Poa pratensis*. Other species of bluegrass are *Poa compressa*, or Canadian bluegrass; and *Poa annua*, or annual bluegrass.

The common names applied to plants differ not only in the various countries of the world, but in different parts of the same country. Often the common name used for a certain plant in one section is used for some other plant in a different section. The scientific name of any plant is the same, however, in every country in the world. This is one of the important advantages of giving each kind of plant a scientific name.

Annual, Biennial and Perennial Plants. These terms are used to indicate the natural life period of a plant. Annuals live for only one year, or more often part of a year, dying completely after the seeds ripen. Winter annuals, of which wheat, barley and crimson clover are examples, germinate in the fall and ripen seeds the following spring or summer. Biennials are such plants as beets, onions, sweet clover, and the hollyhock, which produce seed the second year after planting. Perennials are plants that live for more than two years. Some perennials, like bluegrass, may live indefinitely; while others, such as alfalfa, live only a few years. Red clover is a peren-

nial that lives but two years in Kentucky, as a rule, but much longer in certain other areas.

Reproduction in Seed Plants. Sexual reproduction occurs in all seed plants (spermatophytes). The reproductive organs are borne by the flowers. In most plants a single flower bears both the male and female reproductive organs. In some, corn for example, they are borne by separate flowers in different parts of the plant. In still other species (dioecious) they are borne on different plants, as for example, in asparagus and hemp.

While the flowers of all plants are formed on a somewhat similar plan, they differ greatly in many respects. The most common plan among the angiosperms is as follows: The outermost set of parts is known as the calyx, and the separate members as sepals. Usually the calyx is green. The next inner set is known as the corolla, and the separate members as petals. The corolla is the showy part of the flower and is usually colored or white. Inside the corolla are the stamens, and in the center the pistil. The stamens and pistil are called the essential organs, since it is in these that the reproductive cells are formed. The part of the stamen producing the pollen which carries the male reproductive cells is known as the anther, and the slender stalk which supports it as the filament. The pistil consists of a basal part, the ovary, containing the ovules in which are the female reproductive cells, and a style, the stalklike portion above. On some part of the style, usually the tip, is a moist, naked surface for the reception of pollen. This is known as the stigma. In some species the style is lacking. In corn, the silk is both style and stigma, as the entire exposed surface is receptive to pollen.

Neither calyx nor corolla is present in the flowers of the grasses; instead, the stamens and pistils are enclosed by two chaffy parts known as glumes.

In corn, the anthers are produced on the tassels, and the pistils are borne on what is known as a cob. Some flowers have a calyx and no corolla.

The development of a seed begins with the fusion, or union, of male and female reproductive germ cells, microscopic in size, a process known as fertilization. The beginning of fertilization is pollination, or the falling of pollen on the receptive stigma of the pistil. In each pollen grain are two germ cells, or nuclei. One of these, known as the tube nucleus, extends into the style and finally

into the embryo sac which contains the egg, forming a tube. The other pollen cell divides, forming two nuclei which pass thru the pollen tube, thereby reaching and fusing with the female nuclei in the egg. After fusion, growth occurs by cell division and the embryo, or young plant, takes form. After a certain stage of development is reached, varying with different plants, the embryo ceases growth and becomes dormant. The dormant embryo, together with a store of food material which usually surrounds it, is enclosed in a hard, protective covering. This is the seed which, when planted in warm, moist soil, germinates, which means that the embryo resumes growth.

In some instances the seed or seeds produced by a single flower is contained in a pod or in a more or less fleshy fruit, as, for example, the seeds of berries, apples, peaches, melons, tomatoes, and peppers.

Self Pollination and Cross Pollination in Plants. In many species of plants the stigma of the flower is almost always pollinated by pollen from the same flower or from other flowers on the same plant. This is known as self pollination, and it results, of course, in self fertilization. In other species, cross pollination usually occurs, which means that the pollen which reaches the stigma of one plant is produced by another plant or other plants. In still other plants, both cross and self pollination occur.

The important crop plants naturally self pollinated are wheat, oats, barley, rice, soybeans, cowpeas, and potatoes. In some instances self pollination occurs because the anthers discharge their pollen before the flower opens. In other species—wheat and oats, for example—the pollen is discharged as the flower opens, and some of it falls inside the flower and on the receptive stigma. The flower remains open but a few minutes, so that there is little chance of pollen from other flowers getting in. However, a very small amount of crossing does occur even in naturally self fertilized plants. In crossing two varieties of self fertilized plants, it is necessary to remove the anthers before they open and then to cover the flower by a small bag to keep out undesired pollen. As soon as the stigma becomes receptive it is hand pollinated with pollen from the selected plant.

The most important naturally cross pollinated cultivated crop is corn. The pollen is borne on the tassel, and it is so light that it is carried away from the plant bearing it and pollinates the silks on other plants. An isolated corn plant usually produces only a few kernels because of lack of pollination.

It is an easy matter to self-pollinate corn. The ear is covered with a small paper bag before the silks appear. At the same time, or a little later, the tassel is enclosed in a 10- or 12-pound paper bag. The pollen accumulates in the larger bag, and when the silks are well out the pollen which has accumulated is poured over the silk. The silk is protected from other pollen by again covering the ear shoot with the larger bag. This is usually left on until the corn is gathered.

Other crops which are naturally cross pollinated are rye, clover, and many of the pasture and meadow grasses. Self pollination of naturally cross pollinated crops usually results in reduction in size of plants and a loss of vigor. Cross pollination of naturally self pollinated crops may result in increased vigor.

Crops in which both cross and self fertilization occur include tobacco, cotton, and the sorghums. Complete self fertilization may be effected by covering the flowers with a bag. This is often done with tobacco to prevent any crossing with other varieties or inferior plants. No reduction in vigor results.

How Plant Characters are Transmitted. Plant characters are those qualities which identify a plant and serve to distinguish it from other forms. All the characters of a plant are represented in the cells of which the plant body is composed by what are called genes, "factors", or determiners. In some way not clearly understood these factors have the power to regulate the growth of the plant and produce its distinguishing features. We have learned that plants produce germ cells especially for reproduction. The reproductive cells, called gametes, carry the same factors as the cells of the plant which produced them. If both male and female gametes are produced by the same plant as is true in self-fertilized plants, each carries the same hereditary factors and the fertilized egg which is the product of their fusion develops into a plant like the parent. For example, suppose we have a variety of wheat, a self-fertilized crop, with long beards and red seeds. Both male and female gametes carry factors for long beards and red seeds and the plants resulting from their fusion will also have long beards and red seeds as long as self-fertilization continues. The progeny of a self-fertilized plant is known as a pure line. Suppose, however, the bearded variety with red seeds is crossed with a variety which has very short beards and white seeds. One gamete will carry factors for long beards and red

seeds and the other factors for short beards and white seeds. As a result the cells of the resulting hybrid plants known as first-generation, or F_1 hybrids, will carry factors for all four characters, namely long beards, red seeds, short beards and white seeds. In this particular cross, the F_1 plants will have short beards and red seeds because these characters prevail over long beards and white seeds or, as it is usually termed, are dominant. Dominance is not always complete, however; for example, in a cross between some kinds of yellow and white corn the F_1 generation will produce pale yellow seeds. Each male and female gamete produced by the F_1 generation plants will carry a factor for either long or short beards but not both, and a factor for red or white seeds, but never for both. About one-fourth will carry factors for long beards and red grains; one-fourth factors for long beards and white grains; one-fourth factors for short beards and red grains; and one-fourth factors for short beards and white grains. Thus we have four kinds of both male and female gametes as regards factors for length of beard and seed color. Any one of the female gametes may be fertilized by any one of the male gametes; for example, the female gamete carrying factors for short beard and red seed may be fertilized by a male gamete carrying the same factors, by a gamete carrying the factors for short beard and white seed, a gamete carrying factors for long beard and red seed or a gamete with factors for long beards and white seed. It is clear then that 16 different combinations will be represented in the fertilized eggs, and in the next generation of plants (F_2 generation) produced by the fertilized eggs. Gametes combine according to the law of chance; therefore about equal numbers of each combination will be produced. When male and female gametes carrying the same factors combine, the resulting plant will be pure for these characters and will breed true as long as it is allowed to self-fertilize. Such combinations occur in 4 out of the 16 produced. The two parent forms will be reproduced; namely, plants with long beards and red seeds and plants with short beards and white seeds. In addition a form with short beards and red seeds will be produced and a form with long beards and white seeds. This shows how it is possible by hybridization to obtain new varieties in which the desirable characters of the parents are combined. The greater the number of characters by which the parents differ, the greater the number of new true breeding forms produced by hybridization.

In cross-fertilized crops, like corn, all the plants are hybrids and even after years of selection a variety of corn breeds true for only a few characters, such as, for example, the color of seed and cob. It is true that wide difference in other characters may be eliminated by years of field selection, but small differences still persist.

Corn, as stated, can be easily self-fertilized and by this means it is possible to obtain inbred lines that breed true for all characters just as do pure lines of wheat or other self-fertilized crops. Once corn is reduced to a pure line it breeds true for all characters, even if allowed to cross-pollinate, provided, of course, no mixing with other corn occurs. Corn and probably most or all other naturally cross-pollinated crops become greatly reduced in size and vigor by self-fertilization. If two inbred lines are crossed the F_1 generation of plants will be as large and vigorous as the parents from which the inbred lines were obtained. Often the yield is better. Hybrid seed corn, now so widely used, is produced by crossing two or more inbred lines. Methods of producing hybrid seed will be discussed later.

Questions on Lesson I. 1. Why are plants so important to man? 2. How do plants differ in the kind of food they are able to use? What are parasites? Saprophytes? What is the function of chlorophyll? 3. What is photosynthesis? In what kinds of plants does photosynthesis occur, and when? 4. Describe the growth of plants. 5. Define species. Variety. Genus. Family. Gymnosperm. Angiosperm. 6. How are plants named? What is the chief advantage of scientific names? 7. Define annual, biennial and perennial plants. 8. Make a drawing of a tobacco flower, showing the different parts. Define stamen, stigma and ovule. 9. Describe fertilization in plants. What is a seed? 10. Name the most important self-pollinated crops; the most important cross-pollinated. What effect has continued artificial self-pollination on corn? 11. Why are the seed heads on tobacco plants often covered with paper bags? Is the vigor of tobacco reduced by self-pollination? 12. What are gametes? Explain how new varieties are obtained by hybridization.

LESSON II

The Beginning of Plant Culture. There is little doubt that man lived on earth a long time before he learned the simplest of arts or even the use of fire. His food supply consisted of seeds, fruits and roots of wild plants and such animals as he was able to capture. Trees and caves were his dwelling places. It has been pointed out by students of antiquity that each important advance toward civilization was associated with an increased food supply. After man learned the use of fire, he discovered that certain plant products which could not be eaten raw were palatable when cooked. The invention of the spear and the bow and arrow enabled him to kill more animals for food, and when he learned to fashion clay into cooking utensils he added to his food supply products that required cooking in water to make them palatable. Then came the domestication of animals. The dog, which was probably the first animal domesticated, helped him in hunting. The domestication of such animals as goats, sheep and cattle was still another step of vast importance in increasing his food supply. These animals were pastured on wild grasses and were driven from place to place as new pastures were needed or the water supply became scanty. Certain tribes still follow this nomadic manner of life. Finally men learned to cultivate plants. This not only enormously increased his food supply, but encouraged a settled manner of living and the building of homes and eventually cities, necessary before a high state of civilization can be achieved.

In what part of the world or how long ago man first learned to cultivate plants is of course unknown. On the walls of certain caves in Europe occupied by men of the Stone Age at least fifty thousand years ago are engravings which indicate that these ancient people practiced some kind of an agriculture. Doubtless agriculture is even more ancient in Egypt, Western Asia, China and India, for civilization was reached in those countries much earlier than in Europe. Good evidence that some of our present crop plants have been cultivated many thousands of years is the fact that the wild forms from which they were developed are apparently extinct. This is true of corn, for example, which was unknown to the rest of the world previous to the discovery of America. Its wild ancestor has never been found despite very extensive search.

History of Crop Plants. In excavating the sites of villages occupied by the so-called Lake Dwellers of Switzerland at least five thousand years ago, well-preserved wheat and barley and various other seeds were found. Careful study has shown that they were of varieties practically identical with present crop varieties. These varieties differ greatly from any wild forms which may possibly be their ancestors; hence it seems evident that they had been cultivated for many hundreds or perhaps thousands of years previously. It is believed that wheat and barley are the oldest cultivated crops. However, rice is also of very ancient cultivation, and certain millets were also extensively grown in prehistoric times, particularly in the Orient. Chinese scholars claim that wheat, rice, certain millets, and the soybean are native to China and were first cultivated in that country. Evidence to prove this is lacking, however.

Some of our important crop plants came under cultivation at a much later date than those already discussed, and it is possible to trace their ancestry with greater certainty. The potato, for example, is known to have originated from a wild species still growing wild in parts of South America. Most of our cultivated meadow and pasture grasses and legumes have been cultivated a comparatively short time and differ little from wild forms.

Crop Improvement. The great changes which our prehistoric ancestors brought about in the wild forms they selected for cultivation were the results of selecting and propagating the superior variant forms which nature produces in all species. As stated, some of these early varieties were practically identical with varieties grown today in various parts of the world. Modern plant breeders still search for the variant forms which may give rise to superior varieties. However, hybridization, or the crossing of varieties already in existence, is a much more rapid and certain method of improvement. By hybridization it is possible to combine the desirable qualities of two or more varieties into a single variety. A good example of this is the production in recent years of barley with smooth beards. Anyone who has grown ordinary barley knows how the rough, barbed beards scratch and irritate the skin. A rather worthless variety with smooth heads was found in Europe. By crossing this with the rough-bearded sorts, excellent varieties with perfectly smooth beards have been obtained.

The development of disease-resistant varieties of our common

garden and field crops has been one of the most valuable contributions of plant breeders in recent years. So serious has the disease factor become in many instances that without these resistant varieties it would be practically impossible to raise some of our valuable crops. Included among these are rust-resistant varieties of wheat and oats, smut-resistant wheat, root-rot-resistant varieties of tobacco, wilt-resistant flax and cowpeas, cabbage resistant to yellows, tomatoes resistant to wilt, corn resistant to various diseases, anthracnose-resistant clover, and numerous others. The development of hybrid corn is another outstanding achievement which has made it possible to increase corn yields 10 to 20 percent and to obtain a much better quality of grain.

Introduced Crops. America gave the world three important crops—corn, potatoes and tobacco. The potato has long been one of the most important crops in Europe, and corn and tobacco are also grown in many parts of the world besides America. Most of our other crops were introduced from Europe and Asia. In this list are included all the small grains and most of our grasses and legumes. In many instances the varieties first introduced were not well adapted to the climatic conditions in various parts of this country. For many years the United States Department of Agriculture has had men in all parts of the world seeking better adapted varieties, and some of great value have been found.

The grain sorghums, such as kaffir corn, milo maize, etc., have enabled farmers in the drier parts of the United States, especially western Kansas and Texas, to increase greatly their production of grain. The so-called Turkey varieties of wheat from Russia are extremely hardy and have made the growing of winter wheat in Kansas, Nebraska, and other western states possible, and have added millions of bushels to our wheat crop. Alfalfa and Sudan grass are other valuable additions to our list of crops. There is no doubt that plants and varieties of plants will be discovered in the future much better adapted to the various soil and climatic conditions of the different parts of the country than those we now have.

Crops of the United States. The United States is such a large country, with such a wide variety of climates and soils, that nearly all the important crops of the world can be grown successfully in some part of it. The kind of crops grown in any particular region

depends chiefly upon the climate (temperature, sunshine and rainfall), topography (whether land is level, rolling or very hilly) and upon the nature of the soil. The distance from markets also may have much to do with the kind of crops grown in a region.

Of course the most profitable crop in any area always is grown most extensively, but it is seldom a good plan to depend wholly upon one crop, even if it is usually much more profitable than others that may be grown; hence farmers in most regions raise several different crops.

Corn is by far the most important crop of the United States. The climate of all that part of the country east of central Kansas and Nebraska is favorable for growing this crop except the most northern parts. The central states, Illinois, Iowa, Nebraska, Missouri, Indiana, Ohio, Kansas, Kentucky and some others, contain so much rich, level land that they are able to grow a very large part of the crop. This group of states is known as the corn belt.

Cotton is the second crop in importance. It requires a long growing season to mature, and only the southern part of the country can raise it successfully. A small amount is grown in southwestern Kentucky.

The hay and forage crops come next to cotton in value. The northern part of the country is best adapted to producing hay, because most grasses grow best in a cool climate. In the northeastern states grasses thrive well and hay is grown extensively because of the good markets for it there. Alfalfa is grown most extensively in the western states, but it is rapidly gaining in importance all over the country.

Wheat, the fourth crop in importance, can be grown quite successfully in nearly all parts of the country, the most southern states having the poorest climate for its culture. Nearly all the great corn-growing states raise considerable wheat, but the greatest amounts are raised in states or parts of states not so well adapted to corn. Winter wheat yields better than spring wheat, as a rule, and it is grown wherever the winters are not too severe for it. Montana and the Dakotas raise most of the spring wheat. These states contain much fertile, level land and, as the seasons are rather short for corn, and the rainfall often deficient, it is not grown extensively; wheat and other small grains are raised instead. Kansas and Nebraska are the greatest winter-wheat states, chiefly because

wheat is a safer crop in the central and western parts of these states than corn. Indiana, Ohio, and Illinois produce large crops of wheat. Kentucky has rather a small amount of land well adapted to growing wheat.

The oats crop ranks next to the wheat crop in value. Oats are a cool-weather crop and do much the best in the northern part of the United States. Iowa, Minnesota, Illinois, Wisconsin and Michigan are the greatest oat-growing states. The oat crop fits so well in farm rotations, however, that much is raised, even where the climate is not so very favorable for it. In the southern states, winter oats give better yields than spring oats, but oats are not grown extensively in the South. Kentucky is too far south to grow spring oats successfully, and too far north for winter oats. As a result the crop is not of much importance in the state.

Potatoes rank next to oats. They are another cool-weather crop. While nearly every farmer in the country raises them as a garden crop, most of the crop for commercial purposes is grown in the more northern states. Maine, New York, Michigan, Wisconsin and Minnesota are the largest producing states. In Kentucky the crop is raised extensively on a commercial scale only around Louisville and near Cincinnati, Ohio.

Probably the sugar crop ranks next to potatoes, if we include the crops of Porto Rico, Hawaii and the Philippines, which are, of course, a part of the United States. Most sugar is made either from sugar cane or from sugar beets. Sugar cane is a tropical plant and requires a very long season to mature. For making sugar it is grown in the United States proper chiefly in Louisiana, although a few thousands of tons are produced in other gulf states.

Considerable sugar cane is grown in all the Gulf states for making syrup. The sugar of Porto Rico, Hawaii and the Philippine Islands is made from sugar cane.

Sugar beets are grown in certain areas in northern United States and by irrigation in several of the far western states. The refined or manufactured sugar produced from cane and from beets is identical in appearance, quality, and chemical composition.

Tobacco ranks eighth in value. In growing tobacco, soil is more important in producing the qualities desired in various tobaccos than climate. Kentucky, North Carolina, Virginia and parts of bordering states seem to have the best soils for producing the

kinds of tobacco used in largest quantities and they are the most important tobacco-growing states. Tobacco suitable for making cigars is grown in Ohio, Wisconsin, Pennsylvania and the New England states, but in none of these states is the tobacco industry as important as in the first named. In Kentucky, tobacco usually is the second crop in value, altho in recent years it has ranked first several times.

Barley is an important crop only in California, Minnesota, the Dakotas, Wisconsin, Kansas and New York. These states grow spring barley, a crop which has about the same climatic requirements as oats. Kentucky can raise winter barley successfully, but spring barley yields very poorly. Little barley is grown in the state, but the acreage has increased greatly in recent years. It requires a rich soil. Barley ranks next to tobacco in value of the crop.

Rye is hardier than wheat and gives better yields on poor soil. It is not a very important crop in the United States, but several of the northern states raise from eight to ten million bushels each. In Kentucky rye is grown chiefly as a cover crop and for pasture. It has few advantages over wheat as a grain crop, in this state. The following crops are of considerable importance in certain sections.

Buckwheat is grown principally in New York and Pennsylvania. It is a good poor-land crop and thrives best in cool climates. Some is grown in Kentucky, as a late summer and fall crop, usually following wheat.

Sweetpotatoes are an important crop in the South, especially in the Carolinas, Georgia and Alabama. Sweetpotatoes require a sandy soil, for best results.

Flaxseed production is important in the northwestern states. Flax requires a very rich soil to give good yields of seed.

Rice is one of the most important food crops of the world and is the chief food of hundreds of millions of people in Asia. It is a true cereal which requires a long season to mature and must be flooded with water during its growth. Louisiana is by far the largest producing state in this country, her crops varying from 16,000,000 to 24,000,000 bushels annually. Texas, Arkansas and California produce about as many bushels of rice each as Kentucky does of wheat. Several other Southern states produce small amounts.

Field beans are grown extensively in California, Michigan, Colorado, Idaho, and New York. They thrive best in a cool climate and, what is more important, are not so likely to be injured by the bean weevil, where the climate is cool.

Peas for canning are grown as a field crop in several northern states. They are a cool-climate crop.

Tomatoes for canning are grown as a field crop in many sections.

The grain sorghums, such as kafir corn, milo maize, feterita, etc., are very important crops in western Kansas, Texas, and Oklahoma. They are very drouth-resistant and will make a good crop of grain, with but little rain. Sweet sorghums also are grown all over the country, on a small scale, for forage and syrup.

Hops are grown in New York and California. Soybeans are grown extensively in several states. Peanuts are grown extensively in Virginia, North Carolina and other southern states. They require a fairly long season and give the best results on rather sandy soil. The production of seed of various grasses, alfalfa seed, clover seed, millet seed, etc., is an important industry in a few small areas.

Finally, pasture crops must not be omitted in enumerating the crops of the country. It is difficult to estimate the money value of pasturage, and consequently it has been left until the last for consideration. A large proportion of the land area in the United States is utilized for pasture, and these pastures provide about one-half the forage consumed by herbivorous animals. The other half is provided by harvested forage crops, such as hay, silage, corn stover, and straw. It is evident, then, that the value of the pasturage in the United States is equal to the value of all hay and forage crops.

To give a better idea of the immense production and value of field crops in this country than these brief descriptions have afforded, a table is presented showing the average yields and farm values of the most important crops of the United States for the twenty-year period, 1918 to 1937, inclusive, as estimated by the Bureau of Crop Estimates of the United States Department of Agriculture. Reports for all crops as well as other interesting data are published each year in the yearbook of the Department of Agriculture. Anyone interested in agricultural statistics should consult the yearbooks, which may be found in most public libraries.

In order to show how large a share of the world's crops is pro-

duced in this country, the estimated world production of several crops for the year 1935-36 is also given. Production in China is not included for crops indicated, as statistics of production for these crops are not available. It should be emphasized that the figures on world production are only rather rough estimates.

PRODUCTION AND VALUE OF CROPS

The United States.	Yield	Value
1. Corn	2,498,825,000 bus.	\$1,794,230,000
2. Cotton lint*	13,158,000 bales	1,057,580,000
3. Hay	83,128,000 tons	†1,004,770,000
4. Wheat	793,501,000 bus.	809,457,000
5. Oats	1,147,250,000 bus.	472,291,000
6. Potatoes	332,753,000 bus.	360,486,000
7. Tobacco	1,334,060,000 lbs.	248,803,000
8. Barley	203,209,000 bus.	116,627,000
9. Sweetpotatoes**	68,460,000 bus.	74,662,000
10. Grain sorghums††	95,821,000 bus.	67,584,000
11. Rice	41,564,000 bus.	43,164,000
12. Rye	49,578,000 bus.	42,384,000
World Production.		
Wheat	4,700,000,000 bus.	
Rye	1,817,000,000 bus. (Not including China)	
Corn	4,600,000,000 bus.	
Oats	4,727,000,000 bus.	
Barley	2,312,000,000 bus.	
Rice	2,200,000,000 bus. (Old statistics)	
Cotton	26,500,000 bales	
Sugar	31,462,000 tons	
Tobacco	4,450,000,000 lbs. (Not including China)	
Potatoes	8,127,000,000 bus.	

* The value of cotton seed averages about \$150,000,000 annually, making the total value of the cotton crop \$1,207,580,000 in round figures. Production averages about 6,000,000 tons.

** Nineteen years, 1918 to 1936, inclusive.

† Approximately.

†† Eighteen years, 1919 to 1936, inclusive.

The crops studied in these lessons comprise only those grown in Kentucky. Some are not grown extensively but are of such great national or world importance that every student of agriculture should know a few facts concerning their culture and uses. This is particularly true of cotton. For convenience in studying, the crops considered are divided into three groups as follows: (1) cultivated crops; (2) the small grains; and (3) hay and pasture crops.

Questions on Lesson II. 1. How did primitive man live? How did the discovery of the use of fire tend to increase his food supply? 2. Why were the domestication of animals and the cultivation of plants such important steps in the development of civilization? 3. What are some of the evidences that the cultivation of plants has been practiced for thousands of years? 4. What are probably some of the oldest cultivated crops? What are of more recent development? 5. How were prehistoric people able to improve the plants they cultivated, so greatly? Is this method still followed? What other method is now also used? 6. Discuss the development of disease-resistant varieties of crops. 7. What crops did America give to the world? What very useful crops have been introduced into America in more recent years? 8. Name the most important crops of the United States. In what part of the country are the following crops most important and why? Corn, wheat, tobacco, barley and grain sorghums. 9. What is the approximate yield and value of the 12 most important crops grown in the United States? 10. What part of the world crop of corn, wheat, cotton and tobacco does the United States produce?

LESSON III

CORN

Corn is, in its possibilities, the greatest cereal food crop in the world because, with a suitable climate and soil, it produces about twice as much grain per acre as any other grain crops. The fact that so much of the United States has a climate favorable for raising corn and contains so much good corn land, accounts very largely for her wealth and prosperity.

Corn is native to America and was unknown to the civilized world before America was discovered. At that time the Indians of North and South America were cultivating corn wherever climatic conditions permitted, and it certainly had been grown for many hundreds of years before white men landed on the shores of the new world.

Ever since the first settlers arrived, corn has played a very important part in the history of our country. Every boy who has studied history knows that the corn the Indians shared with these early settlers actually kept them from starving. The Indians taught the white men how to raise corn, and for a long time it was the principal food of the colonists. Certainly the rapid settlement of the colonies would have been impossible without the corn crop. Later this same crop made it possible to settle and develop the great central part of the country very rapidly.

In some years the corn crop of the United States amounts to 3,000,000,000 bushels, which is nearly three-fourths of all the corn grown in the world. These figures are so large that one cannot comprehend them. If this corn could be divided evenly, every man, woman and child in the country would have about 25 bushels of corn. If all the grain of all kinds grown in Europe were divided evenly, it would give each inhabitant but about 15 bushels. If the 3,000,000,000 bushels of corn were put into wagons holding 50 bushels each, and each wagon allowed a space of 20 feet, it would require 75 rows of wagons reaching from New York to San Francisco, a distance of more than 3,000 miles, to hold it all. The wheat crop is the most important crop in the world, but the corn crop of the United States is almost three-fourths as large as the wheat crop of the world. It is one-and-a-half times as large as the oats crop of the entire world, by weight, and one-and-a-half times

as large as the rice or the rye crop of the world. Is it any wonder that corn is called "King Corn" in America?

You may wonder why corn is not grown more extensively in other countries, since it is such a valuable crop. As a matter of fact, corn probably is grown nearly as extensively as possible, for outside of the United States there are few large areas where the climate and soil are suitable for the crop. Argentina ranks next to the United States in production, but it produces only about one-fifteenth as much as this country. Considerable corn is produced in Europe, also, in the countries that border on the Mediterranean.

The Corn Plant. The botanical name of corn is *Zea mays*. In Europe it is called maize or Indian corn, as the word *corn* there means wheat, barley, oats and other small grains. The English speak of heads of wheat or rye as ears of corn. The word corn in America, however, always refers to maize.

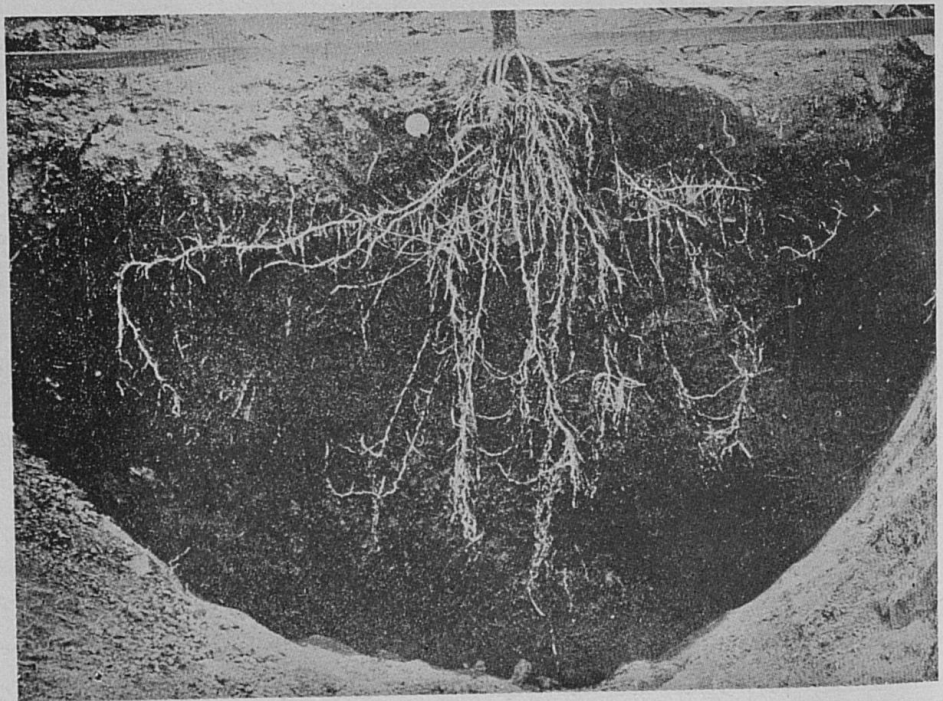
Corn belongs to the grass family and is a grass just as truly as bluegrass or timothy. Wheat, rye, barley, oats and rice, also, are grasses. A grass which is grown chiefly for its grain is called a cereal. Corn has few close relatives among the grasses. It is unlike any other grass in the way in which it bears its flowers and seeds. The tassel bears only pollen, while the seeds are borne on an ear at a joint of the stem. No other plant produces an ear similar to corn.

The corn plant varies in height from two feet, in some of the dwarf popcorns, to twenty feet or more in some late tropical varieties. The stem of corn is solid, filled with pith. It is divided by joints or "nodes." The stem extends into the soil for several inches and here the nodes are very close together. Each of these nodes bears a "whorl" or set of roots. Above the soil each node bears a leaf and some of them bear an ear, which is really a shortened branch. A very small corn plant has its full number of nodes closely crowded together. As the plant grows, the spaces between the nodes lengthen, but no more nodes are produced. The spaces between nodes are called internodes.

Suckers or Tillers. Frequently corn branches from some of the nodes at or just beneath the ground. These branches are called "tillers" or suckers. Sometimes these suckers grow large and produce ears, but in field corn this does not occur often. Suckers are

most likely to appear when corn is planted thin, on rich land, or in seasons with plenty of rain.

The Root. When a grain of corn is planted, a single root grows out from the tip of the grain first. A few hours later the stem appears. Then two more roots appear. These roots are called the temporary roots, as they support the plant but a short time. When the plant is a few inches high the so-called permanent roots grow out from the stem about an inch below the ground. The depth below the surface at which the permanent roots appear under similar soil conditions is the same, regardless of the depth of planting the seed.



The root system of a corn plant.

Corn roots grow very fast. At first they spread out, but when the plant is about 12 days old they begin to grow down, and in a few days may reach a depth of 12 to 15 inches. When the corn plant is in tassel, the roots have spread out 3 to 4 feet in all directions and have gone down into the soil from 3 to 4 feet.

As the corn plant matures, brace roots start out from nodes above the surface and grow into the ground. They are large above the surface, but in the soil are like ordinary roots. Their chief

use is to support the stalk and prevent it from being blown down.

The Leaves. A corn plant a few days old has its full number of leaves, but they are, of course, very tiny and wrapt closely together. As the stem lengthens, the leaves increase in size and begin to show. The leaves of a full-grown corn plant have a very large surface and give off large amounts of water carried to them from the roots. The leaves are the manufacturing part of the plant. In times of drouth or great heat, the leaves roll up and so retard the loss of water.

The Flowers. The male flowers which produce the pollen are borne on the tassels. They are in pairs and each pair is enclosed between two chaffy parts known as empty glumes. This constitutes what is known as the spikelet, which is formed only in the grasses. The anthers, three in number, are enclosed by two chaffy parts typical of the grasses, known as the lemma and palea. Wallace and Bressman in their book on corn estimate that an average tassel of corn bears about 7000 anthers each containing 2000 pollen grains giving a total of 14,000,000 pollen grains per tassel. This is approximately 2000 pollen grains for each silk on the ear. No wonder corn usually pollinates so well!

The female flowers are borne in pairs on the cob but with very few exceptions only one of the pair develops. By stripping the husks from a shoot just as the first silks appear, the ovaries (undeveloped grains of corn) may be seen. They are arranged in neat rows on the cob each with its attached silk. The silks from the base of the ear appear first and those from the tip last. The tassel of a plant begins to shed pollen as a rule a few days before the silks emerge and continues for a week or more. After pollination the silks soon dry up. If not pollinated, the silks remain receptive to pollen for 10 to 12 days depending upon the weather. Where pollination is delayed the silks continue to lengthen and may become a foot long.

The Ear. The so-called "shoot" of corn may be regarded as a telescoped branch of the main stem. The ear stem or shank has numerous nodes or joints close together. According to Montgomery, an authority on corn, the nodes of the ear shank are equal in number to the nodes on the main stem above the ear. The husks arise from the shank nodes and are modified leaves.

Classification of Corn. All kinds of corn interbreed freely and

most authorities regard the various forms as comprising a single species. However, there are marked differences in grain texture in corn which are associated to some extent with other plant characters, and, on the basis of these differences, the species is divided into four important groups. The endosperm of corn, the starchy material of which a large proportion of the grain consists, may be wholly or in part dense and hard, or soft and flour-like. Differences in the amount and arrangement of these two forms of starch are the distinguishing characteristics in three of the four important groups; namely, flint corn, dent corn, and soft or flour corn. The endosperm of the other group, sweet or sugar corn, is composed partly of sugar and has a tough, rather waxy texture becoming very hard when dry.

Flint corn (*Zea indurata*) has a layer of hard material on the outside of the grain and soft material inside. The ears of flint corn are usually long and slender. Most varieties have either 8 or 12 rows of grain, the number being uniform in each variety. The grains are oval and shallow. All corn colors occur; white, yellow, red, blue, etc. Most varieties of flint are quick maturing and are grown chiefly in the New England states and in other northern areas where the growing season is short. Argentina, next to the United States, the largest corn producing country in the world and the largest exporter, grows flint corn largely because the peculiar distribution of rainfall necessitates the use of early varieties of corn. Leading American varieties of flint corn are Longfellow, Canada Yellow, Smut Nose, and Thoroughbred White Flint.

Popcorn is regarded as a type of flint corn. The grains and ears are small and practically all the endosperm consists of hard starch. Colors in popcorn are white, yellow, red and blue while in some varieties a mixture of colors occurs.

Dent corn comprises perhaps 95 percent of the corn acreage of the United States. The grains of dent corn have side walls of hard starch but unlike flint corn, none on the crowns. As the grains ripen the soft starch shrinks more than the hard starch causing a dent in the crowns. Thus the name dent corn. The dent in some varieties is quite shallow and in some of the Southern prolific varieties, is practically absent. The classification of such varieties as dent corn is based on characters other than indentation. All

corn colors occur but yellow corn is by far the most extensively grown in the Corn Belt proper. In the South white corn is more popular. Yellow corn has yellow endosperm while red corn has white endosperm, only the hull being red. In blue corn the color is usually carried in the aleurone layer, a layer of cells just inside the hull. The grains of dent corn are more or less wedge-shaped and usually considerably flattened. The ears vary in size, shape, hardness of grain and other characteristics. Some Northern varieties of dent corn grow only 5 to 6 feet high and mature in 80 to 90 days, while some Southern varieties exceed 15 feet in height and require 150 to 200 days to mature.

The great diversity in ear and plant characters—much greater than in flint and soft corn—indicate that dent corn may be of hybrid origin. The Indians grew flint corn, soft corn and probably sweet corn; also a type that the colonists called gourd seed which apparently was a large, late-maturing type of white corn bearing an ear with 20 to 30 rows of rough, deep, very soft shoe-peglike kernels. Wallace and Bressman believe that dent corn probably resulted from crossing a large flint type of corn with the gourd seed and present considerable evidence to support this view. They consider that while there may have been many other sorts mixed in forming modern dent corn, the chief characteristics of dent corn as it is known in the Corn Belt today are derived from the large flint and the gourd seed. Varieties of dent corn are described in Lesson IV.

Soft corn, also known as flour corn and squaw corn, is grown chiefly by the Indian tribes in the West. In general appearance the ears resemble flint corn. However, the kernels are composed almost entirely of soft starch. Because of uniform shrinkage, no dent is formed in the tips of the grains. The most common colors are red, white and blue.

Sweet corn is supposed to be a sport or mutation from field corn. Some varieties have apparently come from flint corn; Golden Bantam, for example. Evergreen resembles dent corn in most ways and has probably come from that type. Medium late varieties of sweet corn such as Evergreen, Country Gentleman, and Black Mexican are best adapted to Kentucky. Several yellow varieties developed by hybridizing Golden Bantam with Evergreen and other white kinds have been introduced and they have proved

quite satisfactory in this state. Sweet corn is far superior to field corn for "roasting ears" and should be more widely grown for home use on Kentucky farms.

In addition to the four main corn groups described, a number of other types are known. One of these is pod corn (*Zea tunicata*) which has husks around each grain as well as surrounding the ear. It is grown only as a curiosity, as is a type with variegated leaves (*Zea japonica*) developed in Japan and one from China with waxy kernels.

Questions on Lesson III. 1. What can you tell about the importance of the corn crop in the United States? 2. Where did corn originate? How did the colonists learn to raise and use it? 3. How much corn is grown in the United States? Why is corn called "King Corn?" 4. To what family does corn belong? What is a cereal? How is corn unlike any other cereal? 5. If you were trying to tell a man who had never seen or heard of corn, about its appearance, what would you tell him? What are nodes? 6. What are suckers? Brace roots? Where are the roots of corn formed? (How near the surface?) 7. Describe the flowers of corn. Explain why cross-pollination prevails with corn. 8. Name the four important groups of corn and describe the grain of each. 9. How was dent corn probably developed?

LESSON IV

CORN (continued)

Climate and Soils for Corn. It has been stated already that the climate of much of the United States is favorable for the growth of the corn plant. Corn originated in a hot country and, altho it has been carried to northern regions, it still requires hot weather to mature properly. The summers in the corn-growing regions of the United States, especially in the great Corn Belt, are generally very hot and the days long with a large proportion of sunshine. These hot summer days are often very uncomfortable to man, but they are just what the corn crop needs.

In addition to hot, sunny weather, corn requires a large amount of water, especially during July and August, or when the ears are filling out. At this stage the plants have reached their full size and have a tremendous leaf surface exposed. In the long, hot summer days water is transpired thru the leaves very rapidly and, of course, is being drawn just as rapidly from the soil by the corn roots. At this stage a shortage of water very quickly injures the crop.

Few soils have a large enough water-holding capacity to furnish corn with sufficient water for a very long time when the demands are so heavy. Consequently, frequent good showers are necessary during July and August to renew the soil supply. Some soils do not have a very large water-holding capacity because of their sandy, light character or because rock is near the surface. On such soils a rain is needed every week or ten days to prevent injury to the crop. Other soils are capable of holding much more water, and a good crop can be grown with less rain. This is true of bottom lands or deep soils which contain a large proportion of clay either in the surface or subsoil. The great areas of corn land in Illinois and Iowa hold water well and there are few crop failures there. In Kentucky the bottom lands will make a good crop of corn even in dry years.

Organic matter (decaying vegetable matter) helps soils to hold more water, and we can lessen drouth injury as well as make soils more fertile by keeping them well supplied with it. Injury from drouth is much more frequent in the South than in the main Corn Belt, partly because much of the land in the southern states is of a

sandy nature, but also because the soils, as a rule, contain so much less organic matter.

The best corn lands in the United States are black loams, well supplied with organic matter and rich in plant food of all kinds. Such are the prairie lands of Illinois, Iowa and other states, and the river-bottom lands of Kentucky. Corn is a rich-land crop. It requires, especially, a large supply of nitrogen to produce the rank, vigorous growth necessary for good yield. It does best where the small grains like wheat and oats are likely to produce such a rank, soft growth of straw that it falls. Corn is a rank feeder and can obtain its plant food from coarse manures, clover sods, etc., while other cereals need more easily obtained plant food. Perhaps the most profitable and safest place to use stable manure or coarse vegetable material of any kind is for corn. Also the best place in a rotation for corn is after a crop of clover, alfalfa, cowpeas, etc., which leave much nitrogen in the soil.

The ability of corn to yield when soil and climatic conditions are very favorable is, as has been said, much greater than that of other grain crops. The largest yield on record is 255 bushels on a single acre. Several times yields of over 200 bushels have been obtained from an acre, and large fields often yield over 100 bushels per acre. Several Kentucky club boys have grown crops of over 125 bushels on an acre.

The average yield of corn in the United States is less than 30 bushels per acre, and the average yield in Kentucky less than the national average. We have already discussed the influence of July and August rainfall upon yield. With very favorable soil conditions the water supply is probably sufficient to produce an average yield of 60 bushels per acre in Kentucky, if we consider a long term of years. In some instances, where soils hold water well, this average might be higher and in other cases lower. The chief reason for low yields of corn in Kentucky is not climate, but poor soils, and the average yield in the state can be almost doubled by making soils favorable for the crop.

Rotation of Crops. By rotation of crops is meant that the crops grown are changed around from field to field in a regular way from year to year. For example, a field may be in corn one year, in wheat the next, and in clover the next. Most farmers practice some rotation, and the best farmers work out a regular

system of rotation for their crops. There are many reasons why all farmers ought to practice rotations and it may not be out of place to mention some of them here.

1. Crop rotation helps to control weeds, insect pests and plant diseases. A pasture may become very weedy. The best thing to do is to plow it up and put the land in some cultivated crop where the weeds can be kept down. Where corn is grown for a number of years on the same piece of land, the soil may become infested with various insects which injure the crop. Another crop may not be injured at all. The same thing is true of plant diseases.

2. Crop rotations provide an opportunity to keep soils supplied with organic matter and nitrogen. Cultivated crops use up these materials rapidly. Grasses and clovers increase the organic matter. In a rotation of crops provision is made for plowing under catch crops and so further adding to the humus supply. This is, perhaps, the most important reason for rotating, where corn is grown, for this crop needs large quantities of nitrogen and organic matter, as has been stated.

3. In adding manures to land, certain crops—corn for example—can use them to better advantage than other crops. By rotation of crops we can get the best use of these materials, while giving the entire farm the advantage of them.

4. We save labor by crop rotation. Wheat and grass, oats, etc., can follow corn and tobacco without breaking the land.

Of course, the kind of a rotation practiced on any farm will depend upon how many different crops are grown, the kind of farming, whether stock or grain, and upon the topography of the land. For the corn crop, the important thing in a rotation is to have corn come at a time when the soil is in the best condition.

Let us try to plan a few rotations that would work well with the various crops grown in Kentucky.

Suppose we want to raise corn, tobacco and wheat, and also have some clover for hay and some grass for pasture. Perhaps a four-year rotation would be most suitable. This farm should be divided into 4 fields of about equal size or about the same acreage of each crop should be grown. One field could be occupied by corn and tobacco, the second by wheat, the third by first-year clover and grass, and the fourth by second-year clover and grass. One of the latter two fields could be used for hay and one for pasture. If

more pasture were needed, the rotation could be made longer by leaving the land in grass longer. The next year field No. 4 would go in corn and tobacco, wheat would go where corn and tobacco had been and clover where the wheat was.

Another rotation that can be used where clover does not grow well is this: Corn and tobacco first year, wheat second year, followed by cowpeas to plow under. Third year, soybeans for hay, followed by grass. Fourth year (or more) grass for pasture.

Fertilizers. Kentucky Extension Circular 54 contains a series of lessons on soil fertility, so we shall not give much space here to discussing the problem of keeping land productive. In those lessons you are told to use phosphorus and lime where the soils do not contain enough of these materials to raise good crops. Of course, they should be used for corn as well as other crops. You are told also that nitrogen and organic matter must be added to soils by the use of stable manure, plowing under leguminous crops etc. In case of some crops, commercial nitrogen can be used profitably, but this is seldom true with corn.

Dent Corn Varieties and Adaptation. As stated in lesson III, the Indians apparently did not develop dent corn unless gourdseed corn be considered a dent. However, it certainly differed greatly from dent corn as known today. The first dents probably were selected from mixtures resulting from crosses of flint and gourdseed. Since gourdseed was a late corn, the first dents were doubtless medium late also and not suitable for growing much farther north than Virginia. Probably early dent varieties were obtained by crossing these late dents with early flints. Possibly, too, soft corn entered into some of the crosses. It seems evident that much mixing of types and varieties continued all thru the first half of the last century, particularly in the great Mississippi Valley corn-growing areas. This widespread mixing or hybridizing followed by selection, produced in each region of the United States varieties of dent corn more or less peculiar to the region and representing adaptation to its soil and climatic conditions. The varieties best adapted to any particular area, as measured by yield, are usually those which occupy most of the growing season. To grow earlier varieties than necessary, results in lower yield because later-maturing varieties produce larger plants and consequently larger ears. Yield, of course, depends largely upon size of ears.

A large majority of the hundreds of varieties of dent corn developed are of only local importance. A few, however, partly because of superior merit and partly because they happened to attract national attention in some way, as, for example, by consistently winning prizes at corn shows, have become widely distributed and have largely replaced local varieties. One of the best known of these is Reid's Yellow Dent, classed as medium late in the main Corn Belt, and as a medium early in Kentucky. This and strains selected from it, such as Krug, Iodent, Black, etc., are the most widely grown varieties in the main Corn Belt. Reid was developed by Mr. Robert Reid, who brought to Illinois from Brown County, Ohio, a yellow variety known as Gordon Hopkins corn in 1846. This was crossed with a small yellow local variety, and from the hybrid thus produced, selection was begun. Selection was continued by Mr. Reid for many years and later by his son who won a prize with this corn at the World's Fair held in Chicago in 1893. This advertised it widely. Another extensively grown variety, Leaming, developed by James Leaming in Ohio, became widely grown largely because of the publicity it received from winning prizes at the World's Fair in Paris, in 1878. Leaming is a rather early variety and is no longer so popular as in former years. Other widely grown varieties are Boone County White, a late variety developed in Central Indiana; Iowa Silver Mine, a medium early white developed by J. A. Bagley, of Illinois; St. Charles White, a popular variety in Missouri for many years; Kansas Sunflower, a late yellow, and Pride of Saline, a late white, both originating in Kansas; Minnesota 13, a very early yellow, originated at the Minnesota Experiment Station; Clarage, a standard early yellow in Ohio; Golden Glow, an early yellow produced by the Wisconsin Experiment Station; Tennessee Red Cob, and Hickory King, long a favorite in the South, especially for thin land. Many other varieties are important in certain areas.

Kentucky has never produced a variety of corn that became widely known, altho numerous local varieties are grown. A large part of the corn acreage in the state is now planted to varieties originating in adjoining states. Boone County White and the apparently identical Johnson County White, Pride of Saline, late strains of Reid's, St. Charles White, Tennessee Red Cob, Neal's Paymaster and Hickory King are most extensively grown.

Because dent corn was developed from such a complex mixture, and because it is a cross-fertilized plant, none of the varieties produced is very uniform in many plant characters. Close inspection of a field of Reid, for example, will show that individual plants vary considerably in time of maturity, position of the ears on stalks, shape of ear, number of rows of grain, shape and type of grain, and in most other characters. Actually the variety breeds true only for color of grain and cob. It is possible by starting with a very limited number of plants and selecting closely for uniformity, to obtain much greater uniformity than exists in any of our present corn varieties. Because of the very close breeding necessary to obtain such uniformity, however, yield may be reduced just as vigor in the corn plant is reduced by artificial self-pollination. For most purposes, great uniformity except in color of grain is not of importance. The most important characters to select for are vigor, freedom from disease, strong stalks and roots and good yield.

It was stated that much of the corn acreage of this country consists of a relatively few varieties. It is more accurate to say various strains of a few varieties. After a variety of corn leaves the originator's hands and is carried to different parts of the country, it may come to differ quite markedly in various respects from the original type. Sometimes the effect of a change of environment is immediate. Several years ago the Kentucky Experiment Station obtained seed of a variety from Michigan. There it grows 7 or 8 feet high, produces good-sized ears, and yields well. In Kentucky it grew only 5 to 6 feet high and produced ears about 6 inches long. It yielded little more than half as much as the ordinary Kentucky varieties. If this variety had continued to be grown, it would doubtless have become larger because the largest ears would have been saved for seed and the largest ears come from the latest-maturing plants, which are also the largest plants. In this way varieties become adapted to the environment to which they are moved and as a consequence we have numerous strains of the same variety, which explains the wide adaptation of certain varieties. Kentucky strains of Reid are about 10 days later than Iowa strains, and most of the Boone County White grown in the state is later-maturing than Boone grown in central Indiana where it originated.

If a farmer has a productive variety of corn to begin with and

selects for seed each year large, sound ears, it will yield in most instances better than any variety he can find. However, it is a good plan to try other varieties in a small way to determine if they are better than the home variety. When necessary to buy seed, it is safest to get it near home; if that is not possible, then from a place where the climate is like that at home. Corn from Kansas and central and southern Missouri does well in Kentucky, as a rule.

Corn Breeding and Hybrid Corn. While modern varieties of dent corn are far superior to the older varieties in uniformity and many other characters, it is doubtful if they yield much better. Apparently, therefore, mass selection, the method followed in developing our standard varieties, is not effective in increasing yield. Another method widely tested by experiment stations and other research agencies a number of years ago was known as ear-to-row breeding. This consisted in determining the relative yielding capacity of a large number of ears of an adapted variety. In most instances, two or three 25-hill plots, systematically distributed, were planted from each ear and the seed left was saved for planting the following year. The yields of the plots planted from each ear were accurately determined. Usually the yields of the plots grown from different ears differed greatly. The next year the remnants of the 15 or 20 ears which had produced the highest-yielding plots were mixed together and planted in an isolated plot to prevent crossing with other corn. Theoretically, seed from this plot should yield more than the original corn. In most instances, however, it failed to do so and ear-to-row breeding was discontinued. Later, many experiment stations crossed different varieties of corn and compared the yields of the first-generation hybrids thus obtained with the yields of the parents. In a few instances some increase was obtained but not enough to pay for the trouble of producing the crossed seed each year.

Finally, however, corn breeders did find a method of breeding by which it is possible to produce seed that yields much better than seed of ordinary cross-fertilized varieties of corn. This is known as hybrid seed. The method used in producing hybrid seed is rather simple altho it is not easy to explain why it gives such good results. To begin the work the breeder goes into the fields planted to well adapted varieties of corn and self-pollinates a large

number of ears. At the Kentucky Experiment Station the inbreds produced have come chiefly from Boone County White, late strains of Reid, Neal's Paymaster, Iowa Silvermine, Jarvis, Woodburn White Dent, and local varieties. As has already been explained, corn is self-pollinated by putting a small paper bag over the ear shortly before the silk appears. Generally a semi-transparent glassine bag is used as the silks can be seen thru such a bag without removing it. As soon as the first silks appear, the tip of the ear is cut back a half inch or so and the small bag replaced. At the same time the tassel is covered by a 12-pound pinch-bottom paper bag which is fastened tightly around the stalk by pinning or with a paper clip. In about two days the silks will have grown out again and pollen has collected in the tassel bag. The tassel bag is removed, care being taken not to spill the pollen which is a yellowish powder. Then the small bag is removed from the ear and the pollen poured over the silk. Finally the large bag is put over the ear to replace the small bag and fastened to the stalk with a pin or paper clip. This keeps out pollen from any other source. Usually the bag is left on until the corn ripens. If heavy rains occur before the ears can be pollinated it may be necessary to replace the tassel bag since water-soaked pollen makes a pasty mass which cannot be used in pollinating.

Perhaps the best way of explaining how pure inbred lines are produced is to give the history of one of the Kentucky Experiment Station inbred lines, Kentucky inbred 122, for instance. In 1928 a number of plants in a field of Boone County White corn were self-pollinated and 40 inbred ears were obtained. Each of these ears was the starting point of an inbred line. They were designated as B28-101, B28-102, B28-103, etc., the letter B indicating they were from Boone County White and the number 28 indicating the year the selfing began. The next year, 1929, a row of about 40 plants was grown from each ear. The effects of one year's inbreeding are quite evident in corn as shown by a considerable decrease in size of the plants and ears and in some lines a great reduction in vigor. The best plants in the best rows were self-pollinated but about a third were considered too poor to carry on. B 28-122 was one of the good ones and four of the self-pollinated ears of this line were saved. In 1930 a short row was planted from each of these ears but corn was a failure that year because of drouth. The

remnants of the ears had been saved, of course, in view of such an emergency and again a row from each ear was planted. Some plants in each row were self-pollinated but at harvest time when it was possible to determine the relative desirability of each row, the selfed ears from only one row were saved. In 1932 a row was planted from each of the three best ears but only the self-fertilized ears from one row were kept to carry on the line. The same procedure was followed in 1933 and 1934. By this time the line had become so uniform that it was evident the inbred was practically a pure line. Of the 40 strains only 5 including B 28-122 were kept. As noted, some were discarded the first year. Later others were dropped because of some abnormal character or because of low yield, susceptibility to disease, weak stalks, etc. This indicates the importance of starting with large numbers of inbreds in order to obtain good inbred lines. Since constant selection is practiced this method of obtaining desirable inbreds is known as selection in self-fertilized lines.

After 5 or 6 generations of inbreeding it is safe to raise an inbred line in an isolated plot—at least 40 rods from other corn—and allow it to cross pollinate. Possibly a small amount of hybrid vigor will show in the next generation grown from such seed but not enough to be of importance. It is necessary, however, in order to keep inbred lines pure to do some hand pollinating each year. Most inbred lines are quite dwarfish and produce small ears with small grains, often like popcorn. The most productive inbreds seldom yield half as much as ordinary corn. When two unrelated inbred strains are crossed, however, the first-generation plants are of normal size and often yield 10 to 20 percent more than the best adapted, open pollinated varieties. The seed obtained by crossing two inbred strains of corn is known as single-cross seed. Small amounts for testing are obtained by hand pollination. Where larger amounts are wanted, the two inbreds are grown in an isolated plot. One serves as the male or pollen parent, the other as the female or seed parent. In planting, one row of the male is alternated with two rows of the female. If one inbred is later than the other, it should be used as the male parent. When the tassels begin to appear on the female plants, the plot is gone over every day so the tassels on the female plants can be pulled out before they shed any pollen. If this is done, all the female plants will be

pollinated with pollen from the male rows, thus giving a perfect cross.

As stated, inbred strains do not yield much and the seeds are small. It is not practical, therefore, to use single-cross seed for general planting. To overcome this difficulty, two single crosses are crossed in an isolated plot just as in producing single-cross seed. Since the first generation of a single cross produces heavily, good yields of full-size seeds are obtained from the cross. The seed obtained from crossing two single crosses is known as double-cross hybrid seed. Practically all commercial hybrid seed sold at the present time is double-cross seed.

Not all combinations of inbreds are superior. In fact, some are very poor. The breeder must therefore test all possible combinations in order to find the best. This is the really difficult part of corn breeding.

Good hybrids not only outyield ordinary corn but have much stronger stalks and better root systems. They are also more resistant to disease in many instances. The use of hybrid seed has increased very rapidly in recent years and in the great corn growing states a large percentage of the crop is now grown from hybrid seed. The Kentucky Experiment Station has produced several good white hybrids and considerable amounts of seed of these hybrids are grown in the State. These have been the highest yielding hybrids in the yield tests conducted in various parts of Kentucky. Some of the later yellow hybrids from the Corn Belt are also adapted to Kentucky and are far superior to any of the yellow varieties grown. Seed of these yellow hybrids is produced by a number of Kentucky growers.

Importance of a Good Stand. It is estimated that the average stand of corn in Kentucky is only 75 percent perfect. Of course, there are many reasons for imperfect stands. Cutworms, wireworms and other insect pests destroy many plants. Crows and sometimes other birds, and moles do considerable damage. Some hills are destroyed in cultivating and, finally and most important of all, poor seed causes poor stands of plants. It is probably safe to say that one-half the missing plants in a field of corn are missing because the seed failed to grow. As has been pointed out frequently, there is no way of increasing the yield of corn so cheap-

ly as by planting seed all of which will grow, for it costs very little to take good care of the seed and to test it before planting.

Care of Seed. The corn crop of Kentucky usually matures well and a large percentage of it is sound. If thoroly dry before severe freezing weather, most corn will grow, but if it contains much moisture at that time it is likely to be injured for seed, for the freezing of the water in the grain breaks apart the tissues. To be certain of having good seed the seed ears should be gathered in late October and spread out in thin layers or, better, hung up where the air can circulate freely. Under such conditions the corn dries rapidly and is usually dry enough by the time freezing weather occurs to stand low temperatures without injury. Two methods of hanging up seed corn are shown. Occasionally the fall is so cool and damp that corn cannot be dried without the aid of heat. If a basement with a furnace is available, this solves the problem nicely. Sometimes a tobacco stripping shed or a toolhouse can be used. Commercial seed growers should by all means provide facilities for drying the seed artificially when necessary.

Testing Germination. When seed corn has been cared for properly, there is little danger of poor germination; however, to be on the safe side, it is advisable to test germination before shelling the corn. From each of 50 ears taken at random shell 8 or 10 grains. Mix the shelled corn together thoroly and plant a hundred grains in a box of moist sand. Keep in a warm place and water well to prevent the sand becoming dry. Good seed should show a germination of 95 to 98 percent but germination of 90 percent is fairly satisfactory. When seed corn is selected from the crib, it is highly important to make a germination test. If less than 90 percent of the seed germinates, it pays to make a germination test of each ear. The rag-doll test is perhaps the simplest of all home-made testers. To make the rag doll test, use strips of canton flannel or muslin about 10 inches wide and 40 to 60 inches long. A 60-inch strip provides spaces for testing 40 ears. Spread the cloth on a table and make a line lengthwise thru the center with a soft lead pencil and cross marks every 3 inches to within 4 or 5 inches of the ends. Number each space, placing the numbers near the edges. Now moisten the cloth thoroly and spread out again. Take a kernel from 6 different places on one of the ears to be tested and place the six kernels in one of the numbered spaces on the cloth.

Number the ear to correspond to the number of the space. This may be done by writing the number on a small square of stiff paper or thin cardboard which is then attached to the butt of the ear with an 8d nail. When the spaces have all been filled, the cloth is rolled up rather loosely and rubber bands placed around the middle and at both ends. The middle band should be rather loose and the end bands tight. Light cord may be used instead of the more convenient rubber bands. Soak the dolls in lukewarm water for about an hour. Then wrap up in a wet burlap sack and set on end in a pail or stone jar. For good ventilation and to permit surplus water to drain out, an inverted pan should be placed in the bottom of the pail or jar. Keep where the temperature does not fall below 60°F and sprinkle often enough to keep the dolls moist. After the seeds begin to sprout, take off the end bands.

The germination test should be ready to read in 5 or 6 days. Carefully unroll each doll and note results. If all six kernels from any ear have not produced strong sprouts, the ear should not be used for seed. The labor cost of individual ear testing with the rag doll, as determined at the Iowa Experiment Station, averaged 18 cents per hundred ears. This seems very low. However, even if the cost is 50 cents per hundred ears and only one-fourth of the ears prove suitable for seed, the cost of obtaining enough good seed for an acre is only about 25 cents.

Shelling and Grading Seed Corn. To obtain a uniform drop of corn where machine planting is done, and hence an even stand, it is necessary that the seed be fairly uniform, especially in thickness of kernel. Fair uniformity may be obtained usually by removing the butt and tip grains before shelling the ears. If further uniformity is desired, and it is advantageous where the grower does not want to thin a stand, it is necessary to use a seed-corn grader. A small one quite satisfactory for grading a few bushels of seed can be purchased for about a dollar. These small graders usually make two grades of flat grains and remove thick, round grains.

Commercial growers employ large, power graders which make a number of grades of great uniformity. A large proportion of the commercial seed offered for sale at the present time is hybrid seed and this is usually very carefully graded. In shelling hybrid corn only the damaged tip grains are discarded. The large grains

from the butts of the ear and the small round grains from near the tip grow just as well as the flat grains and yield just as much corn. They are therefore graded out and sold at a lower price. For hand planting these grades are perfectly satisfactory and by selecting planter plates with the proper sized holes they may be planted quite uniformly with a corn planter.

Questions on Lesson IV. 1. What kind of climate does corn need? What kind of soil? At what stage of growth does a shortage of water cause most injury? 2. How can soil be made to hold more water? Where are the best corn soils found? 3. How much corn per acre has been grown? What is the average yield in the United States? What are the chief causes of low yield? How may the yield be increased? 4. Name four reasons why crops should be grown in a rotation. How should one decide what rotation to follow? Give a good rotation for a farm where a large amount of corn is grown. 5. Tell how our modern varieties of dent corn have been developed. How can the wide adaptation of a few varieties of corn be explained? 6. Name the most widely grown varieties of corn in Kentucky. Why is it best to raise varieties that require most of the growing season to mature? 7. What is hybrid corn? Describe the production of hybrid seed corn. Why has it become so popular? 8. Why should seed corn be dried before freezing weather? What is the best way of handling seed corn? 9. Describe the "rag doll" method of testing individual ears for germination. When does it pay to make an individual ear test of seed corn? 10. Discuss shelling and grading seed corn.

LESSON V

CORN (continued)

Plowing. It seems to make little difference in the yield of corn in Kentucky whether land is plowed in the fall or winter or early in the spring. When the soil washes badly, as on hilly land, spring plowing is, of course, best. On level land or where stiff sod is to be plowed, fall plowing can be done safely and is desirable, as it lessens the amount of work to be done in the busy spring season and helps get the planting done at the best time. Spring plowing should be done as early as the land is in condition to work, because it prevents loss of moisture. However, when land needs organic matter quite badly, it often pays to plow late so a good growth of rye or crimson clover can be plowed under. In late plowing, the land should be dragged down as fast as plowed, to prevent clods from getting hard. Much labor can be saved if this is done. As a matter of fact, when plowing in hot, dry weather, one should wait but a few hours to follow with the drag.

In fitting land for planting, the problem is to make a loose, level seed bed, free from large clods, with just as little labor as possible. Where land is fall or winter plowed it is best to disk deeply as early as possible in the spring and, if any clods are thrown up, to follow with a smoothing or drag harrow. If very hard rains occur before planting time, it may be necessary to disk again, but under ordinary conditions the land can be kept in good condition by running over it occasionally with a drag harrow. Land ought always to be worked just before planting corn, to destroy all weeds at that time and give the corn a chance to get ahead of the weeds. The best time to cultivate a corn field is before the corn is planted.

Planting. In planting corn the common practice in the neighborhood is the safest guide. Farmers have learned by years of community experience the best time to plant and the best rate of planting. In Kentucky, corn generally is planted in rows $3\frac{1}{2}$ feet apart. There seems to be little difference in yield whether planted in hills or drilled, but checked hill corn is so much easier to keep clean that this method is generally advisable, except where corn is planted on hillsides. Then the rows should follow the contour of the hill to prevent washing of the soil.

It makes little difference, as far as yield is concerned, how corn is planted; whether by hand, by one-horse planter, or by check-rower. It is simply a question of getting the work done most cheaply

and quickly. The farmer who grows a large acreage should use a two-row planter, if possible, but the smaller farmer can get along very well with a cheaper planter or can plant small fields by hand.

There is no advantage in planting corn deeper than necessary to get the seed well covered in moist soil. Very deep planting makes the corn longer in coming up and in cold, wet seasons may prevent its coming up at all. The belief that deep planting will cause corn to root deeply is a mistake, for, as already explained, the permanent roots will be formed at a certain depth regardless of the depth of planting. In dry regions corn often is planted in the bottom of furrows and as it grows the soil is worked into the furrows. In this way only can corn be made to root deeply. This method is known as listing. It probably cannot be practiced safely in Kentucky because of danger of drowning out when heavy rains occurs.

The rate of planting or the number of plants grown per acre should be determined by the fertility of the soil and its ability to hold moisture; also by the variety of corn grown. On uplands the general custom is to leave two stalks per hill, with the hills $3\frac{1}{2}$ by $3\frac{1}{2}$ feet apart. If drilled, the stalks stand about 21 inches apart. In seasons of abundant rain thicker planting gives larger yields, but on an average two stalks per hill is the safest rate with large-growing varieties. On bottom land three stalks per hill, or the equivalent in drilled corn, is perhaps the best rate. Early varieties may be planted somewhat thicker.

Cultivation. The chief purpose of the cultivation of corn is to prevent the growth of weeds. The young corn plants are so far apart that they cannot check the growth of weeds until the corn is large enough to shade the ground. Small grains, on the other hand, are seeded thickly, and very quickly occupy the ground completely, thus checking the growth of most weeds. Then, too, the small grains are either fall sown or sown very early in the spring and usually have made considerable growth before seeds of most weeds germinate. Corn is planted at the season most favorable for weed growth. Cultivation does not benefit the small grains, hence it is fair to assume that it does not benefit corn to any large extent except by keeping down weeds. In several experiments where weeds have been kept shaved off with hoes and the soil disturbed as little as possible, as good yields of grain have been produced as where the crop was given cultivation.

Weeds injure corn by robbing the soil of moisture, shading the plant and using up plant food. A heavy growth of weeds evaporates large quantities of water from the soil. We know how essential to good yields plenty of moisture is at certain stages of growth, and how often corn suffers for water even when given the best cultivation. It is plain, then, that the loss of moisture is the chief cause of injury by weeds. In a certain experiment where weeds were allowed to grow in a plot of corn, a yield of 17 bushels of corn an acre was obtained. On an adjoining plot given good cultivation, the yield was 79 bushels an acre. It is not doubted, however, that cultivation is beneficial in other ways than by destroying weeds, in certain seasons and on certain soils. It retards the loss of moisture while the corn is small, for moisture escapes more rapidly from an unstirred soil than from cultivated soil. When the plants are large enough to shade the ground and the roots reach all thru the soil, there is little chance for moisture to escape, and further cultivation is not of value as far as saving moisture is concerned.

Some soils run together after heavy rains and get very hard. If this happens when corn is small, there is little doubt that cultivation will benefit the crop by making better conditions for the spread of roots. From what has been said, we may conclude that corn should be cultivated often enough to keep down weeds until the plants are about 4 feet high. If clean at this time, further cultivation will scarcely pay.

Much has been written about the depth of cultivation and many experiments have been conducted to discover the effects of cultivating at different depths. Most experiments have shown that deep cultivation, except when the corn is very small, breaks many roots and reduces the yield. In addition, it makes the work harder on the team.

The first cultivation can be done most rapidly and effectively with a harrow or weeder. These implements can be used just as soon as the corn is up well and while too small to be cultivated with an ordinary cultivator. Very little corn will be destroyed if the work is done carefully, and the weeds in the rows and around the hills will be killed before they have gotten firmly rooted. A new implement known as a rotary hoe is excellent for broadcast cultivation.

If the soil becomes hard and packed, the first working with the cultivator may be deep. It is best to cultivate after rains, as weeds

start at this time, and if the ground gets hard it is difficult to prevent the clods from covering up the young plants. Cultivation after the soil has become hard and dry is likely to do much injury to the crop. In Kentucky, four cultivations usually are sufficient.

The best implement for cultivating corn when a crop of good size is grown, is a two-horse cultivator with three or four shovels or wide sweeps or knives on each gang. For very large crops, two-row cultivators, which cultivate two rows at each passage, can be used to advantage. No one who raises more than 10 acres of corn can afford to use one-horse implements. Effective, shallow cultivation is impossible with a two-shovel cultivator.

Harvesting. In most parts of the main Corn Belt, the corn is not cut but the ears are gathered from the standing corn and the stalk fields are then pastured with cattle. In Kentucky much of the corn is cut. The former method is cheaper, but fodder is a valuable feed and if labor can be had to cut the corn, it is a paying proposition. It is very important that fields that have grown a cultivated crop be planted to a cover crop to prevent leaching of plant food and soil washing. In order to sow cover crops it is usually necessary to cut corn.

Hogging down corn saves cutting and husking and little is wasted if handled right. A portion of the crop can be hogged down profitably on many farms in Kentucky.

Corn should be cut when the ears are fairly well ripened. If cut too green, there is some loss in weight of grain. Topping corn or pulling blades is a very unwise practice. It reduces the yield greatly and costs more than the feed is worth.

Corn should be put into the silo when the grains are firm and dented, but before the blades on the stalks are dried up. Large-growing southern varieties of corn give the largest yields of silage. Eureka, Pamunkey, Neal's Paymaster, and some of the prolific varieties are most widely used in Kentucky.

Questions on Lesson V. 1. What can you say about time of plowing land for corn? What are the advantages of fall plowing? Spring plowing? 2. Describe the preparation of the seed bed for corn. 3. When and how should corn be planted in Kentucky? How deep should corn be planted? What is listing? 4. How thick should corn be planted? 5. Why do we cultivate corn? How do weeds injure corn? How often should corn be cultivated? How deep? 6. What can you say about harrowing corn? What is the best implement for cultivating corn? 7. Does it pay to cut corn? Why? 8. Is it profitable to hog corn down? Why? When is corn ready to cut?

LESSON VI

TOBACCO

Tobacco ranks seventh in value among the crops of the United States. Production has averaged about 1,300,000,000 pounds during the last 10 years and value about \$225,000,000 which is about one-third the annual value of the wheat crop of this country. It requires more than 50,000,000 acres of land to produce the wheat grown each year, however, while the tobacco crop occupies only about 1,800,000 acres. Apparently, therefore, the average gross income from an acre of tobacco is almost 10 times as much as from an acre of wheat. This, of course, does not mean that the profits are 10 times as great for the cost of producing tobacco is relatively high.

Unlike most other important farm crops, tobacco production is concentrated in limited areas. North Carolina is by far the most important producing state, having wrested that honor from Kentucky 10 to 12 years ago. North Carolina now produces about one-third the total crop and Kentucky about one-fourth. These two states together produce considerably more than one-half the entire crop of the country. During the past few years tobacco has brought North Carolina growers an average return of over \$100,000,000 yearly, or more than all other crops combined. Next to tobacco is cotton with an annual value of about \$50,000,000. The tobacco crop of Kentucky has had an annual value of about \$50,000,000 in recent years, or about the same as the corn crop. The latter occupies nearly 3,000,000 acres, however, as compared with an average of 400,000 acres of tobacco.

Virginia and Tennessee each produce about one-third as much as Kentucky, or from 100,000,000 to 125,000,000 pounds annually. The crops of South Carolina and Georgia average slightly over 100,000,000 pounds, those of Pennsylvania and Wisconsin 45,000,000 pounds, while Ohio, Maryland and Connecticut produce from 20,000,000 to 30,000,000 pounds each. Other producing states and the approximate amounts produced are: Massachusetts 10,000,000 pounds; Florida 10,000,000, Missouri 5,000,000, and West Virginia 3,000,000 pounds. Minnesota, New York, Kansas and Louisiana also produce small amounts.

Tobacco, like all intensive crops, is of greatest value in regions where the soil is low in natural productivity or where the land is very rolling. Poor soils require heavy fertilization to produce good

yields and the cost of fertilization is so great that crops of low acre value such as corn and wheat cannot be grown profitably. Rolling land is difficult to cultivate and when cultivated frequently it is almost impossible to prevent serious erosion. Where an intensive crop is available, it is necessary to cultivate only a small acreage each year and the rest of the land can be kept in pasture and meadow. Much of the farm land in Kentucky is very rolling which explains why tobacco is a crop of such great importance in this state. Tennessee is much like Kentucky in topography. In North Carolina, South Carolina, Georgia and Southern Virginia are large areas of poor, sandy soil of low water-holding capacity, very poorly adapted for corn and other common farm crops. It is just the type of soil needed for producing flue-cured tobacco, however, and because this kind of tobacco is in such strong demand and sells for a relatively high price, it is by far the most profitable crop that can be grown in these areas. Its only competitor is cotton which has not been profitable in recent years.

Origin of Tobacco and Early History. Tobacco is native to the Americas. Early explorers found Indians in all parts of the country using it in various ways, chiefly for smoking. It is believed, however, that North American Indians used it only for ceremonial occasions; as, for example, in concluding a peace pact when the peace pipe was smoked. Tobacco belongs to the nightshade family in which is also included such well-known plants as the potato, tomato, eggplant, jimson weed, horehound and black nightshade. Some members of the family are poisonous. Tobacco itself contains a poisonous substance known as nicotine, and when its products are used to excess, the nicotine may cause serious injury to the body.

The generic name of tobacco is *Nicotiana*. It was named in honor of a Frenchman, Jean Nicot, who was the first man to describe the plant. There are a number of kinds of species of *Nicotiana*. The only one cultivated to any extent, however, is *Nicotiana tabacum*, which is a South American species. The species most common in North America is *N. rustica*, which grows wild yet in some parts of the United States. It has much smaller leaves than common tobacco and yellow flowers. Whether or not it was cultivated by the Indians is not known. Evidently *N. tabacum* had been culti-

vated, however, and it seems that the Indians of South America and the West Indies had several varieties.

Tobacco was carried to Europe by some of the early explorers and eventually the people there learned to like it. Sir Walter Raleigh is believed to have been the first man to use it in England. In spite of efforts to keep people from using it, the habit spread rapidly and soon there was a demand for every pound that could be obtained. Traders got the early supply from the Indians in the West Indies and South America and later from the Spanish Colonists in Mexico and the West Indies, who had begun to cultivate the crop. Soon after the first settlement was made by the English at Jamestown in Virginia, the Colonists began to grow tobacco for the European market. They found it to be just the crop they needed. It brought a high price for a time and could be used in place of money to purchase the many needed articles from Europe. The best feature of this crop was the large return it gave from a few acres of land. The country was heavily wooded and it took time and much labor to clear land for cultivation; hence it was necessary to obtain as large an income as possible from what could be cleared.

Boys and girls who have studied history learned how important the tobacco crop became in Virginia; how growers were troubled with unfair trading restrictions, and how it brought about rapid development and much wealth to the colony. It played almost as important a part in the development of Maryland which was settled a few years later than Virginia.

Neither the Virginia nor the Maryland Colonists attempted to raise the wild tobacco of North America, *N. rustica*, as it is not well adapted to cultivation. Instead each obtained from South America or the West Indies seed of a variety of *Nicotiana tabacum*. These two varieties came to be known as Virginia tobacco and Maryland tobacco. From them have probably developed nearly all the varieties of tobacco used in this country except some of the cigar varieties.

During the colonial period, the culture of tobacco was almost entirely confined to Virginia and Maryland. Nearly all was exported. After the Revolutionary War the culture of tobacco spread into Kentucky and adjoining areas, settled largely by Virginians. Later the Carolinas became important producing states. In addition to the old Virginia types, new types were developed better adapted for domestic consumption. The production of cigar tobacco also

was begun in several areas in the North and in a small area in Florida. In the discussion of types which follows, later developments in the industry are indicated.

The tremendous increase in the consumption of cigarettes during the past 20 years has had a profound effect upon tobacco production. In 1938 more than 160 billion cigarettes were smoked in the United States alone and this product has become almost as popular in many foreign countries. More than half of all the leaf tobacco consumed in the manufacture of tobacco products in this country is used for making cigarettes. As a result, demand for types of tobacco suitable for making cigarettes has increased rapidly while demand for other types has declined. Today approximately three-fourths of all tobacco produced in the United States is of cigarette types, chiefly flue-cured and White Burley.

American Types of Tobacco

Each kind of tobacco grown in the United States is specially adapted for the manufacture of a certain product or products or, sometimes, for a part of a product. These different kinds of tobacco are known as types. The differences in the characteristics of the various types are the result of differences in the character of the soil upon which they are grown, in the method of curing, variety of seed used, climatic conditions and cultural methods. Certain types are used principally for manufacturing cigarettes, smoking tobacco, chewing tobacco and snuff. These are known as *manufacturing types*. Most of our exports are of these types. The other types are used chiefly for manufacturing cigars and are known as *cigar types*. The difference between these two groups of types is quite marked. Most of the cigar tobaccos are grown in the northern part of the country, while the manufacturing types are grown chiefly in the South. They are sold in different markets and usually manufactured in different plants. Much more of the manufacturing types is grown than of the cigar types.

The types of tobacco grown in Kentucky, North Carolina, Virginia, Tennessee, Georgia, South Carolina and Maryland are all manufacturing types. Pennsylvania, Wisconsin and Connecticut, raise only cigar types, while Ohio and Florida raise both types.

Based on the method of curing, the manufacturing types are classified as flue-cured, open-fire-cured and air-cured. The cigar types are classified, according to use, into fillers, binders, and wrap-

pers. The main part of a cigar, the inner part, is known as the filler. This is wrapped first by strong, elastic leaf known as binder. The wrapper is the thin leaf on the outside.

Since Kentucky produces only the manufacturing types of tobacco, we will confine our study to these types. It may be said, however, that the methods followed in producing cigar tobacco are very much like those followed in producing White Burley. Fillers have rather heavy body and are grown in good loam soil. Wrappers and binders are grown on sandy soil and are light in body. Some of the finest cigar wrappers are grown under shade provided by cloth such as is used in Kentucky on tobacco beds. To provide the shade costs about \$300.00 an acre which makes the production of shade-grown wrapper very costly. However, good wrapper leaf sells at a high price, often for a dollar or more per pound.

Fire-cured Types. The Virginia colonists first tried air-curing their tobacco, but as the early settlements were near the coast where humidity is high, they had much trouble with houseburn. Furthermore air-cured leaf often damaged in shipment to European markets. As a result the practice of curing with wood fires developed. European consumers learned to like the smoky flavor and practically all tobacco grown in Virginia was cured in this manner during the colonial period. Kentucky and northern Tennessee were settled largely by Virginians and tobacco became an important crop there also. Most of the tobacco produced in the early days in these states was probably fire-cured and was sent by river to New Orleans for shipment abroad. Fire-cured leaf continued to be our principal export type until comparatively recent years.

There are four fire-cured tobacco districts; one in Virginia and three in western Kentucky and northwestern Tennessee. The best leaf is produced on the rich, limestone soils around Hopkinsville, Kentucky, and Clarksville and Springfield, Tennessee. This district is known as the Hopkinsville-Clarksville District. West of the Tennessee River in Kentucky and extending south into Tennessee is the Paducah-Mayfield District and north of the Clarksville and Hopkinsville is the Henderson Stemming District. These Kentucky-Tennessee Districts are often spoken of as the "Black Patch." The largest production of fire-cured tobacco in history, approximately 300,000,000 pounds, was in 1919, following the close of the World War. Probably 250,000,000 pounds of this were exported. During

the past 10 years production has fallen off very rapidly because of a declining export demand. Production in 1936 amounted to only about 100,000,000 pounds and exports to about 50,000,000 pounds. The decline in production has been greatest in the Virginia and in the Paducah-Mayfield districts. The Clarksville and Hopkinsville district produces about half the total crop of fire-cured tobacco at the present time.

The cured leaf of fired tobacco is of large size and varies in color from dark red to dark brown or almost black. It has very heavy body—that is the leaves are thick. It is a strong tobacco and smells strongly of smoke. Fire-cured tobacco is used in domestic manufacture chiefly for making snuff. About 35,000,000 pounds are consumed annually by the snuff manufacturers who pay good prices for leaf that meets their requirements. Other grades have sold at a low price in recent years and the crop has not been profitable in most years. There is little chance of improved markets for fire-cured tobacco and it seems likely that production will continue to decline.

Dark Air-Cured Types. The dark air-cured types are those types of air-cured tobacco in which the cured leaf is dark in color. They are (1) the Green River type, (2) the One-Sucker type, and (3) Virginia Sun-cured. They were developed after the colonies had become independent of English rule and as a result of a demand by American consumers for products without the smoky flavor of fired tobacco. Just when the production of air-cured tobacco became important or where it was first grown extensively, is not clear. In addition to the three districts named, Mason and Bracken counties in Kentucky and Brown and Clermont counties across the river in Ohio, raised considerable amounts of dark air-cured tobacco previous to the advent of White Burley. Tobacco from this area was considered of fine quality by manufacturers.

The Green River type is produced in several counties of western Kentucky chiefly Daviess, Ohio and McLean. For many years a large part of the tobacco grown in the Henderson fired-tobacco district has been air cured and is classified as Green River. Owensboro is the principal market but the Green River leaf produced in the Henderson District is sold chiefly at Henderson along with the Henderson fire-cured type.

The varieties of seed used in producing the Green River type

are similar to those used in fire-cured tobacco districts and cultural methods are also similar. Since the tobacco is air cured, however, the cured leaf is lighter in color than fired leaf. Previous to the discovery of Burley tobacco, much of the Green River crop was used to make domestic chewing and smoking tobacco. Later it became an important export type, Great Britain being the chief buyer. Production in some years has exceeded 60,000,000 pounds. The loss of most of the foreign market and the preference for other types of tobacco for the manufacture of domestic products, has



Field of dark tobacco.

forced a tremendous decrease in production of the Green River type. During the past few years only about 15,000,000 to 20,000,000 pounds have been produced. Where production has exceeded this, disastrously low prices have resulted. Burley tobacco is now grown extensively in the Green River district, particularly in Daviess County.

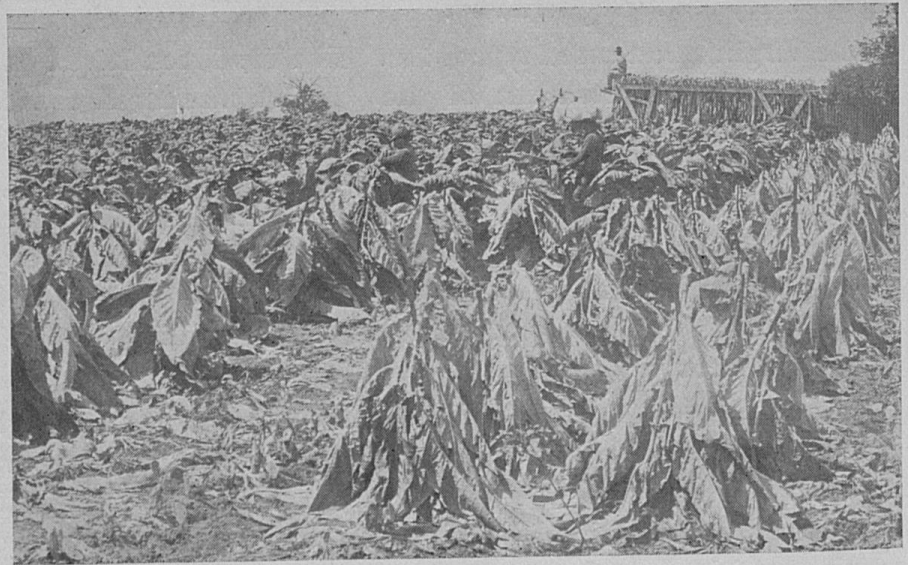
One-sucker tobacco is produced in a district south of the Green River district and extending into Tennessee. A small amount is grown in Indiana just north of Daviess County, Kentucky. The name, one-sucker refers to a characteristic of the variety. It has but one bud in the axil of the leaf instead of the three common on other tobacco. As a result only one sucker is produced at each leaf axil. The origin of one-sucker tobacco is not known. The one-sucker

type has long, narrow leaves with less body than other dark tobaccos. At one time it was an important export type and was also quite extensively used in the manufacture of chewing and smoking tobacco. The crop of one-sucker in 1919 amounted to 68,000,000 pounds; in 1936 to 11,000,000 pounds. This shows very clearly how it has declined in importance, chiefly because of loss of foreign markets. Much of the area once included in the One-Sucker district is now Burley-producing territory.

The Virginia Sun-cured type is much like the Green River. It is grown in a region northeast of the Virginia fire-cured tobacco district. In earlier years it was largely cured outdoors on scaffolds; hence the name, sun cured. This method of curing is no longer practiced, however, and it is now cured in the barn. For many years sun-cured tobacco was very popular for the manufacture of plug tobacco. Production at one time amounted to about 15,000,000 pounds annually but during the past few years only about 3,000,000 pounds have been produced.

White Burley Tobacco. White Burley is one of the two light air-cured types of manufacturing tobacco grown in this country. The other is the Maryland. White Burley is a variety that was discovered in southern Ohio in 1864. It is apparently a "sport" or mutation which came from a variety of Virginia tobacco known locally as Little Burley. At that time the region where it was found produced air-cured dark tobacco. White Burley has cream-colored stalks and stems and light-green leaves. It requires a rich, well-drained soil to produce good quality leaf. When grown on such soil, cured Burley is thin, light in color and very mild in flavor. It absorbs sweetening and flavoring materials readily, being known as a good "drinker" leaf and blends well with other types of tobacco. It ranks with flue-cured tobacco in popularity for the manufacture of tobacco products for domestic use. Flue-cured tobacco is chiefly a cigarette type but Burley is not only used extensively in manufacturing cigarettes but is also the chief type used for manufacturing pipe and chewing tobacco. White Burley soon displaced the dark air-cured type formerly grown in north Central Kentucky and southern Ohio. Demand increased so rapidly and it proved so profitable that its culture extended into the Central Bluegrass Region of Kentucky where previously tobacco had not been grown. During recent years the producing territory has expanded greatly.

In addition to the limestone region of Central Kentucky, the district extends north of the Ohio River 25 to 50 miles taking in all of southern Ohio and a considerable territory in southern Indiana. Toward the east it includes western West Virginia. The western boundary extends in an irregular line from the Green River southward to the southern boundary of Tennessee; thence eastward into



Burley tobacco cut and ready to be put into the barn.

western North Carolina and Virginia. There are also three small producing areas in Missouri, and in parts of the fire-cured tobacco districts of western Kentucky and Tennessee considerable Burley is grown. The total production of Burley averages about 315,000,000 pounds annually, which makes it the second most important type grown in this country. Very little Burley is exported.

The Maryland Type. We have learned that Maryland began the production of tobacco shortly after Virginia. The Maryland crop is grown on a rather light soil and the varieties used have a rather thin leaf. As a result the cured leaf is light in color and body. It resembles Burley in many respects and is remarkable for its free-burning quality. In the Colonial Period and for many years following, Maryland tobacco was mostly exported, chiefly to France and Holland. Maryland was a charter colony which gave it trade privileges denied to Virginia which was a crown colony. In recent years

exports have declined to a low figure but domestic demand has more than compensated for the decline in exports. This is because it is a good cigarette type. It is used in nearly all American cigarettes chiefly because of its good burning qualities. Production in recent years has averaged nearly 30,000,000 pounds annually. The system of marketing Maryland tobacco will be described later.

A small area in eastern Ohio has long grown a type of tobacco quite similar to the Maryland type. This is known as Eastern Ohio Export. It, too, has always been sold on the Baltimore market. At one time several million pounds were produced but Burley has largely replaced it in recent years. Eastern Ohio Export leaf is cured by heat.

Flue-cured Types. Flue-cured tobacco is the world's favorite type for making cigarettes and as a result of the phenomenal increase in the use of cigarettes during the past 20 years, it has become the most important type grown. Total production in the United States has averaged over 700,000,000 pounds annually in recent years which equals the combined production of all other types grown in this country. In addition about 400,000,000 pounds of flue-cured leaf is produced in other countries. About 350,000,000 pounds of flue-cured tobacco are exported annually from the United States, out of total exports of 450,000,000 pounds.

The production of what is now termed flue-cured tobacco began in the early part of the past century, in southern Virginia and northern North Carolina. The soils of these regions are sandy and naturally unproductive; hence they are not suitable for the production of fired tobacco which requires a stronger soil. It was found, however, that tobacco produced on these thin soils was remarkably mild in flavor and as a result it was very popular for the manufacture of domestic tobacco products. Since the odor of smoke was objectionable, it became the practice to use charcoal fires instead of wood fires in curing. Charcoal-cured leaf was of a uniform lemon or orange color and had an excellent aroma. It was the custom in raising these bright tobaccos to clear up an area and to raise about two crops after which the land would be allowed to "rest" for fifteen or twenty years before using again. During this period it would become covered again with scrub timber. Even on virgin soils yields were very low.

After the Civil War, the production of bright tobaccos received

a marked impetus thru the advent of commercial fertilizers. By their use fair yields could be produced on old land, and tobacco could be grown continuously if desired. Curing with charcoal was expensive and finally flue curing was developed. In flue curing a small, tight barn is constructed with a furnace built into one side. From this sheet-iron flues extend into the barn for furnishing heat. No smoke reaches the tobacco and temperatures can be controlled very closely. Most flue-cured tobacco is primed; that is, the leaves are pulled from the plants as they ripen and strung on sticks for curing. The leaves are quite yellow when picked and yellowing is completed by keeping the temperature in the barns at about 100° F for 36 to 48 hours. Then it is gradually raised to about 130° which kills the leaf and fixes the yellow color. Finally temperatures up to 160° are maintained until the stems of the leaves are dry. Curing is completed in 4 to 5 days, after which the tobacco is marketed and the barn filled again. Barns are usually 20 feet square and have ventilators only at the top and bottom.

The flue-cured tobacco territory is divided into two general districts known as the Old Belt and the New Belt. The soil in the latter is more sandy than in the old belt, and the tobacco is lighter in body and color. The old belt is located in southern Virginia and northwestern North Carolina. It produces what is known as U. S. type 11. The tobacco of eastern North Carolina is designated as U. S. type 12; that of South Carolina as U. S. type 13, and that grown in Georgia as U. S. type 14. Methods of production followed in all these districts are the same and the varieties used similar. It may be stated also that varieties of flue-cured tobacco have been developed from those used in the fire-curing and dark air-curing districts and are quite similar to the latter. Differences in the character of flue-cured tobacco produced in the various districts are due entirely to soil differences.

While the flue-cured tobacco consumed in this country goes largely into the manufacture of cigarettes, some is also used in making granulated smoking tobacco, plug and other products.

Yield of flue-cured tobacco averages about 700 pounds an acre. Large amounts of fertilizer—sometimes a ton per acre—are used in growing it. The light color is the result of a limited supply of nitrogen which causes the plants to yellow in the field as they reach maturity. Nitrogen fertilizers, manure and legume crops must be

utilized very carefully in order to produce the desired quality of leaf.

The amounts of the different types of tobacco grown in Kentucky are as follows:

White Burley about 225,000,000 pounds

Air-cured Dark:

Green River about 15,000,000 pounds

One Sucker about 12,000,000 pounds

Fire-cured:

Clarksville and Hopkinsville about 25,000,000 pounds

Paducah and Mayfield 20,000,000 pounds

Henderson 2,000,000 pounds

Tennessee produces as much fire-cured tobacco as Kentucky, or more.

Questions on Lesson VI. 1. How does tobacco rank in value among the crops of the U. S.? Give figures showing that it is a very intensive crop compared with wheat and corn. 2. Name the five most important producing states and give the production in each. How does the crop of Kentucky compare in value with that of North Carolina? 3. Explain why tobacco is such a valuable crop in Kentucky. In North Carolina. What crops do you think could be grown profitably in Kentucky if the demand for tobacco should fail? 4. What class of tobacco is grown in Kentucky? In the southeastern states? Name the different types of manufacturing and export tobacco. 5. Why was tobacco such a valuable crop for the early settlers in Virginia and Maryland? What type of tobacco was grown in Colonial Virginia? 6. Describe the development of flue-cured tobacco. Describe flue-curing. Why has flue-cured tobacco become the world's most important type? What proportion of our tobacco exports is flue-cured leaf? 7. Where did White Burley originate? For what products is it used chiefly? What are its outstanding qualities? 8. Account for the decreased importance of dark tobaccos in recent years. Name the three districts producing fired tobacco and what is the difference between Green River and One Sucker tobacco? 9. How much of each type of tobacco is grown in Kentucky?

LESSON VII

TOBACCO (continued)

Soil and Soil Management for Tobacco.* Yield and quality of tobacco depend largely upon the type of soil in which the crop is grown and the condition of the soil. The individual farmer's choice of soil is limited but even on the same farm some parts are better adapted to tobacco than others and as far as possible production should be confined to the better adapted soil. Good drainage is perhaps the most important factor in determining soil adaptation. This is particularly true of White Burley which requires soils that drain very quickly in order to produce a large proportion of high-priced grades of leaf. The labor and other costs of producing tobacco are high and the grower cannot afford to raise the crop except on soil capable of making good yield and quality. After choosing the best land available, the next step is to get it into the best possible condition for the crop. The best preparation of soil for Burley is to keep it in pasture for a number of years; preferably bluegrass pasture. If land is not adapted to bluegrass, redtop or orchard grass may be used. A legume should always be grown with the grass. If the soil is depleted, it is a good plan to manure or plow under a legume crop before seeding to pasture. In addition a liberal application of phosphate fertilizer should be used in regions where this element is deficient. Also liming may be necessary to get a good growth of grass and legumes. However, not more than two tons of ground limestone per acre should be used on land intended for tobacco, and this should be applied several years before tobacco is to be grown. Top-dressing with manure or feeding stock on a pasture are valuable aids in building up productivity. Land in good condition for raising Burley should be capable of producing 1000 pounds of leaf an acre without the aid of fertilizers.

If necessary to use shorter rotations, legume crops should be plowed under or manure used liberally to build up the organic matter of the soil because an abundance of organic matter is necessary to obtain high-quality Burley leaf. In rotations for Burley, certain crops should be avoided as they seem to affect leaf quality adversely. Among these are corn, timothy, soybeans, sweet clover and alfalfa.

* In this and subsequent lessons on tobacco, the discussion relates only to types grown in Kentucky unless otherwise indicated.

Neither fire-cured nor dark air-cured tobacco is as exacting as Burley in soil requirements. Like Burley these types give good yield and quality on old sod land but perhaps just as good following clover or lespedeza. Lespedeza should always be grown in connection with some grass, however, such as redtop or orchard grass. A good rotation for the dark tobaccos is (1) wheat or other small grain; (2) clover, or lespedeza and grass, and (3) tobacco. Lime in limited amount and phosphate fertilizers should be used on the grain crop.

Fertilizing Tobacco. Even where soil has been carefully prepared for tobacco it usually pays to use some commercial fertilizer in addition to make up for any possible soil deficiency. Where land has been manured liberally, say 12 to 15 tons an acre, only a phosphate fertilizer is needed and on the best soils in the Central Bluegrass Region this may be omitted. Three hundred pounds of 20-percent superphosphate per acre is a fair application. When manure is not available a mixed fertilizer should be used at the row. The proper amount depends, of course, upon the productivity of the soil. On land capable of making 50 bushels of corn an acre, 500 to 600 pounds an acre should be profitable for White Burley. When the soil is capable of making 60 to 70 bushels an acre, 300 to 500 pounds an acre should be used. For most conditions a 5-8-10 or similar analysis is satisfactory. For dark tobaccos a 3-10-10 analysis may be recommended. If fertilized tobacco grows slowly after setting, a side dressing of 100 pounds of nitrate of soda an acre is usually profitable.

The most approved method of applying fertilizers for Burley is in narrow bands on both sides of the row and about two to three inches from the plants. The depth of application *should never* be less than three inches. Some of the modern transplanters have equipment for such placement. Usually, however, the fertilizer must be applied with a one-horse drill. The desired application may be made with such a drill by first marking out the field and then running the drill on both sides of the mark. The fertilizer may also be drilled directly into the mark but a shovel plow should then be run thru the row to mix the fertilizer with the soil; otherwise it may injure the plants. Land for dark tobacco is usually marked off both ways. The bulk of the fertilizer may be drilled in the rows but about 125 to 150 pounds should be

reserved for hill fertilization. In hill fertilization the fertilizer is mixed with the soil in preparing the hill.

Raising the Plants. The tobacco plant, when it first appears, is so tiny and delicate that it must be grown in a special plant bed where some protection can be given it. When the plants have reached a height of 4 to 5 inches they are transplanted to the field.

The production of tobacco leaf of good quality depends to a large extent upon having healthy vigorous plants ready to transplant in good season. Early transplanted tobacco usually has more favorable weather for development than that set late. Perhaps of more importance, especially in sections where tobacco is air cured, is the fact that the early set tobacco ripens earlier and can be harvested when the weather is likely to be most favorable. Warm, moderately dry weather is necessary during the curing period if we are to get leaf of good color and free from damage by house burn, a rot which attacks partially cured tobacco in very damp weather. It is very important then that the soil of the plant bed be very fertile or, lacking natural fertility, that it be well fertilized. Farmers recognize this and pick out the best ground that can be found on the farm for the plant bed. Three to five pounds of high-grade fertilizer to each 100 square feet of bed is sufficient on most soils in Kentucky. This amounts to 36 to 60 pounds on 100 feet of bed 12 feet wide. Five pounds per hundred square feet of bed equals over a ton per acre and it may be risky to use more.

It is very difficult to weed tobacco beds without injuring the young tobacco plants and the work is very tedious; hence it is the custom in Kentucky to burn brush, poles, etc., on the bed after the ground is broken. This destroys the weed seeds in the surface soil so that the bed will be quite free from weeds. Disease germs also are destroyed. In recent years steaming has become a popular method of sterilizing beds. It destroys weed seeds and disease germs much more effectively than burning. Steaming is accomplished by using a shallow wooden or metal pan about 10 feet square. After the bed is prepared the pan is inverted over a section of bed and steam turned into it. A steam pressure of 100 to 125 pounds should be used. The time required is 20 to 25 minutes. If commercial fertilizer is used, it should be applied after the bed is burned or steamed, and raked into the soil lightly.

One-third a level teaspoonful of tobacco seed is sufficient for

100 square feet of bed. This seems like a small amount of seed, but the seeds are very small, and if the stand of plants is very thick the plants will be spindling and weak. Many farmers now sow only $\frac{1}{4}$ level teaspoonful per hundred square feet. This is at the rate of one teaspoonful to each 36 feet of bed 12 feet wide. In order to sow the seed evenly, they should be mixed with wood ashes, corn meal or fertilizer, or still better with a peck of slightly moist sand. The seed should be covered very lightly. The best method of covering is to tramp or roll the bed after sowing the seed. After the bed is sown, a light cotton cloth known as tobacco cotton is spread over the bed and fastened along the sides to boards or held in place by wire pins stuck thru the cloth into the ground. This cloth is necessary to protect the tiny plants from cold weather and insects. It is almost impossible to produce plants without this protection.

In dry weather the bed must be watered. It is best to give a liberal watering every week or ten days rather than to give frequent light sprinklings. Thirty gallons of water per hundred square feet of bed furnishes about as much water as a half inch of rainfall, which is only a moderate shower. To neglect to water beds when needed is a serious mistake as it means later and poorer plants. The plant bed should be made and seeded just as early in the spring as the ground can be worked. In Kentucky most of the beds are planted in March.

Preparation of Land. Heavy sod land should be fall or winter plowed if possible. Other land should be plowed in early spring. Cover crops of rye or wheat should not be allowed to get very large before turning under. Usually it is best to apply manure before breaking the land but it may be applied as a top dressing after breaking and well disked into the soil.

Before the land becomes hard or baked, the field should be disked to destroy weeds and save moisture. Later the land should be worked often enough to keep down weeds and prevent the soil crusting. Just a few days before the plants are large enough to transplant, the field should be harrowed, dragged and marked off in readiness for transplanting.

Transplanting. In the level portions of the White Burley district machine transplanters are used extensively. In other districts the plants are set by hand. Three men are required to operate

the planter and one or two men to haul water, besides men to pull plants. The same number of men can set nearly or quite as much by hand as with the machine. With the machine, however, the crop can be set whenever the plants are ready regardless of the weather whereas if hand setting is relied upon, setting must wait on a "season" which means a rain sufficient to wet the ground thoroly. A season seldom lasts for more than two or three days so that the entire crop cannot often be set in one season. Tobacco plants set by transplanter recover quicker and start growth sooner than hand set plants. Since earliness is so important, it undoubtedly would pay any tobacco grower to own a transplanter if his land is not too rolling to permit its use.

In the White Burley section plants are spaced 12 to 20 inches apart in the row, and rows are made 42 inches apart. The richer the land the closer the plants are set. Close setting tends to give finer, smoother leaf.

In the dark tobacco districts the usual method is to set in checks 42 inches each way. This permits cultivation in two directions. Wide spacing encourages the development of a thick, heavy leaf, a desired characteristic in dark tobacco.

Cultivation. Tobacco must be kept free from weeds. This is the important function of cultivation and the method which accomplishes this at the lowest cost is best. Some hand work with the hoe usually is necessary, but little of this need be done in most seasons. It is desirable to cultivate tobacco just as soon as the plants begin to grow. This is generally, of necessity, a shallow cultivation. Following this cultivation most farmers believe that it pays to break up the crust and destroy the weeds around the plants with the hoe. Later cultivations need not be deep; in fact, very deep cultivation after the roots have spread may do serious damage. Cultivation should cease when it breaks or damages the leaves.

Topping and Suckering. When the tobacco plant is about half-grown the stem elongates or stretches up and flower buds are formed. In order to produce larger leaves with more body or weight the top of the stem bearing the buds is broken off, a process known as topping. The number of leaves left to mature depends upon the type of tobacco. Where a thin, light-colored leaf is desired, as with White Burley, the plants are topped "high," which

means usually that 16 to 20 leaves are left. If a thick, heavy leaf is wanted, as in the fire-cured type, only 10 to 16 leaves are left. Cigar tobaccos are topped high when wrapper or binder leaf is desired, and rather low in the districts growing cigar filler leaf.

After topping, the plants, in an effort to still produce seed, produce new shoots known as suckers, in the axils of the leaves. If these are not pulled off, they will produce flower buds and seeds. The first suckers appear near the top of the plant. When these are pulled off another set appears lower down. Finally, with most varieties of tobacco, more than one sucker will start from each leaf axil.

Where a heavy, thick leaf is wanted as is true of the dark tobaccos, the plants must be suckered rather closely—that is, suckers must be pulled off as often as they appear and before they get large. As already stated, color and texture are more important with some kinds of tobacco than body. This is particularly true of Burley; and with such types of tobacco close suckering is not so necessary. Several plans are used to reduce the work of suckering White Burley and to produce a thinner leaf. One plan is to let one or two top suckers grow until of good size. These are then topped to two leaves. If this is done the lower part of the plant will not produce many suckers.

Another plan is to let the plants bloom out before breaking out the flower head. The first crop of suckers are allowed to get large and the tobacco is cut after these suckers are broken out. Both these practices tend to make a lighter, thinner leaf as well as to save labor. They also give a reduced yield in many instances but lower yield is compensated for by better quality. Perhaps the best practice is to top late and to sucker once before harvest.

Questions on Lesson VII. 1. Why is tobacco called an intensive crop? What can you say about soils for tobacco? 2. When may fertilizers be used profitably on tobacco? In what parts of Kentucky are phosphorus fertilizers needed? 3. Name some of the advantages of having early tobacco plants. 4. Why are tobacco beds burned? What are the advantages of steam sterilization? 5. Describe the seeding of tobacco beds. Why is the bed covered with cloth? 6. What are the advantages of machine transplanting? Why is White Burley set so closely in the rows? 7. What is the principal object in cultivating tobacco? How long should cultivation continue? 8. Why is tobacco topped? How many leaves are left to mature in White Burley? Dark-fired? 9. What are suckers? What influence do suckers have on the character of the leaf? 10. Describe methods of handling so that less suckering is necessary? How does this affect quality?

LESSON VIII

TOBACCO (continued)

Harvesting Tobacco. Tobacco usually is harvested 90 to 100 days after transplanting or two to three weeks after topping. Following topping the leaves increase in size and, because of the storage of starch, oil, mineral matter and other materials, become thicker and heavier. As this thickening proceeds, certain changes in the appearance of the leaf occur. With the cigar tobaccos and the dark varieties of tobacco as grown on fertile soils in central Virginia and western Kentucky, the only change is a slight yellowing of the leaves in spots, giving them a more or less mottled appearance. If allowed to stand for some time or until thoroly ripe the yellowing becomes more pronounced. On the thin, sandy soils in the flue-cured-tobacco districts the leaves often become a golden yellow when the tobacco is well ripened. The leaves of White Burley tobacco become first a lighter green and later a pale yellow or cream color. The change in color of tobacco is accompanied by an increased brittleness of the leaves. A common test of ripeness is to fold a portion of a leaf between the fingers. If it breaks, the tobacco is ripe.

The degree of ripeness that tobacco is allowed to reach before harvesting depends upon the character of leaf desired. If a thick, heavy leaf is desired, as with open-fire-cured tobacco and cigar fillers, the tobacco is not harvested until thoroly ripe. For cigar wrappers and binders a thin, smooth leaf with much elasticity is wanted. Harvesting the tobacco rather green tends to give leaf with these qualities. White Burley tobacco should be allowed to stand until well yellowed unless the lower leaves are wasting badly because of drouth or very wet weather. If the plants have been topped or are large enough to top, it usually pays to cut Burley that is damaging by drouth instead of waiting for rain. If not topped, it pays to let it stand. The lower leaves of immature Burley usually make very good quality leaf but the upper, less mature leaves may cure very dark or green. Cutting green increases the chances of injury after housing, especially in seasons unfavorable for curing.

In harvesting tobacco either the entire plant is cut or the leaves are picked off the plant. The latter method is known as priming, and is practiced only in the flue-cured tobacco districts and to a limited extent in the New England and Florida cigar tobacco districts. Priming is an excellent method of harvesting tobacco. The

lower leaves on the plant ripen earlier than the leaves higher up and where the entire plant is cut some of the leaves become overripe before the others have reached the proper degree of ripeness. In priming all the leaves can be gathered at just the right stage. Where the entire plant is cut, some of the material in the leaves is transferred to the stalk as curing takes place, hence a greater yield is obtained by priming. It is an expensive method of harvesting, however, and not practical for all types of tobacco. In priming, the leaves are fastened to sticks for hanging in the barn.

In Kentucky the general practice in harvesting is to split the stalk from near the top to within a few inches of the ground before cutting off the plant. In the white Burley region the plants are put on the sticks immediately, but in the dark tobacco sections they are allowed to wilt before this is done. Tobacco sticks are a little over four feet long, and four to seven plants are put on each stick.

In harvesting cigar tobaccos the plants are cut off at the ground with a knife and are then put on the sticks by a method known as spearing or "spudding." In spearing, a metal spear-head is slipped over the end of the stick and the butt of the stalks forced over this spear-head on to the stick. Tobacco can be harvested more rapidly than by splitting the stalk, but it is doubtful if the plants cure as quickly or quite as well. In recent years spearing has been practiced in Kentucky rather extensively, especially in the Central part of the Burley district.

Curing. Tobacco barns for air curing are provided with ventilating doors along the sides and ends, and also with roof ventilators. In open-fire-curing the barns should be tight except for ventilators at the roof and bottom of the barn which should permit of being closed. Unfortunately most of the fire-curing barns are not very tight and are wasteful of wood. In flue curing the barns are made rather small and have only the kind of ventilation required for open-fire-curing houses. In these houses the temperature can be regulated very closely.

The framework inside tobacco barns is arranged so that the sticks of tobacco can be hung in tiers one above another. The tiers are 3' 6" to 4' 0" apart. The sticks of tobacco are hung 8 to 12 inches apart in air-curing. In recent years many growers in the Burley district, who use coke fires in curing, have spaced the sticks

less than 6 inches apart. This is somewhat risky, however, for in very damp periods it may be impossible to prevent damage in such close hanging even by constant firing.

In fire-cured tobacco districts it used to be the practice to put 6 to 7 plants per stick and space the sticks only about 6 inches apart. Lower temperatures are used in fire-curing now than formerly, and the tobacco is not hung any closer than in air curing. In flue-cured tobacco districts the tiers are close together, but the sticks are spaced 10 to 12 inches apart.

The best results in air curing are obtained when the weather is warm and dry during the curing period. Under such conditions there is little danger of houseburn and the rate of drying can be regulated by ventilator management so as to give the best possible cure. It is best to leave all ventilators open in air curing until the leaves begin to yellow. If the weather is very dry at this time, it may be necessary to close part or all the side ventilators to prevent too rapid drying which might cause the leaves to cure green. There is not so much danger of this in Burley as with the dark air-cured types. Top ventilators should be left open at all times. In the dark air-cured tobacco districts it is a common practice to close ventilators during the day in dry weather, and open them at night. After Burley has yellowed, all the ventilators may be left open until the leaves begin to dry, except in case of rain. After drying begins it is necessary to close side ventilators when the wind is strong to prevent shattering. The air-cured dark tobaccos may not cure a uniform color if dried too rapidly following yellowing; hence in dry weather it is best to reduce ventilation so the leaves may dry more slowly.

It is very easy to air-cure tobacco successfully in fair weather. Even brief periods of damp weather need cause little worry. However, if the weather remains very damp for more than 36 hours after yellowing has begun, and especially if the temperature is high, houseburn is likely to develop. This is a rotting of the leaves caused by an organism which seems to be always present on tobacco but which becomes active only when relative humidity is high. This organism works on dead plant tissues and there is little danger of its causing damage for a few days after tobacco is housed.

When the air outside the barn is saturated with moisture or almost saturated, no amount of ventilation will dry tobacco. The only way to prevent houseburn under such conditions is to heat the

barn in some way. The losses from houseburn may be so serious that every grower should be prepared to use heat when necessary.

It takes some time to raise the temperature in a tobacco barn so it is best to start firing if the tobacco has been very wet longer than 24 hours. Only enough heat should be used to dry off the leaves and under no conditions should the temperature exceed 100 degrees F. any place in the barn. It is especially necessary to avoid high temperature when the tobacco is not fully yellowed, or the green color may be fixed. It is not necessary to continue firing when the weather becomes fair. Coke is the most practical fuel to use for firing. Petroleum coke has some advantages over gas or by-product coke. It burns freely and it is possible therefore to maintain a large number of small fires easily which tends to give a good distribution of heat. Petroleum coke can be burned on top of the ground but better in narrow trenches and still better in stoves. Petroleum coke costs more than common coke and if considerable firing has to be done the latter is cheaper to use, even including the cost of stoves.

Gas coke cannot be burned without stoves, and very small fires cannot be maintained very easily. It is customary to use one stove in the center part of each bent. The use of more stoves and smaller fires is advantageous, because the heat is better distributed.

Oil or grease drums make fairly satisfactory stoves for burning coke, and such stoves are widely used. To prepare for use, cut a number of holes about the size of a dollar in the bottom of the drum and around the side, near the bottom. The bottom thus serves as a grate, while the holes in the side permit raking down the ashes. The drum is set on stones or bricks, and after the coke gets to burning well a piece of sheet iron about 3 feet square should be put over the top to spread the heat. It must not rest directly upon the drum, but should be supported on pieces of iron about 2 inches thick laid across the drum top. Commercial stoves are far more convenient than the homemade stoves, largely because the draft may be controlled.

In firing tobacco, all doors and side ventilators should be closed, but roof ventilators should be wide open. Where barns have metal or composition roofs and are without roof ventilators, openings should be made in the ends of the barns, near the top, and a few side ventilators should be left open on the opposite side from which the wind is blowing. Heat causes the moist air to rise, and if it

cannot escape readily the moisture collects in the top tiers, which may cause houseburn.

Some Burley growers fire continuously, regardless of weather, until the crop is cured. Unless one is in a hurry to finish the curing or the barn is overcrowded, firing in good curing weather is probably a useless expense.

There is no evidence that a temperature higher than 75 degrees, F., on an average, is of any advantage in curing Burley. Probably very high temperature tends to give a leaf with harsh texture.

It pays to use heat when filling a barn if the weather is cold and windy at that time. Tobacco hanging in the barn after curing is completed should be dried out if it remains in very high order for more than two or three days.

In open-fire-curing, the tobacco is allowed to yellow in the barn for about a week before starting the fires. If the weather is cool, the yellowing may be hastened by slow fires. The tobacco should be watched carefully during this period and fires started at once if houseburn begins to develop. The conditions most favorable for houseburn are also most favorable for the yellowing of the leaf, and men most expert in fire-curing say that the nearer one comes to having houseburn without really having it, the better dark fired tobacco cures. Practices in firing differ considerably. Formerly it was the custom to gradually raise the temperature as high as 130° to 140° F and to keep it there until the tobacco was dry. Then it was reduced to about 95° F and light firing with smoky fires continued for two weeks or more. At the present time few growers use such high temperatures and in the so-called "soft" or "slow" cure now widely practiced, temperatures are kept below 100° F. An effort is made to keep the humidity in the barn very high at all times. This is accomplished by sprinkling the floors and walls and by using damp sawdust on the fires. The tobacco itself may be sprayed if other methods fail to maintain a high humidity.

The advantages of flue curing have been pointed out and the methods followed given.

Tobacco leaves injured by bruising, sunburning, or in any other way, do not cure normally so it is very important that the crop be handled carefully in housing and when cut on very hot, sunny days, protected from sunburn by putting into piles after cutting.

Stripping and Sorting Tobacco. When curing is completed and the leaves and midribs are thoroly dry stripping and sorting may begin as soon as the tobacco comes in "order" or "case;" that is, has taken up enough moisture to make the leaves pliable so they do not shatter in handling. To bring this about the air must be saturated or nearly saturated with moisture for several hours and the temperature mild. A warm rain during the night followed by cloudy or foggy weather in the morning usually puts leaf in good order. If the temperature is low tobacco seldom takes up much moisture even when the humidity is high. When conditions become favorable ventilators should be opened to allow the moist air to circulate freely thru the barn but should be closed as soon as the tobacco handles well. Very high order, which means that the leaf is saturated with moisture, is not desirable as it may result in damage to the leaf after bulking.

When the weather during the fall is very dry, as in 1938, preparation for market may be greatly delayed because there is not sufficient moisture to bring the leaf in order. The only practical way to get a crop into condition for handling in such instances is by the use of steam and this method has been employed to a limited extent. Low pressure must be used to avoid damaging the leaf.

In the cigar-tobacco producing regions of New England cellars are built under the barns and the tobacco is brought into order by hanging it over night in the cellar. Such cellars might be useful in Kentucky.

Tobacco is kept in order by "bulking;" that is the tobacco is ricked with the tops of the plants overlapping in the middle and the butts on the outside. Tobacco should be pressed down firmly in bulking and weighted with tier rails or in some other way. The piles or "bulks" should then be carefully covered with tarpaulin, old blankets or pieces of old carpet to prevent loss of moisture. Usually tobacco is taken off the stick in bulking but occasionally, when in very high order it is bulked on the stick. Some men bulk with the butts to the center, but this practice is not common. Sometimes tobacco in the bulk becomes too dry to handle in spite of all precautions. Warm water sprayed on the butts of the stalks with a spray pump will often bring it back into order.

Early in the fall, while the weather is still warm and especially if the stalks are not perfectly dry, it is unsafe to make large bulks.

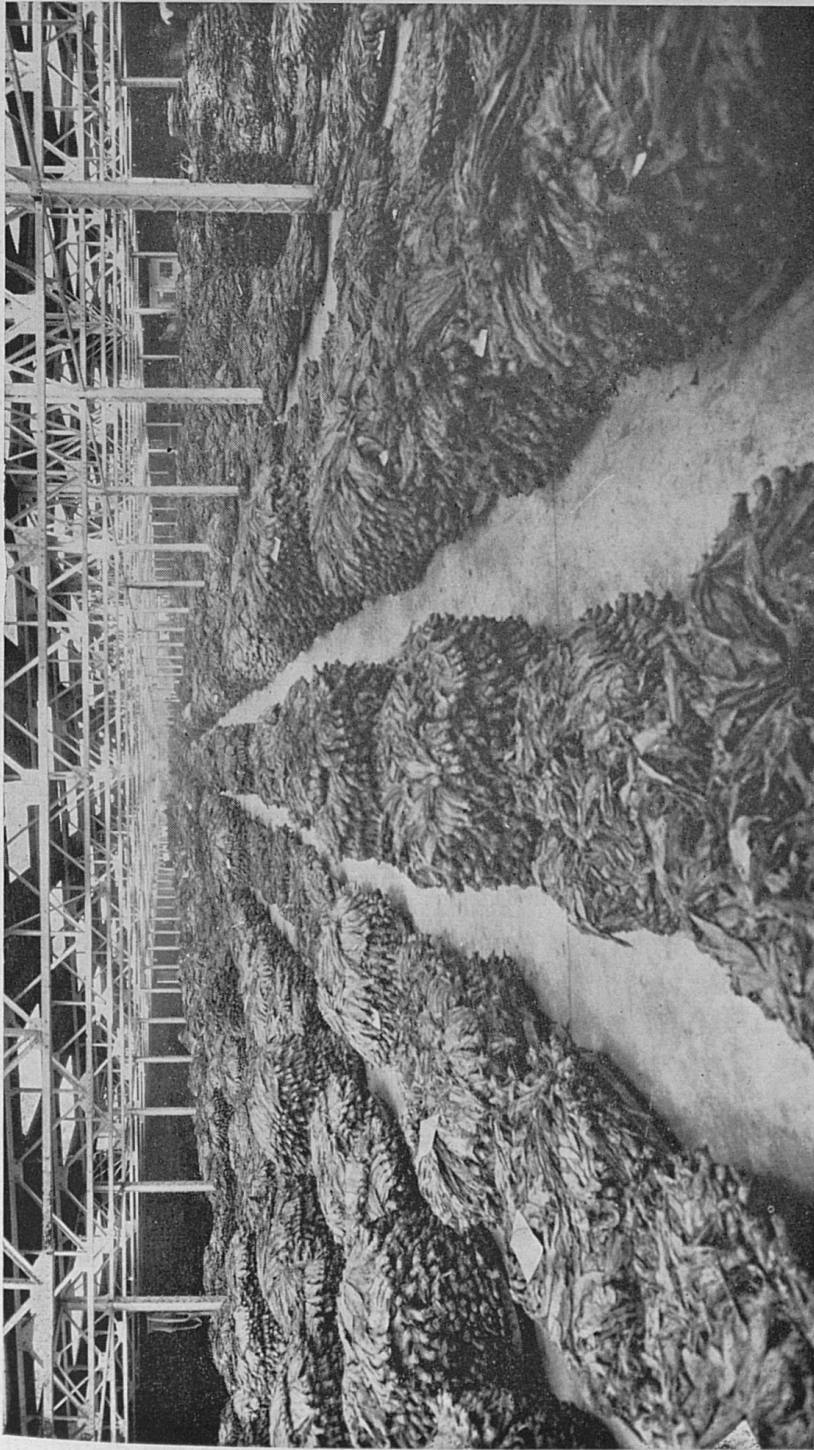
After bulking, tobacco should be examined occasionally to be certain it is keeping properly.

The leaves from the bottom of the stalk are thinner and lighter in color than those farther up on the stalk, so that each stalk produces several grades of leaf. Each of these grades is especially suited for a certain purpose or supplies a certain market demand; consequently it is necessary that they be kept separate. The number of grades differs according to the type of tobacco grown. White Burley is assorted into the following grades on the farms: (1) flyings, (2) trash, (3) lugs, (4) bright leaf, (5) red leaf and (6) tips. In addition each of these grades may be subdivided into two or more grades. For example, the trash, lugs, and red may each be divided into two or more grades according to length of leaf or other qualities. At present the lugs bring the highest price, followed closely by trash, flyings and bright leaf. These grades are used for making smoking tobacco and cigarettes. Usually the growers of dark air and fire-cured tobacco make but three grades: trash, lugs and leaf.

Marketing Tobacco. All the manufacturing types of tobacco except the Maryland are now sold by the loose-leaf system. In the loose-leaf system of selling, well-lighted warehouses with large floor space are maintained in the principal towns in the various districts. The tobacco grower hauls his tobacco directly to the warehouse where it is placed on flat baskets, each grade by itself. Each basket holds 500 to 1,000 pounds, but often, when the grower has a small amount of some grades the baskets may contain only 50 to 100 pounds. The tobacco is weighed and the baskets are arranged in straight rows on the floor, with enough space between rows for easy passage. (See illustration, page 73.) When the floor is full, or at stated intervals, the tobacco is sold by auction, a basket at a time. The grower receives his check in a few minutes after his crop is sold.

Following are some of the more pronounced advantages of the loose-leaf system of selling: (1) The grower can market his tobacco as fast as it is stripped; (2) he does not have to wait for his money; (3) there is good competition; (4) the labor of packing in casks or hogsheads is avoided.

Previous to the advent of the loose-leaf system of marketing, most of the tobacco was sold to buyers who came to the barn, or it



Interior of loose-leaf warehouse. Tobacco on baskets ready for sale.

was packed or "prized" in hogsheads and shipped to one of the auction warehouses located in several of the larger cities in or near the tobacco districts. At these warehouses the tobacco was sold at auction, the quality being judged by samples taken from several places in the hogshead. Hogshead auction houses still are maintained in Baltimore, Maryland, and possibly at a few other points. All the tobacco grown in Maryland is sold in this way. It is prized or packed into hogsheads on the farm. In the cigar-tobacco districts no warehouse system of selling has been developed. The buyers come to the farm and, after inspecting the leaf, name the price they are willing to give for the tobacco delivered at the buyer's headquarters. This method was once common in Kentucky and the better grades of fired tobacco are still sold this way. Cigar tobacco is packed in boxes instead of hogsheads. A box weighs 300 to 350 pounds, while a hogshead of tobacco weighs from 700 pounds in Maryland tobacco to 1,000 to 1,200 pounds in White Burley and shipping tobaccos.

At various times in Kentucky, and some other tobacco-growing states, the growers, dissatisfied with prices, have formed associations for selling their tobacco cooperatively. None of these has been permanently successful. In the White Burley district a mammoth cooperative selling organization was organized in 1921. Perhaps 80 percent of the White Burley crop, or over 200,000,000 pounds, was pledged to this association for a five-year period. Tobacco warehouses, redryers, etc., for handling the crop were bought. Shortly after the forming of the Burley Association similar associations were formed in all the important tobacco-growing districts, including the cigar districts. The tobacco brought to the warehouses was graded by expert graders, and each member given a receipt known as a warehouse receipt, showing how many pounds of each grade of tobacco was delivered. The association was able to borrow money on the tobacco in its warehouses, and the members were given an advance payment on delivery of their crops. This amounted to about 40 percent of the estimated value. Further payments were made as the tobacco was sold. These ambitious attempts to market tobacco co-operatively were scarcely more successful than previous efforts. At the expiration of the initial contract period, the majority of growers refused to renew their contracts, and the movement came to an end. Various causes contributed to the failure of these asso-

ciations, but the most important was the effort to control prices. As a result, huge stocks of leaf accumulated in association warehouses, entailing heavy interest charges on money borrowed for advance payments, and heavy storage costs. In addition, growers were forced to wait a long time—in some instances three years or more—before payments for their leaf were completed. Some associations, after holding much tobacco for long periods, had to dispose of it at a lower price than non-association members had received in cash when they delivered their crops. Naturally, members lost confidence in the management of their associations.

While the failure of the associations was unfortunate and very discouraging to those who believe in cooperative selling, the experience gained probably was worth the price. It was demonstrated that the law of supply and demand must be allowed to regulate prices in cooperative marketing as well as in other methods of selling. The functions of a cooperative marketing association are to handle the commodity in question as economically as possible and to sell it to the best possible advantage. In some instances an association may increase the demand for a product by advertising or finding new markets. Organized on this basis, cooperative selling is unquestionably the best method of marketing yet devised, both for producer and the consumer.

Questions on Lesson VIII. 1. How can one determine when tobacco is ripe? With what type of tobacco is thoro ripening very important? 2. What two methods of harvesting are followed in Kentucky? What is meant by priming as referring to harvesting? What type of tobacco is harvested by priming? 3. Describe the framework in a tobacco barn. In air curing how many plants are put on each stick? How close should sticks be hung? 4. Under what conditions is it advisable to use heat in air curing? Why? How high should one raise the temperature? 5. What method of curing fire-cured tobacco is now generally followed? How does it differ from the old method? 6. Name the "natural" grades into which Burley tobacco is sorted on the farm. How many grades are made in sorting fire-cured tobacco? 7. What are the advantages of the loose-leaf system of selling tobacco? What do you think are the disadvantages, if any? 8. Why have most of the efforts to market tobacco cooperatively failed?

LESSON IX

TOBACCO (continued)

Rehandling Tobacco. It is interesting to know just a little about how the tobacco is handled after the dealers and manufacturers get it. Tobacco leaf is seldom used until it is at least a year old and some manufacturers keep it for two years or even more. The aging of the leaf makes it milder and sweeter and develops a good aroma. These changes are brought about by fermentation. For aging the tobacco is packed in hogsheads or boxes. Most of the air-cured tobacco, particularly White Burley, contains so much moisture when in winter order that it is not safe to store it permanently in that condition. As the weather becomes warm, an active fermentation, known as the "June sweat," begins and unless taken from the hogsheads and dried the leaf will spoil. The buyers now have elaborate plants known as redryers in which the leaf first is dried out perfectly and then just enuf moisture is added by steaming to permit handling without breaking. When packed in hogsheads in this condition the tobacco will keep indefinitely. Before the advent of the dryers a good part of the tobacco was kept on the farm until summer. When sweating began it was taken from the bulk and hung up to dry. When it comes in order (takes up moisture) after this drying it can be safely prized in hogsheads for permanent storage. Dealers or manufacturers who bought the tobacco during the winter season were obliged to take it out of the hogsheads when the weather became warm and dry just as the farmer did.

Tobacco is prepared for manufacturing by taking out the midrib or stem. This is done after the tobacco has been steamed until quite wet. The stemmed tobacco is known as strips. After stemming, it is returned to the hogshead to be kept until needed. Manufacturers keep several hundred millions of pounds of tobacco on hand at all times.

Raising Seed. Until within recent years nearly every farmer saved his own tobacco seed. Lately the practice of buying the seed from men who specialize in seed production has become very common. This is a desirable practice from many standpoints. The good seed grower will keep his seed pure and will constantly endeavor to breed his strain of tobacco up to a high standard of ex-

cellence. He should be a better judge of quality in the growing plant than the average farmer because of his experience, and he understands better the handling of the seed crop. The cost of the seed is such a small matter that any farmer can afford to buy the best seed obtainable.



Seed plant, showing how a seed head is bagged.

In growing seed on the farm the farmer should make his selection of seed-plants with much care. Healthy, vigorous plants showing smoothness and quality should be selected and especial atten-

tion should be paid to the type of plant. Self-fertilization is not injurious to tobacco and by preventing crossing the good qualities of the plant can be perpetuated and greater uniformity secured. Crossing can be prevented by tying a 12 or 14 pound paper bag over the seed head as soon as it has started blooming. At this stage the stalk is strong enough to support the bag. All fully opened blossoms should be picked off, however. The bag is left on until the desired number of pods have set. It may then be removed and all buds picked off so that the remaining pods will fill out well. It is a good plan to keep the seed from each plant by itself and in planting the bed the next year to plant a portion from each lot. In this way it is possible to determine the best



Applying poison to tobacco.

strain and save seed from it. By following this method the farmer should be able to develop a very uniform strain of excellent quality and a type of plant which suits his fancy. Seed should be allowed to ripen thoroly on the plants as this gives plump, sound seed. There is little advantage in recleaning seed if the seed pods have ripened well.

Insect Pests. Tobacco is attacked by a number of insects, but by far the most troublesome is the so-called tobacco or horn worm. The horn worms are the larvae of two closely related species of

moths. The larvae are almost identical in appearance, but the moths can be easily distinguished. The larvae of both feed upon tobacco and tomato leaves. The moths are very large, measuring 4 to 5 inches between wing tips, and having a stout body. In the tobacco districts they are known as "tobacco fly" and may be seen at dusk sipping nectar from the Jimson weed or from petunias in the flower bed. They fly very rapidly, producing a humming noise with their wings. In the tobacco districts the moths begin to appear shortly after the tobacco is transplanted, and deposit their eggs upon the tobacco plants. The eggs are about the size of mustard seed. In a few days the tiny larva appears and begins to feed upon the leaves. He is a voracious eater even when young, and thus grows very fast. As he increases in size, his appetite becomes enormous, and a full-grown worm will eat half of a good-sized leaf of tobacco in twenty-four hours. When full grown, the larva is anything but handsome, of pale green color, ornamented with whitish dotted stripes upon the sides. A sharp-pointed horn or spikelet is borne on the tail, hence the name "horn" worm. Though repulsive, the tobacco worm is harmless, and the tobacco grower destroys it by pulling apart with his fingers. When full-grown, the larva works its way down into the soil and there transforms to the pupa stage. The pupa has a peculiar appendage known as a tongue case which gives it an appearance something like a jug; hence it sometimes is called jug handle grub. In Kentucky there are two broods each year, and in the Carolinas probably three. The horn worm used to be the bane of the tobacco grower. The worms were picked off by hand, and woe to the farmer who neglected to go over his fields frequently and regularly. It was finally discovered that worms could be poisoned by dusting an arsenical poison on the plants, without danger of poisoning the people who used the tobacco. Now practically every grower uses these poisons, and very little hand worming is necessary. Paris green was used chiefly for a good many years. Then lead arsenate and calcium arsenate became very popular. They stick longer than Paris green and there is little danger of burning the leaves when heavy applications are made. Paris green must be applied very carefully and evenly or the leaves may be injured seriously. However, entomologists are recommending Paris green again rather than lead arsenate. The lead in the latter may cause more injury to health

if consumers get it in the use of tobacco products, than the arsenic. It is now recommended that Paris green be thoroly mixed with 5 parts of builders' lime before applying. The poisons are applied with small bellows or larger machines provided with fans.

Cutworms of various kinds often are troublesome both in the plant bed and in the field while the plants are small. Dusting the plants with lead arsenate usually destroys the worms in plant beds. In the field the farmer usually resets the plants cut off, in the meantime digging up the worms that did the mischief and destroying them. The worm usually can be found near the freshly cut-off plant, just below the surface of the ground. If very destructive, a poison bait should be used. This is made by mixing together 25 pounds of wheat bran and 1 pound of Paris green with enough water to make a thick mash. Some entomologists recommend adding 2 quarts of cheap molasses to the bait. This is broadcast over the field or in the plant bed late in the evening. This amount is sufficient for an acre of tobacco.

Wireworms, the larvae of the click beetle, often cause serious losses in sod ground. They are slender, reddish worms which eat the stems of the young plants. No certain remedy has been found, but if stocky plants are set they often survive attacks of this insect. Flea beetles, tiny beetles that hop like a flea, often puncture the leaves of tobacco plants in the bed and sometimes entirely destroy the plants soon after they come up. They also damage the plants in the field. Dusting with a mixture of 5 parts lead arsenate and one part Paris green is usually effective where the beetles are not very numerous. Barium fluosilicate, sold chiefly under the trade name "Dutox," at the present time, gave better results at the Kentucky Experiment Station than the Paris green-lead arsenate mixture. In addition beds should always be made as tight as possible in areas where flea beetles give trouble.

Where the flea beetles are very troublesome, trap beds are sown alongside the main bed. The latter is carefully boxed and canvased to keep out the beetles. The trap bed, however, is loosely constructed so the beetles can get in easily. As soon as the plants in the trap bed are up well, they are kept dusted with a mixture of one part of Paris green to five parts of lead arsenate. This destroys the beetles and prevents the field from becoming infested

after the plants are set. The same poison mixture is used to destroy flea beetles attacking the plants after setting. Another insect poison now recommended for the control of flea beetles is known as rotonone. It is not poisonous to man or any warm-blooded animal.

Grasshoppers often are very troublesome on tobacco in late summer, especially in a dry season when other green forage is lacking. They gnaw holes in the leaves. Occasionally fields close to grass fields are injured very badly. In fields where injury is occurring the poison bait recommended for cutworms should be used. However, the molasses should be added and a half dozen finely chopped oranges or lemons. The mixture should be broadcast early in the morning.

Tobacco Diseases.* Black root-rot is a soil-borne fungus disease of the roots of tobacco. Formerly it was one of the most serious diseases of Burley tobacco, reducing the yield millions of pounds annually. The development by the Experiment Station of excellent root-rot resistant varieties of Burley in recent years has made it possible to avoid practically all loss from this disease. The latest variety to be released, Kentucky No. 16, is not only very resistant to black root-rot but also is outstanding in both yield and quality of leaf. Evidence of this is the great popularity gained everywhere in the Burley district during the brief period since its introduction.

Black root-rot causes more or less rotting of the roots of tobacco plants, depending on the amount of soil infestation, which, of course, affects growth. On badly infested soil the tobacco may stand for weeks without making any appreciable growth. Growers unfamiliar with black root-rot often attribute the injury to insects, particularly wireworms. Wireworms kill or weaken the plants by boring thru and destroying the underground part of the stem. In black root-rot the roots only are affected. Examination of an infected plant shows that the original roots are largely dead. These dead roots are black; hence the name black root-rot. A new root system may develop from the stem of an infected plant, near the surface of the ground, during hot weather when the disease is less active, and the plant may subsequently make a fair growth. On soil not heavily infested with the root-rot organism, the injury is not always easily recognized. When plants grow slowly in favor-

* By Dr. W. D. Valleau, Plant Pathologist.

able weather and wilt during the day even when soil moisture is abundant, black root-rot is very likely to be the cause. Even when infection is not severe, yield is certain to be reduced. The most severe injury from black root-rot occurs when the growing season is cool and wet.

Where non-resistant varieties of Burley are grown, severe soil infestation may be avoided by practicing a rotation in which several years intervene between crops of tobacco, and by the use of a new plant-bed site each season. Two crops of tobacco followed by six to eight years of grass or other crops should keep the disease from causing serious injury.

Varieties of dark tobacco are not so susceptible to injury from black root-rot as Burley. However, they may be affected quite seriously under certain climatic conditions. The Kentucky Experiment Station has produced several black root-rot resistant strains of dark tobacco and they are being tested at the present time.

Angular leafspot and wildfire are bacterial diseases attacking the leaves of tobacco. They are most likely to cause serious damage during periods of wet weather lasting for several days, particularly if hard, blowing rains occur. Angular leafspot is more common than wildfire but the average observer is not likely to distinguish one from the other. These are usually termed wet-weather rusts by farmers altho in the dark districts the term "blackfire" is generally used. Both angular leafspot and wildfire cause a spotting of the leaves. The latter may be distinguished from angular leafspot by a wide, bright yellow halo which surrounds the small dead center of each spot. In angular leafspot, the nearly black spots are small and irregular in shape. The surrounding halo is much narrower than in wildfire. As the spots become older the dead areas may enlarge. When conditions remain favorable for the continued development of these diseases, they may almost ruin a tobacco crop, especially dark tobacco. In 1938 much of the dark tobacco crop of western Kentucky was hardly worth cutting. The diseases attack Burley just as severely but do not reduce the salability of the tobacco so greatly as in case of the dark types. These diseases, particularly angular leafspot, may be nearly always found in plant beds, altho they may cause so little damage there as to be scarcely noticeable. When these diseased plants are set

in the field, they serve as the starting point for infection if the weather becomes favorable for the development of diseases. In addition to this source of infection in the field, there are apparently other sources of less importance. It has been found that where the diseases are not present in the bed, fields set from such beds have a much better chance of escaping infection or the diseases cause less injury because delayed than where the crop is set from infected beds. According to tests at the Kentucky Experiment Station, two treatments with Bordeaux mixture, the first very soon after the plants appear, and another about 10 days later, control angular leafspot and wildfire in the bed quite effectively. It is applied with an ordinary sprinkling can without removing the cotton. Fifty gallons treats 200 square yards of bed.*

Blue mold or mildew, a disease which has caused extensive damage to tobacco plants in the beds some years in the Southeastern states since 1930, appeared in Kentucky in 1937 and in 1938 was present in plant beds in all parts of the state. In 1939 it appeared in a few beds used the previous year but spread to new beds very slowly. The first sign of it in a plant bed is likely to be the yellowing of a group of plants in some part or parts of the bed. It may then spread suddenly during a damp period over most of the bed causing large, scalded spots on the leaves and, in severe cases, destruction of most of the leaves and death to some of the plants. At this time a moldy growth may be seen on the under side of some of the leaves. The surviving plants begin to recover in about a week or ten days and from that time on appear to be resistant to the disease. Recovered plants may be safely set in the field. Recovery is hastened by an application of nitrate of soda applied at the rate of 1 pound in 5 gallons of water to 200 square feet of bed, and then washed off with an equal amount of water.

Blue mold is usually much more severe in beds located in woods or it may start in a small portion of a bed shaded in the morning

* Bordeaux is made as follows: 1. Fill a clean 50-gallon barrel or oil drum three-fourths full of water strained thru a cloth. 2. Thoroughly mix 4 pounds of commercial hydrated lime in 3 or 4 gallons of strained water. Hydrated lime is the powdered lime in paper sacks commonly sold by lumber yards. 3. Dissolve 3 pounds of powdered bluestone in about 4 gallons of water in a wooden bucket or crock. If powdered bluestone, which dissolves readily, is not available, beat the crystals into a fine powder before trying to dissolve them. Your hardware dealer can get powdered bluestone for you. 4. Pour the lime paste into the barrel of water and stir. While stirring vigorously, add the bluestone solution slowly. 5. Add enough water to make 50 gallons. 6. Stir the mixture each time the sprinkling can is filled. CAUTION. The water, barrel, and other containers should be free from bits of material which will clog the rose of the sprinkler. The rose should be easily removable for cleaning.

by a nearby tree. The beds should be located, therefore, in an open area preferably where they get the early morning sun. Removal of cotton from the bed during the day following the first appearance of the disease in the neighborhood toughens the plants and slows down the spread of the disease. The disease can be satisfactorily controlled by spraying with copper oxide-lethane-oil spray twice a week beginning with the first appearance of the disease in the neighborhood but before its appearance in the bed to be protected. Special directions should be obtained before attempting to use this spray.

Complete control can be obtained by the use of benzol evaporated in the bed and held in by tight sides and a 60-thread cotton cover rather than the more open one usually used. Paradichlorobenzene commonly used in the control of peach-tree borers is also effective in preventing the disease or stopping it after it has started. Both these materials can cause serious injury to plants and so should be used only after proper instructions have been obtained. It is entirely probable that the majority of Kentucky growers, for the next few years will rely on cultural practices, rather than spraying or gassing, to take care of this disease. Experience will tell whether or not the more expensive control measures will be necessary. Tennessee and Kentucky are not in the direct line of spread of the disease from Georgia and the Carolinas therefore the use of a new plant bed site by all growers in Tennessee and Kentucky each year should tend to eradicate the disease from these states.

Mosaic (also called frenching, dry weather french and walloon) is a common disease in nearly all tobacco fields. The disease is caused by a virus, an organism so small that it has not been seen with a microscope and readily passes thru fine filters which withhold the smallest bacteria. The leaves of mosaic plants are mottled with dark and light-colored spots, and often are distorted. The dark-green portions of the leaf appear to be the healthy tissue, and the light-green the diseased. In both White Burley and dark tobacco small spots sometimes develop on leaves only partly grown when infection occurred. These spots gradually increase in size until a large area of the leaf is killed. This is called mosaic burning. It is a symptom of the disease that usually is thought by tobacco growers to be due to other causes. The mosaic virus usually is present in cured leaf tobacco which is chewed or smoked

by tobacco growers. By handling the dried tobacco, the hands become contaminated with the virus and it may then be spread to tobacco plants during weeding or pulling. If affected plants are pulled, it is likely that many healthy ones pulled afterwards will be infected. The disease is also carried over winter in the roots of horenetts and ground cherries, two plants belonging to the same family as tobacco, but this source of infection appears to be unimportant as compared with chewing and smoking tobacco. The disease may be nearly completely prevented by keeping all tobacco trash out of the bed, using cotton which is free from tobacco dust and trash, and by those who work in the bed getting rid of all infected tobacco from the pockets and thoroly washing the hands in soap and water before weeding or pulling plants. Satisfactory resistant varieties will soon be available.

Tobacco is subject to several other virus diseases, to at least one other root-rot, to two diseases which cause swelling of the roots, to at least three diseases which cause stalk rots, and it frequently is struck by lightning which kills small plants and injures the stalks and midveins of older plants.

Questions on Lesson IX. 1. Why is tobacco aged before using? How is the aging done? 2. What is the "June sweat"? How do tobacco manufacturers and dealers get tobacco into proper condition for storing? 3. Describe fully the best methods of raising good tobacco seed. 4. Name the important insect pests of tobacco. Which is the most troublesome? 5. How can tobacco worms be destroyed? What method was employed in past years? 6. Describe root-rot of tobacco. What methods of control are possible? 7. How does wildfire affect tobacco? How may this disease be distinguished from angular leaf-spot? 8. Describe blue mold. What can you say about methods of control? 9. Describe the appearance of the Mosaic disease of tobacco. What is Mosaic burning?

LESSON X

THE POTATO

The potato is found growing wild in the mountainous regions of South America, Central America and Mexico, so that there is little doubt that this plant, like corn and tobacco, is native to the New World. It is interesting to know that two American plants, corn and the potato, have become the second and third in importance of the food crops of the world.

Unlike corn and cotton, the potato grows best where the weather does not get very hot, and cloudy weather does not seem to injure it. This may seem strange, as it came from tropical countries. We must remember, however, that even in the tropics the climate is cool in regions far above sea level. For instance, in studying geography, you probably learned that Quito, the capital of Ecuador, South America, has a springlike climate the year round, altho right on the equator. Mexico City has a very similar climate.

For this reason we should not expect potatoes to thrive very well in the Corn Belt or in the cotton-growing states. As a matter of fact, they do not give large enough yields there to make the crop as profitable as corn or cotton, as a rule. The South finds it profitable to supply northern markets with early potatoes because the high price received makes up for low yield. Of course the market for early potatoes is rather limited, however. Usually potatoes are grown in the cotton and corn states for home use only or a few acres are grown to supply nearby markets. The bulk of the market potatoes are grown in the most northern states, such as Maine, New York, Michigan and Wisconsin, or in some of the far western states where the climate is more favorable for potatoes than for corn. Commercial potato growers in Kentucky have learned how to obtain good yields of potatoes in most seasons in spite of unfavorable climatic conditions. This is accomplished by the use of carefully selected seed of a good variety, liberal fertilization and thoro spraying to control disease and insect pests.

The climate of much of Europe is especially favorable for potatoes, and 90 percent, or nine-tenths, of the entire crop of the world is grown there. They are used not only for human food, but for stock feed and for manufacturing alcohol, starch and other substances. Among the poorer classes in Europe, potatoes are by far

the most important article of food. The potato was introduced into Europe very soon after the discovery of America, but it did not become an important crop until about 1750. The first country to grow it extensively was Ireland, and thus it got the name, Irish potato. The following quotation gives a good idea of how important the potato is in Europe:

"No more important event of its kind has ever taken place than the general introduction of the potato into the agriculture of Europe. The potato has done much for the general welfare of the people, and has increased the national wealth."

The great value of the potato is due to its large yield and cheap production. In regions especially well adapted to their production, it has been estimated that potatoes yield ten to fifteen times as many bushels per acre as wheat. It is true, of course, that they contain about 80 percent of water, and that one pound of wheat has a food value equal to that of 4 to 5 pounds of potatoes. The yield of food from an acre of potatoes, however, may be two to three times that from an acre of wheat.

Germany and Russia are the greatest potato-growing countries in the world, producing together almost half of the world's crop. The average yield, in Germany, is over 200 bushels per acre, or almost twice the average yield in the United States. However, in some sections of the United States, where the climate is especially favorable for potatoes, almost as large yields are obtained as in Germany. For instance, the average yield in Maine is over 250 bushels per acre.

Below are given, in round numbers, the total production and yield per acre, in bushels, of the potato-growing countries of the world, and of the leading potato growing states of the United States. The world figures are the average for the years 1925-26; 1929-30 in most instances.

Country	Total Yield	Yield per Acre
	bushels	bushels
Russia	1,602,000,000	140.6
Germany	1,401,000,000	201.7
Poland	972,000,000	158.7
France	524,000,000	145.3
United States	350,000,000	114.0
Great Britain and Ireland	198,000,000	248.1
Belgium	124,585,000	305.4

Estimated average annual production for the years 1923 to 1932, inclusive, of largest producing states of the United States:

State	Total Yield	Yield per Acre
	bushels	bushels
Maine	44,078,000	258.0
Minnesota	29,620,000	93.0
New York	27,942,000	118.0
Pennsylvania	24,653,000	112.0
Wisconsin	24,311,000	100.0
Michigan	23,371,000	99.0
Idaho	21,733,000	200.0
Virginia	14,328,000	84.0
Colorado	14,584,000	149.0
Ohio	11,435,000	96.0
Washington	8,047,000	162.0
North Carolina	7,540,000	98.0

The average production in Kentucky during the same period was 4,207,000 bushels and the acre yield 84 bushels.

Description of the Potato. The potato belongs to the same family as tobacco and the tomato. The valuable part is the thickened underground stem, called a tuber. It must be understood that the tuber is not a root. The eyes are buds of the stem.

The potato occasionally produces seed. The seeds are borne in balls which look like very small, green tomatoes. The seeds are very tiny, and the first year the plants grown from them produce only small tubers. If these tubers are planted, full-size potatoes sometimes will be produced. New varieties are obtained in this way. It is not often, however, that good varieties are obtained.

Varieties. Many varieties of potatoes are grown in the United States, and new varieties are being added each year. Potatoes differ greatly in length of time required to mature, and the tubers differ in color, shape, depth of eyes and color of sprouts. The question of variety can be discust but briefly here.

In Kentucky, only early varieties are grown for the first, or spring, crop. Commercial growers plant early varieties mainly for the second crop also. For home use, however, late varieties often are planted for the summer, or second, crop.

Irish Cobbler is by far the most popular variety. The tubers are roundish, creamy white, and the eyes are shallow. It matures quickly and is productive for an early variety. The quality is excellent. It is probably the best variety for Kentucky. Early Ohio

was once a very popular early sort, but in recent years Cobbler has largely taken its place in Kentucky, except in a few northern counties selling in Ohio markets, where it is still in demand. The tubers are cylindrical, eyes are shallow, and the skin is dull red. It matures good-sized tubers, very early, but produces few to the hill.

Bliss Triumph is sparingly grown as an extra early variety. The tubers are round and smooth and the skin color bright red. The yield is small and the quality rather poor.

The McCormick variety, under various names, such as the July potato, Peachblow and Hoosier Boy, is perhaps the most extensively grown late potato in Kentucky. In good strains the tubers are shapely and the eyes shallow. It keeps well in ordinary farm storage, even for late planting. It is a vigorous grower and yields well, even in quite unfavorable seasons. As stated previously, late varieties, including the McCormick, are not desirable for spring planting in Kentucky.

Other late varieties extensively grown in the more northern potato-growing region of the United States are Rural Russett, Green Mountain and Burbank.

Soils, Fertilizers and Rotations. In the chief potato-growing states of the North, sandy or gravelly loam soils are considered best for potatoes. In such soils the crop is cultivated and harvested more easily and the tubers are likely to be smoother and of better quality than those grown on heavy soils. In Kentucky, medium loams or clay loams give larger yields than lighter soils, as they hold moisture better. Very few soils in Kentucky are too heavy for potatoes, provided they are well drained and contain plenty of organic matter. Bottom lands are not desirable for potatoes unless they contain considerable sand.

Potatoes can be grown year after year on the same land, if well manured and fertilized. This practice is very common in some of the eastern states. In Kentucky the difficulty of supplying stable manure makes continuous potato-growing unprofitable. Generally they are grown in rotation with other crops, where organic matter is supplied by plowing under cowpeas, clover stubble, grass sods, etc. In fact, the same rotations used for tobacco are suitable for potatoes. Perhaps the most satisfactory rotation is: first year potatoes, second year wheat, and third year clover. Another good rotation is potatoes, wheat and cowpeas followed by a rye cover crop.

Potatoes, like tobacco, are an intensive crop, and the returns from a good yield justify liberal expenditures for fertilizers. Most commercial growers in Kentucky use 500 to 1,000 pounds an acre of a complete fertilizer analyzing 4 to 5 percent of nitrogen, 8 to 10 percent of phosphoric acid and 6 to 10 percent of potash.

Applying Fertilizers. Potato planters have a device which distributes the fertilizer in narrow ribbons on both sides of the seed at any desired depth but not in contact with the seed. This is an excellent way of applying the fertilizer. In planting by hand, the fertilizer should be sown in the bottom of the furrow and mixed with the soil by running a narrow-shovel plow in the furrow. Much care should be taken that the fertilizer does not touch the seed; neither should it be placed over the seed.

Lime tends to produce scabby potatoes, and where the soil needs lime it ought to be applied a year or more before the land is planted to potatoes. Limestone may be applied when preparing the land for wheat, to be followed by clover, as in the rotation suggested. Not more than a ton of ground limestone per acre should be applied.

Planting. It is very necessary to plant the first crop of potatoes early, in Kentucky, in order that as much growth as possible may be made before the hot, dry weather of summer. Fall plowing is a good practice where sod is to be turned under, as this allows the crop to be planted earlier in the spring. A good, loose seed bed should be made for potatoes.

Perhaps the best seed for the first crop is rather small whole tubers, provided they are disease-free. If necessary to cut the seed, the pieces should be between one and two ounces and contain two or three eyes each.

In Kentucky, potatoes usually are planted in rows about 28 to 36 inches apart and about 16 inches apart in rows. This seeding probably gives the largest yields of good-sized tubers in average seasons.

Rather deep planting—4 to 5 inches—is best. Deep-planted potatoes suffer less during dry weather and the tubers do not sunburn. Most large crops are planted by the use of potato planters, as this is much faster than hand planting. The man who raises

only a few acres, however, scarcely can afford a planter, and hand planting will give just as good results.

Second-crop potatoes are planted, in Kentucky, during the latter part of July.



A four-row potato planter.

Cultivation. The main idea in cultivation is to keep weeds down and the soil loose, with as little hand hoeing as possible. This is best accomplished by harrowing the field over once or twice with a smoothing harrow before the plants are up and once or twice after. This keeps the weeds out of the rows until the potatoes are large enough to cultivate with a regular cultivator. Further cultivation should be of moderate depth. At the last cultivation, potatoes usually are ridged. This perhaps reduces the yield a little, but it makes digging much easier and helps keep down weeds, so it probably is a good thing to do.

Diseases of the Potato.* Scab is a common disease, causing roughened, scabby spots on the tubers. The disease is particularly severe on limed and manured soil. Seed treatment has not proved to be entirely successful, because the scab organism has been found to live indefinitely in certain soils and not to affect the crop in others, even tho diseased seed is planted.

Black scurf, or *Rhizoctonia*, is a disease which produces black, hard masses on the skin of the potato. These masses usually are not

* By Dr. W. D. Valleau, Plant Pathologist.

present on Kentucky-grown potatoes, but are common in northern-grown potatoes. They are not injurious in themselves, but planting such tubers may result in a stem and root rot of the plants.

Protection against either scab or scurf may be accomplished by seed treatment. A quick and simple method is the acid-mercury dip. It is done as follows: Add 6 ounces of mercuric chloride to 1 quart of commercial hydrochloric acid (muriatic acid). Pour this into a wooden barrel or concrete tank (not metal) containing 25 gallons of water, and mix thoroly. Place the potatoes in a wooden crate and dip them in this solution, allowing them to remain five minutes. If potatoes are treated after cutting, plant the same day. Replace the solution after treating forty bushels. If potatoes are to be stored after treating, spread them out until dry. *Mercuric chloride and this treating solution are very poisonous.*

Early blight is a spotting of the leaves caused by a fungus. It is common only on second-crop potatoes after cool weather begins. Blight and other similar diseases of the vines can be controlled by spraying with Bordeaux mixture, beginning when the potatoes are about six inches high, and repeating every ten to fourteen days. Bordeaux mixture is made by dissolving 4 pounds of powdered bluestone in water and putting the solution into a barrel half full of water; 6 pounds of chemical hydrated lime is mixed in water in another vessel, to make a thin cream, which is poured into the bluestone solution in the barrel while stirring briskly. Enough water is then added to make 50 gallons of the mixture.

The most serious diseases of the potato are mosaic, leaf roll, and related degeneration diseases. They are caused by viruses somewhat similar in nature to the mosaic virus of tobacco. These diseases are carried in the tubers from year to year. They result in an abnormal growth of the plants, which appear sickly and stunted in case of mosaic, or when affected with leaf roll the plants may be large, erect, and have the leaves rolled upward. In either disease the tubers are small and valueless for market or seed. Both diseases may be kept in check by the use of a small seed plot each year, which should be watched carefully in order to remove every abnormal plant as it appears. This is necessary because sucking insects may spread the diseases from diseased to healthy plants where it may not be apparent until the following year. Seed for the next year's seed plot should be selected from the best hills in the present year's plot,

and the remainder used for field planting. The use of certified seed potatoes is recommended.

Insects. To destroy the Colorado potato beetle, the most serious insect pest of potatoes, add 4 pounds of lead arsenate paste to 50 gallons of Bordeaux mixture. This spray will prevent serious damage from flea beetles and leaf hoppers also. No one should attempt to raise potatoes unless he is prepared to spray the vines.

Harvesting and Storing. Where potatoes are grown for market, it is probably best to dig the first crop and sell, as soon as the tubers are of good size. Usually a better price can be obtained then than later. For home use it is safe to leave the potatoes in the ground until fall; then they can be dug and stored in cool cellars or basements, or buried. If potatoes are to be held over for seed, they usually are put on cold storage.

Questions on Lesson X. 1. Why is it believed that the Irish potato is native in America? What kind of climate does it like? Where is it most extensively grown in the United States? 2. Why are so many potatoes grown in Europe? How long have potatoes been grown in Europe? Why is it called the Irish potato? 3. What country raises the most potatoes? Why is the yield so large there? Why is the yield in the United States so small? Name the five greatest potato-growing countries. 4. What is a potato? Do potatoes produce seeds? Describe how new varieties are obtained from seeds. 5. What kinds of potatoes are best for Kentucky? Why? Name several varieties of potatoes and describe each. 6. What kinds of soil are best for potatoes? Why should lime not be used for potatoes? Describe the fertilization of potato land. 7. When should potatoes be planted? How far apart should the rows be? How deep should the seed be planted? 8. Give the treatment for potato scab. For blight and potato beetles.

LESSON XI

COTTON

Many kinds of plants produce, in some part of their structure, hair-like or threadlike substances that can be spun into yarns for making cloth or into cords, twines and ropes. These substances are known as vegetable fibers, and the plants which produce them as fiber plants. By far the most useful and extensively grown of the fiber plants is cotton. In many respects the cotton plant is the most important in the world. Cloth made from cotton furnishes most of the clothing of a larger part of the inhabitants of the globe. In addition, it finds thousands of uses in the household and in industry. The growing of cotton, the manufacture of cotton fabrics, and the transportation of both the raw material and manufactured products utilize the labor of many millions of persons and employ vast amounts of capital. Cotton is of particular importance to the United States because about half the world crop is produced here. The agriculture of the South was built around cotton, and it is still absolutely essential to the welfare of that section of the country. From a national standpoint, cotton has been and still is a product of the greatest importance. For many years prior to the Civil War the value of cotton sold abroad was greater than the value of all other commodities exported. It was cotton, therefore, that paid for a large part of our foreign purchases and interest on money borrowed abroad. In the enormous export trade of the United States today, cotton plays a relatively much less important part than formerly. This is not only because the value of cotton exports has decreased, but also because the value of other exports has increased greatly. Our exports of cotton continued at a high level until about 5 years ago. Since then they have fallen off alarmingly. There are several reasons for this. Some of our best foreign customers in the past lack the necessary money to buy needed supplies. Other countries which compete for the world's market, Brazil in particular, have increased production enormously and underbid us. The world uses many substitutes for cotton now and this reduces consumption. Despite efforts to reduce production, this country has continued to produce about as much cotton as usual and as a result there is now in warehouses an amount almost equal to our annual production. The Govern-

ment has loaned growers more on this than cotton is bringing, and what to do with it is a very great problem. Domestic consumption requires less than half the crop and a foreign market for the rest is necessary. Thus it is clear that the problem of the cotton grower is really a serious one.

The Cotton Plant. Cotton is a member of the mallow family. Other members of this family with which nearly everyone is familiar are the hollyhock and okra, or gumbo. There are a number of



A plant showing bolls and ripe cotton.

species of cotton, some native to the old world and some native to tropical America. The species grown almost exclusively in the United States is known as *American Upland cotton*. At one time another species known as Sea Island cotton was grown extensively along the coast of South Carolina, Georgia and Florida, and on several islands near the coast, but since the advent of the boll weevil it has been impossible to grow it profitably. Sea Island cotton produces very long, silky fibers especially adapted to making fine cotton fabrics. In recent years considerable quantities of

a species known as Peruvian cotton have been grown under irrigation in southern California and Arizona. This is the species from which the fine cotton fiber of Egypt is produced.

In this lesson only Upland cotton is considered. Upland cotton is a vigorous-growing, much-branched, leafy plant which, under especially favorable conditions, may reach a height of 6 to 8 feet. Usually, however, the height varies from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet. The entire plant is covered with short hairs.

Cotton is a perennial plant in regions where frost does not occur, but in this country it is grown as an annual. The flower buds of cotton are surrounded by three small, leafy parts known as bracts. The bud and bracts are known as squares. Sometimes, however, the buds alone are called squares. The flowers are large and showy, resembling closely the flowers of the hollyhock. On first opening, they are white or cream-colored, but on the second day they change to a reddish or rosy pink color. After the flowers are pollinated, a capsule, or seed case, known as a *boll* develops. A fully developed cotton boll resembles an egg in shape, except that it is sharp pointed at the top. In some varieties the bolls are as large as a small hen egg, while in others they may be less than half as large. Cotton continues to bloom and produce bolls until killed by frost. When the boll ripens the covering splits from tip to base, usually dividing into four or five parts. These segments turn back sufficiently to expose the seed covered with a mass of pearly-white hairs which are the cotton fibers. The seeds and fibers are known as seed cotton, and the fibers, when separated from the seed, as lint. Two to three pounds of seed are produced for each pound of lint. In picking cotton, the boll covering is left on the plant. It is known as the cotton bur.

A cotton fiber consists of a single cell which, under a microscope, resembles a flattened, much twisted piece of rubber tubing. The fibers of Upland cotton vary in length from $\frac{3}{4}$ to $1\frac{5}{8}$ inches. The average length is slightly less than an inch. The fibers are very slender, and it is stated that if the separate fibers in a pound of lint were placed end to end they would reach a distance of 2000 miles.

History and Uses of Cotton. Cotton has been grown from very remote times, as is shown by the writings of early Greek and

Roman historians. It is certain that cotton was in use in India at least 3000 years ago, and in Egypt 2000 years ago. Cotton was also used extensively by the ancient civilizations of Mexico, Peru and the West Indies. At the time of the discovery of America, the manufacture of cotton was well developed, and the products were of excellent quality.



A field of cotton ready to pick

The rise of cotton to a prominent place in modern civilization began with the invention of the cotton gin in 1793 by Eli Whitney. Previous to this invention, cotton fiber had to be separated from the seed by hand labor. This made it expensive, as hand separation was slow and tedious. The cotton gin did the work rapidly and cheaply and made it possible to produce cotton fiber at a relatively low cost. This, together with the invention of improved machinery for spinning and weaving, greatly stimulated the use of cotton. The southern states found cotton to be the most profitable crop that could be grown, and production increased very rapidly. Eventually cotton was grown almost to the exclusion of other crops, a situation which prevails too largely even today.

The extensive use of cotton fiber is due to its relative cheapness and to the excellence of the fabrics made from it. It is easily prepared for spinning; in fact, it may be spun without any mechanical

or chemical treatment, in which respect it stands alone among fibers. It can also be spun into yarns more easily than any other vegetable fiber, and more rapidly. A greater variety of fabrics is made from cotton than from any other fiber, animal or vegetable; these range from the finest threads, laces and dress goods to such heavy fabrics as canvases for tents, tarpaulins, blankets and sack materials. The fabrics used in the manufacture of automobile tires also are made largely from cotton.

Cotton fabrics wear well and can be laundered without injury. Cotton is an excellent conductor of heat, and clothing made from light cotton fabrics is particularly well adapted for summer wear or for wear in tropical countries. There is only one vegetable fiber that makes fabrics superior to cotton; that is flax, from which linen goods are manufactured. Linen is so much more expensive than cotton, however, that it is used sparingly.

Soil and Climatic Requirements. Profitable crops of cotton can be grown only in regions with long, hot summers. In the United States, where about half the world's supply is grown, the northern boundaries of North Carolina, Tennessee, Arkansas and Oklahoma mark roughly the northern limits of cotton growing. The exceptions to this are small areas in southeastern Virginia, southwestern Kentucky, southern Missouri, and southern Illinois. Fair yields often can be obtained considerably farther north, but the results are too uncertain to justify attempts at production, except possibly when the price of cotton is very high. During the latter years of the World War and immediately following its close, cotton production extended northward into new territory in response to high prices. Quite a large acreage was planted in several counties in western Kentucky north of the regular producing territory. While some fair returns were obtained, the venture was not very profitable, and with the advent of lower prices production was discontinued. Some ripe bolls may be produced in almost any part of Kentucky in most seasons, and it is interesting to grow a few plants in the garden in order to study the plant at first hand.

Cotton is not so easily injured by dry weather as corn, as is shown by its successful growth in recent years in the semi-arid region of Texas, where corn rarely produces a good crop. However, a long-continued drouth seriously reduces yield. A warm

spring with frequent light showers, followed by a hot summer of moderate rainfall provides the best conditions for cotton. A rather cool, dry fall is desirable. Too much rainfall during the fall retards ripening, damages the fiber, and interferes with picking.

Cotton is grown on a great variety of soils, but a medium light, well-drained loam of moderate fertility is regarded as the best type. Sandy soil dries out quickly and is difficult to keep in a productive condition. On the other hand, heavy, rich bottom land or heavy clay soil is likely to produce a rank plant growth and a low yield of lint. Most of the cotton soils of the South are low in fertility, and the liberal use of commercial fertilizers is necessary for profitable production. Millions of tons of fertilizers are used on the cotton crop each year.

Production Methods. Land usually is prepared for cotton in the fall or late winter. In the older parts of the cotton belt practically all the planting is done on ridges or beds something like the ridge used for sweetpotatoes but not so high. Bedding provides quick surface drainage, and the soil warms up earlier in the spring. It is also somewhat easier to control weeds on bedded land.

Fertilizers are applied shortly before or at the time of planting. However, where nitrate of soda, or other nitrogen fertilizer, is used, it usually is applied after growth has begun.

Cotton planting begins in early April in the southern part of the cotton belt, and in the northern part in early May. A bushel to a bushel and a half of seed per acre is planted. The planting is done with a cotton-seed drill which plants the seeds in a continuous row and covers them very shallow.

The first cultivation is given as soon as the plants are a few inches high. This is followed by thinning, which is called chopping. The cotton is thinned to one plant to every twelve to twenty-four inches. The richer the soil, the wider the spacing. After thinning, the crop is cultivated again, using an implement that throws earth around the plants. Cultivation is continued until the branches hide the ground.

Picking, Ginning and Baling. Altho several cotton pickers have been invented, most of the crop is picked by hand. Picking begins in the far South in August and continues until December. An average day's work for an experienced picker is about two

hundred pounds of seed cotton. Picking is the most expensive job connected with cotton growing.

Cotton is hauled to the gin directly from the field. After ginning, the lint is pressed into bales about 54 inches long, 24 inches wide and 24 inches thick, weighing 500 pounds, which includes the weight of the iron ties which hold the bale in shape, and the bagging with which it is covered. The seed is either returned to the grower or sold to the gin owner, who then sells it to the oil mills.

Cotton seed is a very valuable by-product of cotton production. Most of it is utilized for the extraction of oil. Cotton-seed oil is one of the most valuable of vegetable oils. It is used for making lard and butter substitutes, for the manufacture of soap, and many other purposes. After the oil is extracted, the residue known as oil cake is ground, forming the valuable protein feed known as cotton-seed meal. Cotton-seed meal is used to some extent as a fertilizer.

Insects and Diseases. The most important insect pest of cotton is the Mexican boll weevil which has invaded the country in recent years. This insect threatened the very existence of the cotton industry for a time, but fairly successful methods of control have been developed. The boll weevil is a small beetle which lays its eggs on the cotton plant soon after the blossoms fall. The eggs hatch into tiny grubs which bore into the young boll and feed upon its contents.

The most serious cotton diseases are wilt and root-rot. Rotation of crops is the best way of controlling these diseases. Recently varieties of cotton have been developed that are resistant to wilt.

Production Figures. The world production of cotton has averaged approximately 26,000,000 bales annually during the five-year period, 1926 to 1930, inclusive. There are only a few countries where cotton is extensively grown. The United States, with an annual crop of about 15,000,000 bales, produces about half of the total world crop. India produces 4,000,000 to 5,000,000 bales; Egypt 1,750,000 to 2,000,000 bales; Russia, Brazil and China about 2,000,000 bales each.

The leading cotton-producing states in this country and the

approximate average production in each are as follows (1928-32 average):

Texas	4,580,000 bales
Oklahoma	4,580,000 bales
Mississippi	1,559,000 bales
Arkansas	1,352,000 bales
Alabama	1,255,000 bales
Georgia	1,241,000 bales
South Carolina	856,000 bales
North Carolina	752,000 bales
Louisiana	745,000 bales
Tennessee	479,000 bales
California	200,000 bales

Cotton cannot be grown profitably in the eastern part of the Cotton Belt for less than 12 to 15 cents per pound. It can be produced much more cheaply in Texas and Oklahoma where the land is more level and more productive. The average price in recent years has been less than 10 cents per pound, and this price level has been maintained only because of Government help.

Questions on Lesson XI. 1. What are vegetable fibers? Discuss the importance of the cotton plant. 2. To what family of plants does cotton belong? What plants belong to the same family? What kind of cotton is grown in the United States? 3. Describe the cotton plant, including the various parts of the plant. What is cotton fiber? Describe the appearance of the fiber under the microscope. 4. What was responsible for the development of the cotton industry? Why is cotton fiber used so extensively? 5. What kind of climate is necessary for the production of cotton? What are the northern limits of the cotton-growing territory in this country? Can cotton be grown successfully in Kentucky? 6. What kind of a season is best for the production of cotton? Why? What soils are best adapted for the production of cotton? 7. Why is cotton planted on ridges? When are fertilizers applied? When is the crop planted? How much seed is planted per acre? 8. What is meant by "chopping" cotton? How much cotton can an experienced hand pick in a day? What is the weight of a bale of cotton? 9. What is cotton seed used for? Discuss the importance of cotton seed. 10. What countries lead in the production of cotton? Give the approximate production of each. Name the leading cotton-producing states in the United States.

LESSON XII

WHEAT

As was stated in the first lesson, wheat was probably one of the first plants to be cultivated. Men learned to raise wheat long before they learned to record history, so that we do not know when or where it was first grown.

Wheat probably always has been the most important crop for human food. Now it is by far the most important, for its use has increased very greatly in recent times and is still increasing. It must not be supposed, however, that its use is general all over the world. In China, Japan, India and other countries of Eastern Asia rice is the chief cereal for human food. In Germany, Russia and some other European countries the poorer classes use rye flour from which the so-called "black" bread is made. The French use eight bushels of wheat per person, the largest amount of any nation in the world. The English use about six bushels per person, and the people of this country three bushels. Wheat is such a popular grain for human food because it makes light, nutritious and appetizing bread and can be used in so many different ways.

The Wheat Crop of the World. Europe produces about one-half of the world's wheat, and North America about one-fourth. The climate of Western Europe is better adapted for producing large yields of wheat than that of much of the United States, and the crop is more carefully handled than in this country, consequently much larger yields are obtained. In Russia the yield is low, partly because of unfavorable climatic conditions and partly because of a poor system of farming. The quality is usually excellent, however.

Many countries of Europe use much more wheat than they raise. Great Britain and Ireland buy over 200,000,000 bushels each year. Germany, Belgium, Holland and Italy also buy large quantities. Most of this wheat is bought from Russia, Argentina, the United States, India, Canada, Roumania, Australia, and Hungary, which countries produce more than they need for their own use.

After the World War, wheat production was greatly increased in many countries. This resulted in overproduction and consequent low prices. The price of wheat in 1930 fell to less than 50 cents per bushel in Chicago, the lowest price in the history of the country with one exception.

The average total production and yield per acre of wheat in the

chief wheat-growing countries of the world during the years 1925-26 to 1926-30 were about as follows:

Country	Total Yield (Bushels)	Yield Per Acre (Bushels)
United States	822,000,000	14.1
Russia	790,000,000	11.1
Canada	430,000,000	18.6
India	320,000,000	10.2
France	291,000,000	22.0
Argentina	243,000,000	12.8
Italy	229,000,000	19.0
Spain	146,000,000	13.7
Australia	136,000,000	10.6
Germany	119,000,000	29.4
Roumania	105,000,000	13.6
Yugoslavia	81,000,000	17.7
Hungary	80,000,000	20.8
Poland	60,000,000	18.3
Great Britain and Ireland	53,000,000	35.0
Czechoslovakia	46,000,000	25.5
Bulgaria	40,000,000	15.2
Egypt	40,000,000	25.8

Wheat in the United States. The region raising most wheat lies west and north of the great corn-growing sections. The most important winter wheat region is in central Kansas, Nebraska and Oklahoma, while most of the spring wheat is produced in the Dakotas and in Montana. There are several reasons for the importance of wheat in these parts of the country. The land is level and fertile, permitting the use of machinery for harvesting the crop and making the use of commercial fertilizers unnecessary as yet. Thus the crop can be produced cheaply. In central Kansas and Nebraska the rainfall is not always sufficient during the late summer to assure a good crop of corn, but wheat ripens before the summer drouth and consequently is a more certain crop than corn. The Dakotas and Montana also frequently suffer from drouth and in addition the growing season is too short in the northern parts to make corn a sure crop.

On the black, loamy prairie soils of Illinois, Iowa and other states, little wheat is grown. Wheat winter kills badly on these loose soils, and oats generally are grown instead. In other parts of the Corn Belt, however, heavier, more clayey soils are found and here wheat is grown in rotation with corn, grass, oats and clover. Wheat is not so profitable as corn, but it fits into the rotations nicely, giving an opportunity of seeding land to grass and clover. Ohio, Indiana, Illinois and Missouri all raise large crops of wheat.

Washington state is a large producer of both spring and winter wheat. Pennsylvania raises a good-sized crop and many other states in the eastern, south central, and southwestern parts of the country raise considerable amounts. Little wheat is grown in the eastern part of the cotton belt because there is not much land suitable for the crop and because wheat rusts badly there. In Texas, however, the climate is drier and considerable wheat is grown.

Kentucky's Wheat Crop. Kentucky is not a very important wheat state. The crop has amounted to about 6,000,000 bushels in recent years. This is not enough for our own use, and some has to be bought from other states. Much of the crop is produced in a few counties of western Kentucky, where there is considerable level, fertile land. Bottom land usually is not desirable for wheat. Probably as much wheat is raised in Kentucky as is advisable. It cannot be grown profitably at prices prevailing in recent years and most farmers raise it only to provide a crop in the rotation with which to sow grass, clover and other forage crops.

Spring and Winter Wheat. Winter wheat is grown wherever the winters are not so severe as to kill the plants. It is more productive than spring wheat and there is more time to sow wheat in the fall than in the spring when farmers are rushed to get in corn and other spring-planted crops. A winter variety of wheat seldom, if ever, gives a good crop if planted in the spring. Winter wheat has a dormant period—that is, it grows for a time in the fall and then growth is checked until spring. If sown in the spring, it still maintains the habit of resting, and is likely to fail to make stems at all.

Spring wheat cannot be grown very successfully where summers are hot, especially if they are damp, because it rusts badly. Kansas and Nebraska used to grow spring wheat until the introduction of the very hardy Russian types of wheat. Since then, winter wheat is grown almost exclusively. While spring wheat can be grown more successfully in those states than in Kentucky, because of a dry climate, the yield is very uncertain. In Kentucky one is fortunate to get any returns at all from spring wheat.

The Wheat Plant. When wheat germinates it throws out three temporary roots, as corn does. The permanent roots appear later, their distance from the surface of the ground being the same no matter how deep the wheat is planted. The roots are quite fine and very abundant.

The stems or culms of wheat are hollow and their length varies very greatly. Common wheat usually grows about $3\frac{1}{2}$ feet high in Kentucky. The weight of the stems or straw usually is little more than the weight of the grain.

Tillering or stooling is the sprouting out of new stems from the underground part of the main stem. Where wheat is thin and the soil fertile, the plants form a very large number of tillers. Thus a poor stand of wheat may become a good one. While tillering is valuable in improving a stand of wheat, it does not pay to sow little seed and depend on tillering to make a thick stand.

The flowers of wheat consist only of the stamens, pistils and ovary. They are enclosed in two chaffy parts called glumes. Two or more of these are grouped together, and the group, in turn, is enclosed in two glumes. These groups of flowers are called spikelets or, sometimes, the mesh. The head, called a spike, consists of a number of spikelets arranged alternately on opposite sides of the stem at the tip. The grains of wheat are later enclosed in the chaff or glumes.

Gluten. The grain of wheat and rye contains a substance known as gluten. This is a sticky substance which holds the particles of flour together when water is added, thus forming a dough. When yeast, baking powder, or other material which forms a gas, is added to the dough, the gas is held by the dough and a light, porous bread is formed. The value of wheat as a bread-making grain is due largely to gluten.

Questions on Lesson XII. 1. What nations use the most wheat? Why is wheat such a popular grain for human food? 2. What part of the world produces the most wheat? What part of the crop does North America produce? Why is the yield of wheat in Western Europe so much better than in the United States? 3. What countries sell wheat? Buy wheat? 4. Why are Kansas, Nebraska, Montana and the Dakotas such important wheat states? 5. What can you say about the wheat crop of Kentucky? Why is the crop so small? 6. Which yields best, spring or winter wheat? Can spring wheat be grown in Kentucky? Why? 7. Describe the roots of wheat. What is the average height of wheat in Kentucky? What is tillering? 8. What are glumes? Spikelets? Spikes? What is gluten?

LESSON XIII

WHEAT (continued)

Kinds of Wheat. There are several classes of wheat, but most of the wheat grown in the United States belongs to the class known as bread wheats. Considerable Durum wheat is grown and used chiefly for making macaroni, spaghetti, etc.

The quality of wheat is affected by climate. That grown in dry regions is hard and contains much gluten. That raised where there is plenty of rainfall is softer and contains less gluten. Flour made from hard wheat is regarded as more valuable for bread making than that made from soft wheat. It is called a strong flour because of the large amount of gluten, and will make larger, lighter loaves of bread. Flour made from soft wheat is better for making biscuits, cakes, etc., and, while it does not make quite as light a loaf as the flour from hard wheat, the bread is just as appetizing and nearly as nutritious.

Kansas and Nebraska produce hard winter wheat and the Dakotas and Montana hard spring wheat. The eastern United States and the Pacific coast states produce the softer wheats. In the markets of the country the wheat of the eastern United States, including Kentucky, is known as red winter or, where a white variety is grown, as white winter wheat. There are many market grades too numerous to discuss here.

Varieties of Wheat. There are a great many varieties of wheat, differing in time of maturity, color of grain and chaff, hardness, percentage of gluten, stiffness of straw, and winter hardiness. Some wheats are bearded, or carry awns, and some are smooth, or lack awns. As a rule the late-maturing varieties are adapted only to the more northern states, while early varieties have a wider adaptation. Late varieties usually outyield early varieties where the climate is suitable for them. The market prefers the so-called red wheats, and varieties with white grains are grown extensively only in the far west and in eastern Canada. Some of them are heavy yielders or have other desirable characters, such as stiffness of straw, which make them of especial value in certain regions.

Winter hardiness is, of course, absolutely necessary in a winter wheat, but such extreme hardiness as is necessary in Kansas and Nebraska is not necessary in Kentucky and other southern states.

Smooth varieties of wheat are most popular, as a rule, because they are easier to handle and the grain does not shatter so badly as that of the bearded varieties. There are some excellent bearded varieties which are extensively grown, however. Of course, good yield and stiffness of straw sufficient to prevent lodging are qualities necessary in all varieties, as a variety lacking these qualities is not likely to be grown long, regardless of its other qualities.



Variety tests of wheat at the Experiment Station.

The varieties in an old community usually are those which experience has shown to be the best adapted to the climatic and soil conditions. In Kentucky only a few varieties are grown extensively. These are mostly early varieties, with fairly stiff straw, and hardy enough to stand quite severe winters. Fultz, a smooth variety with white chaff, is, perhaps, the favorite variety. Currell's Prolific is an important variety in western Kentucky. It has red chaff and is beardless. The Kentucky Experiment Station produced a strain of Currell's several years ago which has stiffer straw than ordinary Currell's and gives a slightly better yield. It is now extensively grown. This is known as Kentucky 47. Fulcaster is the most important bearded variety. Mediterranean Fultz has a very stiff straw and is desirable for bottom land. There is little difference in the yield of these varieties. New varieties of wheat should be

tested thoroly before discarding old varieties. Not many of them have proved equal to the old standard varieties.

Seed Wheat. The best seed is that grown in the immediate neighborhood. However, the source of the seed is not so important as with corn. Wheat is a self-fertilized plant and varieties do not run out except by getting mixed with other varieties or full of cheat, cockle, etc. If kept clean and pure, there is no advantage in changing seed. Before sowing, wheat should be cleaned carefully to take out dirt and light seeds. It is not necessary, however, to remove small grains, if sound, because they produce as well as heavy grains.

Preparing the Seed Bed. Most of the wheat in Kentucky is grown after corn or tobacco and the only preparation of the soil necessary is disking and rolling.

Where wheat follows wheat or other small grain, the land should be plowed as early in the summer as possible, so that a firm, compact seed bed can be made by seeding time. The ideal seed bed is compact, level and free from clods.

Fertilizers. The question of fertilizers is discust in the soil lessons, Kentucky Extension Circular 54. As indicated in those lessons, one must be guided in using commercial plant food by the needs of the soil. Outside of the central Bluegrass region, some carrier of phosphorus should be used on wheat. Two hundred pounds of superphosphate or of basic slag per acre is a good treatment. When the price of wheat is good, nitrate of soda or some other nitrogenous fertilizer often can be applied profitably to wheat, in the spring, as a top dressing. Its need should be determined by the appearance of the crop. If rank and vigorous the nitrate seldom pays; but if not in the best condition, it may give a profitable increase. Commercial nitrogen is expensive and must be used with good judgment.

Seeding. Wheat should be sown early enough to give a good growth before freezing weather. When Hessian fly is present, wheat should be seeded as late as is safe, to avoid the fly. In northern Kentucky the best time for sowing is from October 1 to 10; in southern Kentucky from October 5 to 15.

The experiments conducted by the Kentucky Experiment Station have shown that 6 pecks per acre is the most profitable rate. On very fertile land four or five pecks may be sufficient.

Wheat should always be drilled, as drilled wheat yields better and is less likely to winter-kill.

Harvesting. Wheat should be allowed to ripen well but not become dead ripe before cutting. If cut green the yield will be less, and if allowed to get too ripe, it is difficult to handle and shatters badly. Putting wheat into the barn or stacking is seldom practiced in Kentucky. It perhaps costs a little more to stack wheat than to thresh from the field, but it is a good precaution against damage and probably pays in the long run.

Diseases of Wheat.* Rust is a destructive disease of wheat, especially in the spring-wheat regions. It is likely to be worst in wet seasons and on low ground. There is no known remedy for rust, but early-maturing varieties usually are affected less than late varieties. The rust usually affecting wheat in Kentucky is the blade rust, altho the black stem rust usually is present each year. The black rust has been known to be destructive to wheat for many years, but it has only recently been demonstrated that leaf rust is also very injurious. By dusting plots of wheat with sulfur, which prevents the disease, it has been demonstrated that yield may be reduced as much as 90 per cent by leaf rust, altho the reduction is usually much less.

Stinking smut is a dangerous disease of wheat in Kentucky, but a preventable one. The spores of stinking smut are carried on the outside of the seed and, of course, are planted with the seed. The smut spores start to grow when the wheat seed germinates, and infect the plant. Until recently the best preventive has been the formaldehyde treatment. Use a pound of formaldehyde to 50 gallons of water. Put the wheat on a floor or on a tarpaulin. Sprinkle with the formaldehyde solution, shoveling the grain over until all is thoroely wet. One half gallon of the solution is sufficient for a bushel of grain. Pile the grain up, cover with sacks or blankets and leave for two hours. Then dry sufficiently to sow. Grain treated with formaldehyde should be planted soon after treatment. Recently a simple method of treating wheat for smut has been developed, known as the copper carbonate dust treatment, which avoids wetting the seed and also the seed injury which sometimes occurs with the formaldehyde treatment. It consists in mixing the dust and seed thoroly at the rate of two ounces of dust to one

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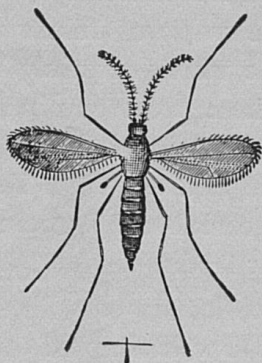
bushel of seed. Mixing must be so thoro that each seed is coated with dust. Mixing machines are on the market or a homemade machine may readily be made from a large churn or barrel. The dust is likely to cause slight sickness if breathed, and so a dust mask or handkerchief should be worn over the nose and mouth while doing the mixing. The seed may be treated at any time and stored, without danger of seed injury. This treatment is used extensively in regions where stinking smut is severe. Another dust also used extensively for treating not only wheat, but other grains as well, is mercury ethyl phosphate sold widely under the trade name of Ceresan. It is used in the same way as copper carbonate dust. In using the dusts, directions on the package should be carefully followed.



Forty bushels of wheat to the acre.

Loose smut is not generally very destructive and, while it can be controlled, the treatment is quite difficult. It consists in soaking the seed four to six hours in cold water, after which it is dipped in water at about 120°F. It must then be soaked in water at 129°F. for 10 minutes and at the end of this period cooled at once by dipping into cold water after which it is spread out to dry. The same treatment applies to the loose smut of barley, but the seed is soaked for 13 minutes in hot water at 126°F., instead of 10 minutes at 129°F. If this treatment is used it is better to use it

for a seed plot large enough to supply about twice the seed necessary for the following year. The plot should be isolated from other wheat fields.



The adult Hessian fly. About five times natural size.

Insects. The one serious insect pest to be guarded against in Kentucky is the Hessian fly. The best way of controlling this insect is by planting late. If the wheat is planted about two weeks before the probable date of the first killing frost, the danger of serious damage will be greatly lessened.

Questions on Lesson XIII. 1. What causes wheat to vary in quality? What kind of wheat is produced in dry regions? In regions of plenty of rainfall? Which makes the best flour? Why? 2. Where is hard winter wheat grown? Red winter wheat? 3. What are some of the ways in which varieties of wheat differ from each other? What qualities in wheat are demanded in the markets? 4. Describe the qualities desirable in a variety of wheat for Kentucky. What are the most important varieties in Kentucky? 5. Does wheat run out? Where is the best place to get seed wheat? 6. How should the seed bed for wheat be prepared? Why is early plowing best? 7. When should wheat be sown in Kentucky? How much seed should be sown per acre. How should wheat be sown? 8. Describe treatments for stinking smut of wheat. 9. What is the best way to control the Hessian fly?

LESSON XIV

OATS

Oats have not been cultivated nearly so long as wheat or barley, it is believed. At least, the crop was unknown to the ancient Greeks or ancient Romans, while wheat certainly had been cultivated for many centuries before these great empires were founded. Cultivated oats probably originated in east or central Europe. With the civilization of central and northern Europe, oats became one of the most important cereal crops, being used extensively for human food as well as for feeding livestock.

As stated in a previous lesson, oats, like the potato, are strictly a cool weather crop and are well adapted only to the more northern part of the United States and to Canada. It is true that they are grown extensively over a good part of the Corn Belt, but this is because a small-grain crop is almost necessary in any system of grain farming, to provide an opportunity for sowing grass and clover. In many sections oats, altho not profitable, are yet the best of the small grains to grow, because they are grown so cheaply and the planting and harvesting do not interfere with other farm operations, or because fall-sown grains can not be grown successfully.

Oats in Kentucky. Kentucky is far south of the region best adapted to spring oats and as yet no strains that can be depended upon to survive our winters have been developed. Notwithstanding these facts several million bushels are grown in the state annually. Most of these are spring sown but in southwestern Kentucky a considerable acreage of winter oats is grown. Oats have no definite place in the rotation in Kentucky. They serve often as a crop for filling in where wheat winterkills, or a small field may be sown to furnish early feed, or even for making an emergency hay crop, a purpose for which they are fairly well adapted.

The Oat Plant. The appearance of the young oat plant, the rooting system and habits of growth are similar to wheat. The straw is softer than that of wheat and the leaf blades wider and more abundant. Like wheat, oats tiller or stool freely under favorable conditions. The flowers of oats form what is known as a panicle. This consists of a central stem with a few widely separated joints. From each joint, or node, several branches are given off.

These differ in length, some of them branching. The spikelets are borne on the ends of the branches and attached by rather long stems or pedicels. Each spikelet consists of two large, soft outer glumes which enclose two or more flowers. Usually only two flowers produce kernels. The flowers are enclosed in glumes or chaffy parts as in wheat, but unlike wheat the ripe kernel, except in hull-less varieties, remains enclosed in the glumes which form what is usually known as the oat hull. In some varieties, particularly in the so-called Red Rustproof, the glumes bear a short beard or awn. About 30 percent of the weight of oats grain is hull which has practically no feeding value; consequently a bushel of oats contains only about 22.5 pounds of real grain or 40 percent as much as a bushel of corn. It may be assumed that a bushel of corn is worth, therefore, at least twice as much as a bushel of oats in feeding value, except, perhaps, for certain classes of stock. While the legal weight of oats is 32 pounds per bushel, very plump oats often weigh 40 to 50 pounds per bushel. On the other hand, poorly filled grain may weigh only 15 to 20 pounds per bushel.

Varieties of Oats. These are almost as numerous as varieties of wheat. There is no clearly marked division between the so-called winter and spring varieties as in the case of wheat and barley. Winter varieties of barley do not form heads in many instances when spring sown. This is not true of oats, and any of the varieties commonly fall planted in the South may be spring sown. In fact the best varieties for spring seeding in Kentucky and the southern part of the Corn Belt are those grown as winter oats in the Cotton Belt. Varieties differ widely in length of time required to mature, color of hull, and character of straw. Like most other crops, the later-maturing varieties give the largest yields under favorable climatic conditions; hence such varieties are most extensively grown in northern United States and Canada. South of the regions naturally well adapted to oats, however, the weather becomes hot before late varieties develop and the grain develops poorly. Under such conditions early varieties which ripen before the advent of very hot weather, give much better yields of grain, on an average, than late varieties. Early varieties may be profitably used as far north as the latitude of Columbus, Ohio. Even in Iowa medium early varieties are preferred to late ones. In Kentucky the earliest varieties obtainable should be grown. The chief

advantage of fall seeding of oats is their early maturity. They become established and make most of their growth in the cool weather of early spring, just at the time spring oats are being planted.

Most of the varieties of oats grown in the North have light straw-colored hulls and are known as white oats. Some good varieties have dark brown hulls and these are known as black oats. Most of the early varieties of spring oats and all varieties fall planted range from light yellow to reddish in color of hull.

Early varieties of oats have short straw, as a rule, and the proportion of grain to straw is larger than with late varieties. Important varieties for the more northern oats sections are Swedish Select, Wolverine, Gopher, Cornellian, Siberian and Victory. For southern Iowa, central Illinois, Nebraska and other areas in the same latitude, medium early varieties are recommended such as Silvermine, Richland, Gopher, Iogren, and Iowar a selection from Kherson. Early varieties recommended for the more southern areas of the spring oats belt, are grown also. Among the most important of these are Fulghum and various selections from it: Kanota, Columbia and Franklin, Kherson, Burt, or 60-Day, and Albion. Columbia, developed at the Missouri Experiment Station, was the best variety tested at the Kentucky Experiment Station in recent years. Burt also gives good yields and Fulghum does well on productive soils.

There are two groups of so-called winter varieties: Turf and Red Rustproof. The latter includes Fulghum, Texas Red, and several others. Fulghum is perhaps the best in this group as it and varieties developed from it are best for spring sowing where earliness is essential. The Red Rustproof varieties cannot be safely sown in the fall north of the Gulf states. The Turf group includes such varieties as Winter Turf, Virginia Gray, Gray Winter, and various strains of these. Turf oats are much more winter hardy than the Rustproof varieties and are grown extensively in Virginia, North Carolina and Tennessee. They are the only oats which have any chance of surviving the average winter in Kentucky.

Uses of Oats and Oat Straw. Most of the oats grown in this country are fed to livestock, especially horses. The city demand for oats for feeding horses used to be large but since the advent of motor trucks and automobiles the demand has fallen off greatly.

A large quantity is used for making rolled oats and oatmeal. In order that oats may weigh heavier and take up less room in shipping, a good part of the oats that are marketed are "clipped." This means that the ends of the glumes are rubbed off by a machine known as a clipper. The market demands white oats and frequently poor-colored or weather-damaged oats are bleached to make them whiter. Oat straw is used extensively as roughage for wintering stock or for feeding steers consuming a heavy grain ration. The straw is softer and much more palatable than wheat straw. It is not so good for bedding, however, as wheat straw.

Soil Requirements. In the Corn Belt oats are regarded as a good poor-land crop and are often sown on land too poor to raise good corn. In Kentucky, however, they should be planted on fairly good land. They succeed best on fairly heavy soil that holds moisture well.

Preparing the Seed Bed. In the Corn Belt oats usually are sown on corn stubble. Sometimes the land is disked before sowing but usually the oats are sown first and covered by disking the land thoroly. In Kentucky it pays to plow the land for oats as otherwise weeds may prove very troublesome.

Time and Rate of Seeding. The earlier oats can be sown the better the chance of a good yield; hence they usually are sown just as early as the ground can be worked. In Kentucky early seeding is especially desirable. In fact it scarcely pays to sow later than April 10. They may be sown safely in February if soil conditions permit.

The usual rate of seeding is two to three bushels per acre. In Kentucky two bushels are sufficient. If clover is sown with oats, it is best not to sow the oats heavily or the clover is likely to be crowded out. Oats usually are sown broadcast in Illinois, Iowa and other important oat states, by the use of a seeder attached to the end of the wagon bed and operated by a sprocket chain driven by the wagon wheel. This is known as an "end gate seeder." Drilling is preferable where it can be done without much extra cost.

Harvesting and Threshing. Oats are cut with a binder and usually threshed from the field. Much of the oats grown in Kentucky are not threshed but used or sold in the sheaf. The oats should be thoroly ripe when cut and should be shocked carefully. If the

weather is wet at harvest time it is often difficult to prevent the oats damaging in the shock. Not much is gained by opening the shocks and attempting to dry the bundles. About all that can be done is to take off the caps so the sun and wind may dry out the heads.

Diseases and Insect Pests. Oats are attacked by rust and this is the most serious disease. The loose smut of oats causes heavy losses, but this is unnecessary as it can be controlled by treatment with formaldehyde. The treatment can be given as directed for wheat, or the so-called dry or modified dry formaldehyde can be used. In the latter method, now generally preferred, a pint of formaldehyde is mixed with 10 pints of water and the mixture put



This field of oats made 75 bushels to the acre.

into a hand spray pump, such as is sold for spraying small lots of potatoes, etc. The oats are piled on a clean floor or tarpaulin. They are treated by scooping into another pile and spraying each scoopful as they leave the scoop. A single stroke of the spray is enough for each scoopful. One pound of formaldehyde will treat about 50 bushels of oats. The oats should be covered with tarpaulins or sacks after treatment and allowed to remain for 5 hours. The covering should then be removed and the oats spread somewhat to allow the fumes to escape.

Mercury ethyl phosphate dust or Ceresan is now superseding formaldehyde for treating oats to control loose smut. Directions on the package should be carefully followed in using this dust treatment.

Oats have no serious insect enemies.

Questions on Lesson XIV. 1. In what part of Europe is the oat crop very important? Why? Where is the chief oat-growing section of the United States? 2. Why are oats often grown even tho the crop is not profitable? 3. What can you say of oats in Kentucky? 4. Compare the oat and wheat plants? Describe the oat grain. 5. What can you say of oat varieties? Where are early varieties of oats desirable? Why? Name some early varieties. Where can winter oats be grown? Why better than spring oats? 6. What is the principal use made of oats? Why are oats clipped? Bleached? 7. Give soil requirements for oats. How are oats usually planted and when? Why is early seeding desirable in Kentucky? 8. Describe the treatment for loose smut of oats.

LESSON XV

RYE

It is believed that rye was first cultivated in western Asia or southern Russia. Apparently this grain has not been grown nearly so long as most of the other cereals, such as wheat, rice and barley. No mention of it has been found in ancient literature, and it has not been found in Egyptian monuments which have yielded specimens of the grains grown in ancient times.

Rye is quite closely related to wheat. Occasionally these two grains hybridize (cross), but the resulting seed seldom grows. Rye grows much taller than wheat, and the stems are more slender. The grain is not fully enclosed in the chaff, as is true in wheat. All varieties of rye are bearded.

Production. Rye for grain is not grown extensively in the United States, but it is a very important crop in Europe, particularly in Russia, Germany, and Poland. These three countries produce approximately a billion and a half bushels annually, which is considerably more than three-fourths of the world production. (Compare the world production of wheat and rye.) In these countries rye bread is used as extensively as wheat bread or even more extensively. A large part of the rye crop of the United States is produced in North Dakota, Minnesota, Wisconsin, Michigan, and Nebraska. North Dakota alone produces about one-third the total crop.

Rye and Wheat Compared. Wheat and rye are the only grains that contain gluten and from which light bread can be made. Wheat flour makes much whiter bread with a more delicate texture than rye flour, and it also makes better looking cakes and pastries. However, the people in many parts of Europe like rye bread and other products made from rye flour as well as those made from wheat flour, or better.

The hardiest varieties of rye are much hardier than any varieties of winter wheat; consequently rye can be fall-sown much farther north than wheat. It is less subject to disease, especially the rusts, than wheat and can be grown in the humid climate of the southern cotton belt more successfully than the latter. It also has fewer insect enemies than wheat. The Hessian fly, which is such a serious

wheat pest, seldom injures rye. Rye produces a fair crop on poorer land than wheat, especially on poor sandy or very acid soil. It is, therefore, a very useful crop in many regions where soil and climate are not favorable for wheat production. Rye is not nearly so desirable a crop as wheat, however, in regions adapted to the latter. It usually yields less than wheat and is much more difficult to harvest and thresh because of the long straw. In addition, the price of rye averages lower than the price of wheat.



Rye grows tall and slender.

Uses. Even tho the production of rye in the United States is relatively small, a considerable part of the crop is exported, chiefly to Europe. The export demand is irregular, however, being influenced by the condition of the crop in Europe. In some years nearly half the total crop is exported; in others only a few thousand bushels. The portion of the crop consumed in this country is used largely for making rye flour and for seed. Many thousands of acres of rye are sown for pasture and cover crop in regions where little or no grain is harvested; consequently seed is brought from areas where the crop is grown chiefly for grain production. Rye is not a good feed grain. It is not relished by animals and, unless mixed with other grain, often causes digestive troubles. Rye never should be fed to poultry. Because of its vigorous growth and hardiness, rye is

regarded as the most generally useful of all the cereals for pasture and cover crop. It is particularly valuable in the South, where it provides pasture during much of the fall, winter and early spring and prevents washing of the soil and leaching of plant food.

Rye in Kentucky. A large acreage of rye is sown in Kentucky for pasture and to serve as a cover crop. Kentucky farmers are coming to realize that it is a serious mistake to leave land unprotected during the winter, and the use of cover crops is increasing very rapidly. Spring lamb production has become an important industry in the state, and there is nothing better for young lambs than a luxuriant rye pasture. Rye pasture furnishes the earliest grazing in the spring and the latest grazing in the fall. If sown early, rye also furnishes much winter pasture, particularly in mild winters. Since the price of wheat has fallen to such a low level, there is no profit in raising it. However, a small-grain crop is necessary in the rotation to provide an opportunity of sowing clover, grass, etc. Doubtless it pays better to utilize the small grain for pasture instead of harvesting the grain; at any rate, the practice is growing. Rye usually is sown for this purpose, altho wheat and winter barley are utilized. Where the small-grain crop is pastured, grasses and clovers sown with it have a much better chance of surviving than if the grain crop is allowed to mature. This is particularly true on rich soil where grains are likely to grow very rank if not pastured.

Only about fifteen thousand acres of rye are harvested for grain in Kentucky. Production averages about 180,000 bushels.

Varieties. Since rye is not a very important crop in the United States, the question of varieties has not received much consideration. In recent years, however, a number of varieties have been developed by breeding and several have been introduced from Europe. These are gradually replacing the "common" rye. Rye is cross-fertilized, like corn, and varieties mix readily when planted near each other; consequently much care is necessary to keep varieties pure. Rosen rye is a selection from a European variety, made by the Michigan Experiment Station. In order to have a source of pure seed, it was arranged with farmers living on an island in Lake Huron, widely separated from the mainland, to grow only this variety of rye, so that no mixing might occur.

In addition to the Rosen rye, several other varieties have been

developed, chiefly by selection from European varieties. Among these are Minnesota No. 2, Advance, Dakold, Giant Winter, and Schlansted. These varieties are particularly adapted for grain production and are no better than common rye for pasture, if indeed equal to it. Abruzzi rye is an Italian variety introduced into this country by the United States Department of Agriculture. More recently several other varieties have been introduced from Mediterranean countries of Europe. All are similar to the Abruzzi but one of these, Balbo, is said to be more winter hardy than the others. These Mediterranean varieties make a very rank fall and winter growth when the climate is mild. They are not nearly so hardy as other varieties and are primarily adapted to the cotton belt. However, in some years Abruzzi has given good results in Kentucky, especially in the southern part. Probably, as a rule, the hardier strains are preferable for this state.

Since most of the rye grown in Kentucky is utilized for pasture or as a cover crop, common rye is just as satisfactory as the new varieties grown in the North. The seed is smaller and a thicker stand is obtained with a given amount of seed than of the Rosen or other northern varieties.

Seeding Practices. Where rye is intended primarily for pasture or for a cover crop, early seeding is very desirable. In Kentucky, rye may be seeded safely in early September or during the last few days in August. Temperatures during September are favorable for rapid growth, and rye sown at this time usually gives good pasture during the late fall and early winter. Because it has had an opportunity to become well rooted, early-sown rye survives the winter in a vigorous condition and starts growth early in the spring. The Hessian fly does not attack rye, hence there is no danger in early planting, as far as this insect is concerned. Rye is such a hardy plant that it may be sown considerably later than wheat, with little danger of winterkilling. However, the late-seeded crop does not protect the soil much and, of course, furnishes no fall pasture. For grain production alone, early October seeding probably is best in Kentucky.

Rye usually is seeded in Kentucky at the rate of a bushel an acre. If seed is not too expensive, however, it pays to seed at least two bushels per acre when pasture is the chief consideration.

Questions on Lesson XV. 1. Why is it believed that rye was not cultivated so early as wheat and barley? How does the rye plant differ from wheat? 2. In what countries is rye most extensively grown? What states in this country produce the most rye? 3. In what respect are rye and wheat similar? How do products made from rye flour differ from those made from wheat flour? 4. What are the advantages and disadvantages of rye as a farm crop, as compared with wheat? 5. Why is so little rye grown in the United States? How is the rye crop of this country utilized? 6. What can you say of rye as a feed for farm animals? Why is rye such a good pasture and cover crop? 7. What are the chief uses made of the rye crop in Kentucky? Is it safe to sow clover and grasses in rye that is to be pastured? 8. What can you tell about varieties of rye? What is the source of Abruzzi rye? Is it well adapted to Kentucky? 9. What are the advantages of early seeding of rye? At what rate should rye be seeded?

LESSON XVI

BARLEY AND BUCKWHEAT

Barley

There is good evidence that barley was one of the earliest cultivated food crops, its culture probably being as ancient as that of wheat and rice. One of the wild species of barley from which cultivated varieties developed is still common in Asia Minor, and it is concluded that the cultivation of this grain was begun in that part of the world. Some authorities believe that barley was an important bread grain in early days in southwestern Asia and Egypt, and later in much of Europe.

Barley is closely related to wheat and rye, and the plants are quite similar in appearance to wheat. Usually, however, they do not grow so tall. The leaves are somewhat broader and differ slightly in color from those of wheat. The head of barley is a spike which closely resembles the spike of wheat. Each barley flower is enclosed by two awl-shaped outer glumes, thus forming a spikelet. Three spikelets are borne at each joint of the rachis. In wheat there is only one spikelet at each joint of the rachis, but each spikelet contains two or more flowers. In most commercial varieties of barley the glumes, or chaff, are attached tightly to the grain, forming what is known as the barley hull. Some varieties are hull-less however, and thresh clean like wheat. The legal weight of barley is 47 pounds a bushel in Kentucky. Hull-less barley weighs 60 pounds to the bushel. The grain of barley, when separated from the hull, looks very much like a grain of wheat, but is more pointed at the ends. Barley contains no gluten; hence light bread cannot be made from the flour.

Production and Uses. Barley is the least important of the small grains. Russia and the United States are the largest producing countries, each raising about 350,000,000 bushels annually. Germany, Roumania, Canada and India produce over 100,000,000 bushels each, and a number of other countries, including Poland, Spain, France, and Denmark, over 50,000,000 bushels each. Production in the United States has almost doubled during the past twenty years.

The leading producing states in this country and their approximate production for the five-year period, 1928-1932, are as follows:

Minnesota, 50,000,000 bushels; North Dakota, 40,000,000 bushels; South Dakota, 36,000,000 bushels; California, 30,000,000 bushels and Wisconsin, 22,000,000 bushels. The production in Kentucky has increased during the past few years from about 150,000 bushels annually to over 400,000 bushels. Formerly, nearly all the crop was produced in the central Bluegrass region, but now it is becoming important in other parts of the state.



A field of winter barley.

A large part of the barley crop of the United States is used for feeding livestock. Rolled or ground coarsely it is an excellent feed and is very similar to corn in value for fattening livestock. Several million bushels of barley are used for the production of malt.

In Europe, barley is an important feed grain, and large amounts are used in brewing. Barley is used to a limited extent for manufacture of food products, chiefly breakfast foods and pearl barley. The latter is used in soups. A very small amount of barley flour is manufactured.

Varieties. No other small grain has so great a diversity of forms as barley, and the widest variation in appearance occurs among its numerous varieties. As stated in a preceding paragraph, the spikelets are arranged in groups of three alternately at the joints of the rachis, making six rows of grain from the bottom to

the top of the spike. This most common form is known as six-rowed barley. However, in some varieties the spikelets are so arranged that the outer grain on one spikelet is in line with the outer grain in the spikelet above. This gives a spike with four rows. Again, there are numerous varieties in which only the inner flower of each spikelet is fertile and only two rows of grain are produced. Such varieties are known as two-rowed barleys.

Most varieties of barley are heavily awned, or bearded. The awns are lined with sharp barbs, making the crop very disagreeable to handle. However, some varieties are without awns or have only very short spurs, while in others the beard is replaced by a small appendage resembling a hood. These are known as hooded varieties. The beards in barley seem to serve some special function, and it has been impossible to develop a hooded or beardless variety that produces as much or as high quality grain as bearded varieties. In recent years plant breeders have been able to produce varieties with smooth beards which yield as well as the varieties with barbed beards and are rapidly replacing the latter.

As regards adaptation to climatic conditions, varieties are classified into two groups, the humid and arid. Varieties included in the former are adapted to humid regions, that is, regions with considerable rainfall; those in the arid group are adapted to dry regions. The humid group includes both spring and winter varieties. Spring varieties are grown chiefly in the United States. No other cereal matures so quickly as spring barley, hence it can be grown in regions where the growing period is too short for wheat or oats. Spring barley requires a rather cool summer for successful production and is adapted only to the more northern portions of this country. In Kentucky, spring barley does not often make a profitable yield, and its culture should not be attempted, as a rule. Winter varieties can be grown very successfully in Kentucky, however, as the crop ripens before the hot days of summer. Unfortunately, winter barley is not so winter-hardy as most varieties of winter wheat, and it is not a safe crop north of the latitude of Kentucky.

Varieties of spring barley in the humid group most extensively grown in the United States are: Manchurian-Oderbrucker, the chief variety in the Mississippi valley and in the northeastern states, a six-rowed variety; Chevalier and Hanna, two-rowed varieties,

most popular in North and South Dakota; Velvet and Glabron, both smooth-awned, six-rowed varieties, produced by the Minnesota Experiment Station, which are replacing Manchurian-Oderbrucker very rapidly in Minnesota, Iowa and Wisconsin. Sparton, a two-rowed variety with smooth awns, has been developed by the Michigan Experiment Station.

Only a few varieties of winter barley are grown extensively. The common winter barley grown in Kentucky and Tennessee for many years is generally known as Tennessee Winter. Probably most other winter varieties have been developed from this, by selection or hybridization. It is six-rowed, and strongly bearded. Union Winter is slightly earlier and does not grow so tall. A variety of hooded barley produced by the Tennessee Experiment Station and known as Tennessee Beardless is quite popular, especially for hay production and for hogging down. Kentucky No. 1 is a selection made by the Kentucky Experiment Station from Tennessee Winter and it is superior in strength of straw and winter hardiness.

The arid type of barley is grown only in the western states. The chief variety is the Coast barley, which is sown either in the fall or early spring. Hull-less varieties are grown to some extent in the Rocky Mountain region.

Soils. The best soils for barley are well-drained loams or silt loams. The latter are the prevailing soil types of Kentucky. Sandy soils are least satisfactory. Good drainage is particularly necessary for winter barley. Soil must be in a productive condition to produce good yield. On thin soil the crop may not grow tall enough to harvest. In Kentucky a good supply of nitrogen in the soil seems to be very necessary for barley.

Advantages and Disadvantages of Barley for Kentucky. Barley has been grown in the Bluegrass region of Kentucky for many years, but it is only recently that other sections of the state have developed much interest in the crop. The low price of wheat probably has been responsible for this increased interest. On good land, barley yields much more than wheat, in most seasons. It is more subject to winter killing in severe winters than wheat. It is a better nurse crop for clover and grass than wheat, and in the opinion of many is a better pasture crop than rye. Barley is par-

ticularly favored as a cover crop preceding tobacco. The grain is harvested and threshed easily.

Because of lack of hardiness, barley should be planted at least a week earlier than wheat, so it can become well established before severe weather. Where the crop can be pastured, barley may be seeded as early as August 20. Unless pastured, however, very early-sown crops often become so rank that they lodge badly. The corn crop seldom can be cut early enough to follow with barley, consequently it does not fit into rotations so well as wheat. Even where it is possible to plant barley after corn, the crop seldom makes a good growth, probably because of a too limited supply of available nitrogen.

The Hessian fly attacks barley, altho it seldom injures it severely. Early-sown barley may serve as a breeding plant for this pest, from which it may spread to wheat fields. Wheat is not grown extensively enough in Kentucky to make the Hessian fly a serious menace.

Cultural Methods. The cultural methods for barley are similar to those for wheat, already described. Six pecks per acre is the usual rate of seeding.

Barley should be cut when the grain is in the hard dough stage. If cut too early, the grain will be shriveled, while if allowed to stand until dead ripe the grain may become discolored. There is also much loss from shattering in harvesting very ripe barley. Barley should be shocked in rather small, long shocks and capped very carefully. Careful capping protects the grain and prevents discoloration. Barley left in the field for a long time will be badly damaged. Where early threshing is impossible, the grain should be stacked or put into the barn until threshing time. In threshing, the concaves of the separator should be adjusted to thresh as closely as possible without cracking the grain. Sometimes the beards of barley are so tough that they are not all removed by threshing. Such barley is difficult to sow, and it may pay to run the portion intended for seed thru the separator again.

Diseases and Insects. Barley is sometimes seriously injured by army worms, in Kentucky. They eat the leaves and cut off the heads. As soon as injury is noted, poisoned bran mash, prepared as described for the control of cutworms, should be broadcast over the field at the rate of 25 pounds an acre. It is quite effective.

Both the covered and loose smut attack barley. The former may be controlled by treating with formaldehyde or Ceresan dust, as described for wheat, and loose smut by the hot-water treatment.

Buckwheat

Buckwheat is not a grain in the true sense of the word, for the word, grain, refers to the edible seeds of grasses. Buckwheat is used like the grains, however, and can conveniently be studied in connection with them. The plant belongs to the buckwheat family, to which also belong the beechnut, the docks and smartweed. It is a quick-growing annual which branches freely in thin stands, but very little under field conditions. The leaves are triangular in shape and of fair size, totally unlike the blades of grasses. The flowers are pinkish-white and of small size. A field of buckwheat in flower is a very attractive sight. Buckwheat is a good honey plant and often is grown for this purpose by bee-keepers. The plants grow two to four feet tall. The grain of buckwheat is somewhat larger than a grain of wheat, but is triangular in shape like a beechnut or the seeds of the docks. It is covered by a hard hull, and the inside is soft and pure white. In most states the legal weight of buckwheat is 48 pounds to the bushel.

Importance and Uses. Buckwheat is a crop of slight importance in the United States, the annual production amounting to less than 15,000,000 bushels. Most of the crop is produced in New York and Pennsylvania. In Kentucky buckwheat is grown to a limited extent as a late summer crop following the small grains or on land where other crops have failed.

Buckwheat is used most largely for the manufacture of buckwheat flour, from which the well-known buckwheat batter cakes are made. It is also used to some extent for feeding stock, especially hogs and poultry, and is regarded as a good feed. For hogs it should be ground and bolted to remove the hulls, but this is not necessary for poultry.

Culture. Buckwheat should not be sown in Kentucky until July, so that it will bloom during the cool days of fall. Little seed forms where the plants bloom in hot weather. The usual rate of seeding is three pecks per acre. It may be sown broadcast and covered by harrowing or drilled with the grain drill. Two varieties are grown in this country, the Silverhull and the Japanese.

The latter is preferred in Kentucky. The plants continue to bloom and produce seed until killed by frost; hence it is advisable, in Kentucky, to delay harvesting until October unless frost threatens earlier. In the East much of the crop is grown on hilly land and is cut with a cradle. The self-rake reaper is used on more level areas. The crop can be cut very satisfactorily with the binder, but very small bundles should be made. In damp weather it is good practice to cut the bands before shocking, to facilitate rapid drying. The shocks should be made narrow and left uncapped.

Threshing is done from the field, as the fleshy stems do not dry out sufficiently to permit stacking. Buckwheat cracks easily and only a few teeth are used in the concaves of the separator. If dry, clean threshing may be done by using blank concaves. The grain keeps better if stored in burlap sacks than if bulked in bins.

Questions on Lesson XVI. 1. Why is it believed that the culture of barley began in western Asia? In what way does the barley plant differ from wheat? 2. Describe the spike and grain of barley. What is hull-less barley? Why is it impossible to make light bread from barley? 3. What are the most important barley-producing countries? Name the five largest producing states in the United States and state the approximate production of each. 4. What can you say of barley as a feed for livestock? Why should it be ground or crushed? What is the average acre yield of barley in the United States? How does the price compare with that of corn? 5. What is meant by six-rowed and two-rowed barley? Why do bearded varieties of barley outyield beardless varieties? What two groups of barley varieties are grown? What are the adaptations of each? 6. Name the leading varieties of barley grown in the United States and tell where each is most extensively grown. Why is spring barley not grown in Kentucky? 7. Discuss the soil requirements for barley. What do you think of barley for Kentucky? Give reasons for your answer. 8. When should barley be sown in Kentucky and at what rate? At what stage should the crop be cut? Why? 9. Why is buckwheat not a true grain? Describe the grain of buckwheat. What uses are made of buckwheat? 10. When should buckwheat be sown in Kentucky? Why not sow earlier? Which is the better variety in Kentucky? Why is buckwheat threshed from the field? Do you think more buckwheat should be grown in Kentucky? Why?

LESSON XVII

ALFALFA

Probably alfalfa is the most valuable hay crop that can be grown in Kentucky. A good field of this crop will give three to four cuttings each year, yielding from three to five tons an acre of hay that is more palatable to livestock than any other kind of hay. Furthermore, the stand, if properly handled, will last four to eight years.

Alfalfa is not a new crop in America by any means. The early American colonists made many attempts to cultivate the plant but, in general, with poor success. In 1854 alfalfa was introduced into California from Chile, and there its culture met with great success. The soil and climate of the western half of the United States were found to be admirably adapted to the crop, and in a short time it became the most important hay crop in the region lying west of the Missouri River. Kansas, Nebraska and California raise over a million acres of alfalfa each, while several other western states raise nearly as much.

It was natural that every effort would be made in other parts of the country to produce such a valuable crop, but just as in colonial days the attempts were not very successful east of the Great Plains region for many years. Occasionally a section would be found where the crop thrived admirably and in these fortunate sections a considerable acreage would be grown. Attempts were continued, however, and gradually it was recognized that alfalfa would thrive only where the soil contained calcium carbonate (limestone) and that most of the failures with the crop had been due to lack of lime. Then it was easy to understand why alfalfa succeeded so well in the west where the soils are alkaline and why it had been possible to raise it in certain areas in the humid part of the country. In Kentucky, for example, alfalfa has been grown successfully for many years in the limestone hill region of north central Kentucky. These soils contain many fragments of limestone and are therefore naturally suited to alfalfa. It may be mentioned here also that sweet clover requires a sweet soil, and the appreciation of the value of this crop has only come since its lime requirement was understood. It was soon found that alfalfa could be grown successfully on any type of soil if fairly well drained and of fair fertility, provided that lime was applied. While liming soil is a rather expensive operation

the ability to raise alfalfa and sweet clover after liming is worth all that it costs. It has been found in recent years that liming is necessary in most parts of Kentucky in order to raise red clover successfully; also that the use of lime, especially in connection with phosphatic fertilizers, is the most practical method of restoring productivity on worn soil.



Alfalfa almost too big to mow.

The recognition of the need of lime was decidedly the most important step in making alfalfa growing possible, but we have, during the past few years, learned a number of other things about it all of which help toward greater success with the crop. Our farmers are finding that on soil in the proper condition it is easier to get a stand of alfalfa than a stand of clover. They are finding it more productive than clover, and more drouth-resistant. They are finding that it makes the best hay possible to obtain for all kinds of livestock. The soils of Kentucky are well adapted to alfalfa and it should be extensively grown.

History. Alfalfa is believed to be the oldest plant to be grown solely for forage. It was cultivated by the Greeks and Romans, having been introduced into Greece from Persia. Persia is regarded as the region where it was first cultivated. Wild alfalfa found in that region is very much like our common alfalfa in appearance. From Italy alfalfa was carried to western Europe and England, probably

early in the sixteenth century. Its introduction into America has already been discussed.

The name alfalfa is of Arabian origin. In most countries the name, lucern, is used instead of alfalfa. The scientific name of alfalfa is *Medicago sativa*.

Where Alfalfa Can Be Grown. Alfalfa has very wide adaptations as to climate. In the United States it may be grown in nearly



Alfalfa on the left, limed; on the right, not limed.

every state in the Union. The introduction of very hardy varieties has made it possible to grow alfalfa very successfully in North Dakota, Minnesota, and our most northern states. It is also grown in Canada. On the other hand it thrives in the Gulf states, under favorable soil conditions. High temperature with high humidity—that is much moisture in the air—is injurious to the crop. When the air is dry, as in the southwest, alfalfa stands very high temperatures. The crop thrives best in dry regions under irrigation.

Varieties. Alfalfa seed cannot be produced satisfactorily in humid regions and practically all the seed used in this country comes from the semi-arid regions of the West. Most of the seed sold in Kentucky comes from Utah, Idaho and Nebraska, Kansas and North Dakota. It is of the so-called common variety. In recent years a number of hardy varieties of alfalfa, of which the Grimm is the

most important, have been introduced into this country. Other hardy varieties are Cossack, Baltic and Canadian Variegated. These hardy varieties are of great value in the northern states where much cold resistance is necessary. The common variety is not a pure strain but is made up of a number of strains varying in resistance to cold. When grown under severe climatic conditions, only the strains most resistant to cold survive and the seed from these plants has greater hardiness than seed from milder regions. In Kentucky extreme hardiness is not necessary and in tests conducted at the Kentucky Experiment Station the common alfalfa seed from Kansas has given as good results as the hardy strains of common or the hardy varieties such as Grimm. Imported seed has not proved desirable. In fact some of it is worthless in this country.

The Alfalfa Plant. The alfalfa plant has a strong, deep-growing taproot similar to that of clover. The depth of the roots depends upon the age of the plants and the nature of the soil. The roots of plants six months old often penetrate the soil to a depth of five feet. In the West, where there is no permanent water-table and where the soil is quite uniform in character to great depths, roots have been reported found at a depth of 50 feet. The depth of the roots accounts to a considerable extent for the ability of the plants to withstand drouth. The taproot is about a half inch in diameter near the crown and usually has few lateral branches. Alfalfa, being a legume, bears nodules on the roots, the nodules being rather small as compared with those of the soybean and cowpea.

The young plant sends up a single stem but as it grows older other stems arise from the crown. Where the stand is not very thick, old plants sometimes send up a great number of stems, as many as 200 having been counted. The crown becomes much branched and may reach several inches in diameter, under favorable conditions. The plants start growth very early in the spring and reach the blooming period in Kentucky about the first of June or often earlier. At about the time the first blooms appear, new shoots come out from the crown and grow rapidly. These often are cut off when the alfalfa is harvested, but this causes no injury to the succeeding crops. Three cuttings can be made in Kentucky and in favorable seasons four.

Flowers and Seeds. The flowers of common alfalfa are purple and are borne in a cluster called a raceme. The pistil grows into a

spiral pod containing several seeds. The seeds are rather larger than red clover seeds and are kidney shaped. The color of the seed is a rather uniform greenish yellow. The number of seeds per pound averages about 225,000. A bushel weighs 60 pounds. Alfalfa seed is likely to be freer of weed seeds than red clover seed. The most serious impurity occurring is dodder and in buying seed care should be taken to see that the seed is free from this pest.

Alfalfa seeds germinate very quickly—5 to 7 days—and the early growth is very rapid. The seed retains its ability to grow for three years or more.

Soils. The alfalfa plant will not thrive on poorly drained soil and if natural drainage is not good, the land should be tile drained. Any land that will raise good clover usually is suitable for alfalfa as far as drainage is concerned. Good yields of alfalfa can be produced only on soils well supplied with plant food and before seeding a field to alfalfa it should be put into a productive condition. The necessity for lime in the soil has already been emphasized. Most soils in Kentucky, even in the Central Bluegrass section, must be limed before alfalfa will succeed. In north central Kentucky there is much land that naturally contains sufficient lime and frequently bottom lands also contain sufficient lime to satisfy the needs of the crop. In case of doubt, the soil may be tested for lime by the methods given in the lessons on soils.* Two tons of rather finely ground limestone per acre are sufficient on most Kentucky soils. Except in the central Bluegrass region, a carrier of phosphorous should be used for alfalfa. Five hundred to 800 pounds of superphosphate per acre should supply enough phosphorous to last for several years. If preferred, a smaller quantity—say 200 pounds per acre—may be applied as a top dressing each year. In some instances the use of potash fertilizer in addition to phosphate increases yields materially. If land is not in a fairly productive condition, it usually pays to give the field an application of manure or to plow under a crop of cowpeas, soybeans, or sweet clover. The latter crop is the best one to grow for this purpose. It makes a rank growth on worn land if plenty of lime is present and when plowed under adds much organic matter to the soil. It also tends to put land into excellent physical condition. Sweet clover bears the same kind of nitrogen-gathering bacteria as alfalfa and a crop of sweet clover well supplied

* Kentucky Extension Circular 54, 5th edition revised, page 23.

with nodules gives a much better inoculation for alfalfa than is possible by any method of artificial inoculation. A good system to follow in preparing thin land for alfalfa is to lime and apply phosphate as directed, and then to sow sweet clover. This should be plowed under in July and alfalfa sown in August.

Starting the Crop. As already stated, it is easy to get a stand of alfalfa, and the grower has the choice of various ways of seeding. Either spring or summer seeding may be practiced. Perhaps summer seeding is the most reliable method for the beginner but spring seeding is much easier and experienced alfalfa growers usually prefer it. The chief advantages of summer seeding are (1) a better chance of getting good inoculation and (2) less trouble with weeds and wild grasses. In Kentucky there is often an excellent chance to sow alfalfa after tobacco is harvested and probably there is no better way of seeding. Alfalfa may also follow a crop of early potatoes or a crop of soybeans cut for hay. Perhaps the most common method of preparing for summer seeding is to break land as soon after the removal of wheat or other small-grain crop as possible. A good seed bed should be prepared and the lime and fertilizers applied. The alfalfa is sown after a good shower in August. No companion crop should be planted with summer-sown alfalfa. The seed should always be covered in summer seeding to a depth of a half inch to an inch. The covering may be done with a spike-tooth harrow or a weeder. A clover-seed drill may be used where the seed bed is firm.

The method of spring seeding regarded as most satisfactory by the majority of Kentucky growers, is to sow with a light seeding of oats as early in the spring as possible. The ground should be plowed, put into good tilth, and the oats drilled in. Then the alfalfa seed should be sown broadcast. A light covering is perhaps best but not absolutely necessary. Alfalfa may be sown in wheat or other grain crop just as clover is sown, provided the land has been limed previously, but lime applied to the surface of the ground in the spring may not give effective results. Perhaps the safest way of seeding in fall-sown grains is to use a clover-seed drill or to cover the seeds with a harrow. When alfalfa is seeded in winter grain it is very desirable to pasture the grain crop quite closely until about April. Unless this is done, many failures result from spring seeding in winter grains. Usually 12 to 15 pounds of seed per acre are sown, but often much lighter seedings give equally good results.

Inoculation. Inoculation is absolutely necessary to success. The most practical way of inoculating alfalfa is to use the commercial cultures. Enough to inoculate a bushel of seed costs about \$1. This method of inoculation is very easy and tests seem to show that it is quite reliable. Directions for use always accompany the cultures. If preferred, inoculated soil from an alfalfa field or sweet-clover field may be spread at the rate of 400 to 500 pounds per acre and harrowed into the soil. This is perhaps the most reliable way of getting good inoculation. Still another way is to moisten the seed slightly and sprinkle with screened inoculated soil, shoveling the seed over until each seed is coated with the soil. As much soil should be used as will stick to the seed, usually about a half peck per bushel.

Cutting and Curing. Under no circumstances should summer-sown alfalfa be cut or pastured the same year. All the growth is needed to protect the plants during the winter. Spring-sown alfalfa may be cut once the first year, as a rule. It should not be clipped frequently, however, even if weeds are troublesome. Frequent clipping does more harm than the weeds. Alfalfa should never be cut so late in the fall that there is not enough time to make a good growth before killing frosts occur. A fair fall growth is absolutely necessary to ensure the plants wintering successfully.

Until recently the usual recommendation in regard to cutting alfalfa was to cut when the new shoots appeared at the crown. Recent experiments conducted at the Kansas and Wisconsin Stations have shown, however, that the vigor of the plants is greater and the life of the stand longer if cutting is deferred until the plants are nearly in full bloom. The hay is better if cut at an early bloom stage, however, and in Kentucky the life of the stand does not seem to be much shortened if cutting is done in the early bloom stage. It is perhaps better, however, to allow one cutting to stand until in full bloom.

The best alfalfa hay is obtained if the alfalfa is raked into windrows when well wilted, but before the leaves are dry. Shocking soon after tends to make still better hay, but adds to the cost of harvesting. Hay handled in this way has a better color and aroma than if cured in the swath and more of the leaves are saved. The leaves make up about half the weight of the plants and have a much greater feeding value pound for pound than the stems.

Alfalfa is dry enough to store when the stems break when a small handful is twisted several times. Before shock-cured hay is put into the barn, the shocks should be opened for a few hours to allow accumulated moisture to dry off.

Cultivation. After a field has been in alfalfa for some time, weeds and grass often become troublesome. Such fields can be cleaned out quite effectively by harrowing thoroly just after a crop is cut. Special spring-tooth harrows and cultivators are made for cultivating alfalfa and they are preferred to other implements. A good, sharp, spike-tooth harrow will do a fair job or a disk harrow may be used if the disks are not set at too great an angle. Alfalfa roots are very tough, and are not easily injured by cultivation.

Alfalfa and Soil Improvement. Alfalfa is a good crop for improving the soil provided the manure made by feeding it is returned to the soil. Soil already in a fair state of fertility will not be greatly improved by growing and removing alfalfa without the return of manure. No legume crop will improve land much unless it is returned to the soil by plowing under or in the form of manure.

Questions on Lesson XVII. 1. Why has the acreage of alfalfa in eastern United States increased so rapidly in recent years? 2. Give the history of alfalfa in America. What discovery had so much influence on alfalfa production in eastern United States? 3. Where did alfalfa originate? What other name has alfalfa? 4. Where can alfalfa be grown? What can you say about varieties of alfalfa? Where is alfalfa seed produced? 5. Describe the alfalfa root. The stems. The blossoms. The seeds. 6. What are the soil requirements for alfalfa? How would you fit a worn field to raise alfalfa? 7. What are the advantages of summer seeding? Spring seeding? Describe the best methods to follow in seeding at both times. 8. Why is inoculation of alfalfa necessary? What are the best methods? 9. When should alfalfa be cut? Why is it better to cure in wind-row or shock instead of in the swath? What proportion of the alfalfa plant is leaves? 10. Why should alfalfa be cultivated? How? 11. Is alfalfa a soil improving crop? Explain fully. 12. Write a short article telling how alfalfa growing would help Kentucky agriculture. Do not depend upon the lesson only, but give some of your own ideas.

LESSON XVIII

THE CLOVERS

Clover is the common name for a genus or group of leguminous plants, some of which are of great agricultural value. Those of greatest value are red, alsike, white and crimson clover, all of which probably are native to the old world. Many species of clover are native to America, and a few of these, particularly hop clover and Carolina, are of possible economic importance. The leaves of all true clovers consist of three leaflets which are attached to the tip of the stem. This characteristic is responsible for the botanical name of the genus, *Trifolium*, a Latin term meaning three leaves. Unfortunately, the name clover often is applied to other legumes which are not true clovers. For example, melilotus is called sweet clover; lespedeza, Japan clover; and even alfalfa sometimes is called alfalfa clover.

Red Clover

Importance and Adaptations. Red clover is by far the most important of the clovers, and the leading legume of both Europe and the United States. It was brought to America during the Colonial period and for many years was the only legume grown to any considerable extent. Red clover is perhaps the most generally useful of all legumes. It provides good pasture, makes good hay, and fits well into almost any rotation. Various other excellent legumes have been introduced into the United States from time to time, but red clover has lost none of its popularity where it can still be grown successfully. Red clover does not thrive under so wide a range of soil and climatic conditions, however, as some other legumes, as, for example sweet clover and alfalfa. It is rather exacting in regard to soil requirements and can be grown successfully only on well-drained, sweet or only slightly acid soil in a productive condition. It succeeds best on soil containing considerable clay, and poorest on sandy or gravelly soil. The silt loams which constitute a large percentage of the soils of Kentucky are not quite so well suited for growing red clover as the clay loams of the Corn Belt. The distribution of red clover in the United States, however, probably is influenced more by climate than by soil. It is not drouth-resistant, having greater water requirements than corn, but, unlike corn, it does not stand the excessive heat and humidity of the Cotton Belt very successfully. In winter-hardiness, it seems to be about equal or slightly superior to the hardy strains of alfalfa.

Most botanists regard red clover as a short-lived perennial since, under very favorable climatic conditions, the plants sometimes live for three years or more. In most parts of the clover region, however, few plants live more than two years, which is attributed largely to the prevalence of clover diseases.



Red clover makes excellent pasture for sheep.

Varieties. Only two distinct varieties of red clover are recognized, the common or medium, which is the ordinary red clover with which everyone is familiar, and mammoth red, also called sapping and peavine clover. Mammoth red blooms about two to three weeks later than the common red, and the plant is larger and coarser. The seeds of the two varieties are identical in appearance and cannot be distinguished by even the best seed analysts. Common red clover usually makes both a hay and a seed crop the second year, while the mammoth makes but one crop. Mammoth red has the reputation of being better adapted to thin land than common red, but it is questionable if this reputation is deserved. Mammoth red is better to seed with timothy or redtop for hay production than common red, because it matures more nearly with these crops. However, the common red is the more generally useful variety.

Strains of Common Red Clover. The seeds of any given variety of our cultivated crops usually produce plants very similar in appearance. Among these plants, however, there are often groups

of individuals differing widely in such characteristics as resistance to cold or heat, resistance to certain diseases, resistance to attacks of some kinds of insects and soil adaptation. Such groups are known as varietal strains. When a variety containing various strains is grown in any place for a number of years, only those strains survive which are adapted to the environment. Common red clover is an example of a variety from which many adapted strains or groups of strains have developed. When grown in a region of severe winters, a strain is obtained very resistant to cold. Similarly, when grown where certain clover diseases are prevalent a strain resistant to these diseases is obtained.

It is only in recent years that the extent to which adaptation of red clover occurs has been recognized. It was first brought to attention by the unsatisfactory results obtained in many parts of the country from foreign seed, particularly seed from Italy and Chile. In the more northern states very few of the plants produced by the seed from these countries survive the winter. In more southern states the plants proved very susceptible to disease. Further tests during the past few years have shown that no imported seed of any kind except Canadian gives as satisfactory results any place in the country as American seed. Furthermore, it has been found that seed produced in one part of this country may be poorly adapted to many other sections. For example, the plants produced from northern-grown or western clover seed are likely to be destroyed in Kentucky and other southern states by certain diseases which attack clover severely only in these states. Conversely, plants from seed produced in more southern latitudes may not be winter-hardy in the North. Evidently the best clover seed for any region is that produced locally or where climatic and soil conditions are similar. A few Kentucky farmers have kept the same strain of seed for many years, and these strains have developed much resistance to the various diseases which attack clover in Kentucky. In tests at the Kentucky Experiment Station these adapted strains have proved superior to all others. The problem now is to produce sufficient seed of the adapted strains to supply the needs of Kentucky farmers. Next to the best Kentucky strains, seed of adapted strains from Tennessee and from adjacent parts of other states as, for example, Southern Illinois and Southern Indiana gives the best results. Formerly Kentucky purchased clover seed from various parts of the country, with-

out regard to adaptation. It is certain that much, tho not all, of our difficulty in producing clover successfully was due to the use of poorly adapted seed. Other causes are increased acidity of many of our soils, and decreased fertility. Liming, the use of phosphate fertilizers, and adapted seed should make it possible to utilize this great legume crop again as in former years.

Seeding. In Kentucky, red clover generally is sown in wheat, barley or rye or with spring oats. While companion crops are actually detrimental to the growth of the young clover plants, they are almost necessary, to hold weeds in check. As a rule, seeding in fall-sown grains is preferable to seeding with spring oats. Pasturing the grain crop improves the chances of maintaining a good stand of clover, especially in dry springs. While red clover seed usually is sown on top of the ground, without attempting to cover the seed, it is expected that the seed will become covered lightly by freezing and thawing or by rains. Success in getting good stands depends to a considerable extent upon the effectiveness of the covering. Seeds sown on frozen ground, particularly when in a so-called "honey-comb" condition, or sown on a dry surface, are more likely to become covered than seeds sown on a wet surface. A still better way to ensure good covering is to sow with a clover-seed drill or to run a harrow over the ground after seeding. In neither operation is much of the seed covered. A small amount of soil is loosened up on the surface, however, which during showers is washed over the seeds, covering them very thoroly with a thin layer of soil. This method should always be preferred in seedings made after March 1. In seeding with oats, the clover seed usually is sown at the same time the oats are sown, using a grass-seed attachment to a grain drill. This is a satisfactory practice, but care should be taken that the seed is not covered too deep. It should be allowed to fall behind the disks, not in front. The use of a culti-packer after sowing the oats and preceding the seeding of the clover is an excellent practice. Red clover may be sown in late summer with fair success, but it is not so well adapted to summer seeding as alfalfa.

Seeding rates with red clover vary from 6 to 10 pounds per acre. Unless seed costs are very high, it pays to seed liberally. When sown with timothy, 5 to 6 pounds of clover seed and about 3 to 4 pounds of timothy seed are sown to the acre. A timothy-clover mixture is used much more frequently than clover alone, all over the clover

belt. Usually it is to be preferred to pure clover. In Kentucky, orchard grass is a good grass to grow with red clover. The seeding mixture should consist of about 6 pounds of clover seed to 10 of orchard grass.

The great superiority of adapted strains of red clover has already been discussed. The purchaser should make every effort to get a well-adapted strain, free from seeds of noxious weeds, and having a high percentage of germination. The importance of the clover crop justifies much effort in obtaining seed that is most likely to give good results. It is better to economize in seeding by sowing less seed than to sow seed of inferior quality.

Pasturing and Clipping Young Clover. In most seasons red clover makes sufficient growth the year seeded to furnish considerable pasturage; in fact, farmers thruout the clover belt rely on their fields of young clover quite largely for late summer and fall grazing. Very close pasturing, especially if continued late into the fall, reduces the next year's crop, but a moderate amount of grazing generally is regarded as beneficial. Where young clover is not grazed it is a common practice to clip fields one or more times after the grain crop is removed. This is a decided help in controlling weeds. Sometimes, in favorable seasons, young clover makes a very large growth, equal to that of the second year. If the crop can be harvested in early September, there is no reason why it should not be harvested for hay. However, it ought not to be cut so late that the plants will not have time to make a good growth again before winter.

Making Clover Hay. The best hay is made by cutting clover when in full bloom or very shortly after. When cut at this stage and carefully cured, red clover hay is equal to alfalfa hay, both in nutritive value and palatability. A clover-timothy mixture should be cut when most of the clover blooms are beginning to brown slightly. At this stage the timothy is just beginning to bloom. The methods of curing recommended in the lessons on alfalfa are also the best for making good clover hay. Usually clover requires slightly more time for curing than alfalfa.

The Seed Crop. Not many Kentucky farmers harvest the second crop for seed. Instead, they utilize it for pasture or hay. The superiority of home-grown seed makes it highly desirable that more attention be given to seed production in the state. It is especially

desirable that seed be saved from adapted strains whenever possible. To produce plump seed, the seed crop should not be harvested until the heads are brown and the seeds are in the dough stage; if allowed to become dead ripe, many of the heads break off in harvesting. In most instances the seed crop is mowed and raked into windrows at once. A better method is to use a buncher attachment on the mower, as raking causes some loss of seed heads. The usual custom is to allow the crop to dry in the windrows or bunches, but it may be cured in small cocks. After drying thoroly, the seed is threshed with a special clover huller or a grain separator with clover hulling attachments. The average yield of red clover seed is less than 2 bushels per acre, but yields of 4 to 5 bushels are sometimes reported.

Alsike Clover

Alsike clover plants are more slender than those of red clover, and the blossoms are pink and shaped something like white clover. The seeds are much smaller than those of red clover, and are greenish yellow in color. This clover was named alsike because it was first cultivated in the vicinity of a town in Sweden named Alsyke. It is also sometimes called Swedish clover.

Alsike clover is longer lived under certain climatic conditions than red clover and is more resistant to cold. It is particularly adapted to wet land. It makes but one cutting and usually yields less than red clover. It is not so well adapted to Kentucky as red clover. Sometimes, however, it may survive conditions fatal to red clover. For this reason many farmers sow it in connection with the latter.

White Clover

Everyone is familiar with white clover, for it appears naturally in pastures, lawns and on roadsides in all parts of Kentucky. This clover is adapted only for pasture and in combination with various grasses, particularly bluegrass, must be regarded as one of our most valuable pasture plants.

Crimson Clover

Crimson clover is a winter annual grown chiefly as a green manure crop for soil improvement. The crop is seeded in late summer and reaches the blooming stage in early May in Kentucky. The bright crimson flowers are very striking in appearance, and a field of this clover in bloom is a very beautiful sight.

Where it can be grown successfully, crimson clover is perhaps the most valuable legume in existence for soil improvement. However, it is not very winter-hardy and frequently winterkills in Kentucky. In addition, it is difficult to get a good stand of plants.

Crimson clover makes hay of fair quality if cut when in bloom.



Crimson clover is an excellent catch crop.

Questions on Lesson XVIII. 1. What are the most important clovers? What clovers native to America are regarded as of some agricultural value? Why was the clover genus named *Trifolium*? Is sweet clover a member of the genus *Trifolium*? 2. Discuss the importance of red clover. Where is it grown principally in this country? Why? Is Kentucky a good clover state? 3. Name two varieties of red clover and compare them in value. What is meant by the term "varietal strain"? Describe how clover becomes adapted to a certain environment. 4. If you were purchasing red clover seed, what kind would you attempt to buy? Why? 5. Name some reasons why red clover failures have been so frequent in Kentucky in recent years. What remedies would you suggest? 6. Why is a stand of clover more likely to persist if the grain crop is pastured instead of allowed to mature? What can you say about the time of seeding clover? 7. You are offered two grades of clover seed. One priced at \$10 a bushel contains 4 percent of weed seeds, including some dodder, and gives a germination of 70 percent. The other, priced at \$13, contains less than 1 percent of weed seeds, chiefly foxtail, and gives a germination of 98 percent. You have 20 acres of land to sow and can spend but \$20. Which seed would you buy? Give your reasons. 8. Under what conditions and to what extent is it advisable to pasture young clover? At what stage should clover be cut for hay? 9. Why is it desirable to produce more clover seed in Kentucky? Describe methods of handling the seed crop. 10. How does alsike clover compare in value with common red? Why do farmers sow alsike clover in Kentucky? What is the chief value of crimson clover? Of white clover?

LESSON XIX

SWEET CLOVER, LESPEDEZA AND VETCH

These three legumes are not very similar in many of their characteristics, but are grouped together in this lesson for convenience.

Sweet Clover

Sweet clover is the common name for members of the genus *Melilotus*. In parts of the country the name, *melilotus*, is used instead of sweet clover, and this name is really preferable. There are numerous species of sweet clover, all natives of the Old World. Only two are of much importance agriculturally, namely, white, or Bokhara clover, and yellow sweet clover. Both are biennials—that is, the plants live for two years. An annual variety of white sweet clover was discovered in Alabama by Professor Hughes, of the Iowa Agricultural Station, a number of years ago. The name given to it, Hubam, refers to its discoverer and the state in which it was found. Another species is annual yellow sweet clover, a small-growing type common on the Pacific Coast and in parts of the South, where it is used for pasture and green manuring. White sweet clover is the most widely grown, but the yellow is equally popular in some parts of the country. Both are similar in appearance during most of the growth period. As the names indicate, one has white flowers and the other yellow. Yellow sweet clover matures earlier and does not grow quite so tall and rank as the white. Hubam has not proved so valuable as anticipated and is rather sparingly grown. For most purposes it is decidedly inferior to either of the biennial types. Annual yellow sweet clover is of value in only a few areas where soil and climatic conditions are especially favorable for its growth. In this lesson the discussion refers to the white and yellow biennial sweet clovers.

Description. Sweet clover closely resembles alfalfa during early stages of growth, but can be easily distinguished from it by the bitter taste of the leaves and stems. The plants often reach a height of three to four feet the first year, but do not bloom. A bud crown is formed, carrying the buds from which grow the new shoots the next spring. The crown does not persist, as does the crown of red clover and alfalfa, and but one set of buds is formed. Both the first and second year, any renewed growth following cutting or grazing must come, therefore, from the buds on the stem. The seed crop ripens in August, altho clipping or pasturing in the spring may cause later maturity. The seeds are enclosed in a hull and quickly

shatter from the plants after ripening. Very few germinate until the following spring.

Adaptation and Uses. Sweet clover is an important forage crop in America only. Even in this country it was considered of little value until comparatively recent years. It is interesting to know that Pendleton County, a limestone hill county in north-central Kentucky, was one of the first places in the country where the value of sweet clover was recognized and the crop utilized extensively for pasture and soil improvement. The successful experience of Pendleton County with sweet clover attracted much attention over the country and no doubt aided greatly in popularizing the crop. Sweet clover is grown today more or less extensively in all parts of the United States and ranks among our most important forage crops. The largest acreage is found in some of the Corn Belt states.

Sweet clover is grown successfully in any climate found in this country. It is winter-hardy in our most northern states and thrives in all parts of the Cotton Belt. It is very drouth-resistant and yet endures wet and poorly drained soil better than clover or alfalfa. Sweet clover, like alfalfa, requires a sweet soil, and most soils in Kentucky and many other states must be limed before the crop can be grown successfully. Provided its lime requirement is met, however, sweet clover makes a good growth even on very poor soil.

Sweet clover is of outstanding value for pasture and soil improvement under some conditions but is not a very satisfactory hay crop. Increased soil productivity and a greater development of the livestock industry are necessary for putting Kentucky agriculture on a more profitable basis, and sweet clover can be of great assistance in such a program of improvement.

Lime and Phosphate for Sweet Clover. It is desirable to apply one to two tons of ground limestone to the acre as an initial treatment. Such an application, with subsequent applications of a ton an acre once every eight to ten years, will ensure favorable conditions for sweet clover or other lime-loving plants at all times. Very good results can be obtained with much smaller applications, however, for Kentucky soils are not strongly acid. Of course light applications give effective results for a short time only. Where a limited amount of money can be spent for lime, it is a good plan to use light applications on a number of acres, rather than to lime a few acres heavily. Even as little as 500 pounds an acre of finely ground

limestone may permit raising one or two fair crops of sweet clover in many instances, but it is scarcely advisable to use less than 1,000 pounds to the acre. Limestone ground to pass a 10-mesh screen is fine enough.

Outside of the Bluegrass region, the best yields cannot be obtained without the use of phosphate fertilizers. They are especially necessary on badly worn land. The liberal use of phosphate on sweet clover intended for pasture is particularly profitable. Such fertilizers benefit the pasture and most of the fertilizer is returned to the land for the use of crops which follow. Two to three hundred pounds of superphosphate an acre, or equivalent amounts of other phosphate fertilizers, is a fair application.

Seeding. Unhulled, hulled and scarified sweet clover seed can be bought on the market at the present time. A large percentage of most lots of sweet clover seed has such impervious seed coats that germination is greatly delayed, often for a year or more. If the seed coats are scratched, water can penetrate and germination proceed. A machine known as a scarifier has been invented for scratching the seed and so improving germination. Many growers believe that scarifying injures the seed, however, and prefer to use either the unhulled or hulled seed that has not been scarified. Probably for spring sowing the use of scarified seed is advisable, while for earlier seeding the unscarified seed is best. Much sweet clover is sown during early winter, and many who follow this practice prefer to use unhulled seed. The rates of seeding generally used are 15 to 20 pounds of unhulled seed or 12 to 15 pounds of the hulled. The methods recommended for seeding red clover are equally satisfactory for sweet clover. Summer seeding of sweet clover is not advisable.

For pasture it is much better to sow other pasture crops with sweet clover rather than to use it alone. Sweet clover, 4 to 5 pounds; orchard grass, 5 pounds; and lespedeza, 5 pounds is a good mixture in Kentucky.

Inoculation. Inoculation is not quite so necessary for sweet clover as for alfalfa, but always is advisable when the crop is grown on land that has not grown sweet clover or alfalfa previously. As stated in the lesson on alfalfa, both these crops have the same strain of nodule organism. The same methods of inoculation may be used as for alfalfa.

Pasturing Sweet Clover. Sweet clover should not be pastured the first year sown until late summer or early fall. The second year,

the growth should be kept pastured enough to prevent the plants becoming stemmy, but not so close as to kill them. Sweet clover grows remarkably fast the second year, and two to three head of cattle to the acre often are necessary to keep it grazed sufficiently. The best plan, where pure sweet clover pastures are used, is to divide the pasture area into two parts and to seed and graze them alternately—that is, to have one field containing young sweet clover while the other is occupied by the second year crop. The latter will furnish grazing until late summer, and the young sweet clover may then be pastured safely.

Sweet Clover for Hay. Sweet clover is not a very good hay crop. In fact, it is not advisable to attempt to use the second-year crop for hay at all unless one is confronted with a shortage of other hay. The first year's growth makes very good hay, but often does not get large enough to pay to cut. It should not be cut, in any event, until September or the vigor of the next year's crop will be impaired.

Sweet clover may be injurious to livestock if it forms the entire roughage, consequently it should be fed in connection with other kinds of hay.

Saving the Seed. For seed, sweet clover usually is cut with a binder when three-fourths of the seed have turned brown. Since the seeds shatter badly, sheet-iron pans often are hung under the packers on the binder to catch the seed that is knocked off. Cutting at night or early morning is resorted to also in order to prevent heavy loss from shattering. After drying in shocks for a few days, the seed is threshed with a grain separator. Combined harvesters are excellent for harvesting the seed crop. In fact this is the only really successful method of harvesting. A good supply of seed for home use may be obtained easily by threshing by hand.

The Lespedezas

Lespedeza is the scientific name of a genus of legumes some species of which are native to America and some to eastern Asia. The scientific name of the genus has been generally adopted also as the common name for the cultivated species. Only two species have become agriculturally important, *Lespedeza striata* and *Lespedeza stipulacea*, both introduced into America from eastern Asia. A number of perennial species have been introduced also and are being tested experimentally. One known as *Lespedeza sericea* attracted much attention a few years ago and it was considered to

be an important discovery. It has not lived up to expectations, however, and is not widely grown.

Three varieties of *Lespedeza striata* are grown: the common, Essary, or Tennessee 76, and Kobe. Common lespedeza, also known as Japan clover, was first found in 1846, by John C. Porter, of Monticello, Georgia. Just when and how it was introduced is not known. Apparently it became widely spread over the South during the Civil



Korean lespedeza on the Experiment Station farm at Lexington.

War, probably thru its use as forage by cavalry troops. Since the Civil War, the common lespedeza has spread as far north as central Indiana and Ohio, and from the Atlantic Ocean to Kansas. According to Doctor Pieters, formerly in charge of forage crop investigations, United States Department of Agriculture, the spread northward has resulted from variations in the seeding habits of individual plants. When seed from the far South is sown in the latitude of Washington, D. C., only a few plants produce seed. It is these earlier plants which establish the species at a new point. The variation among individuals is not confined to seeding habits alone. Professor Essary, of the Tennessee Experiment Station, found much variation in size and, by selecting large plants, was able to produce a variety which grows much larger and taller than the common *Lespedeza*. It was named Essary, or Tennessee 76. Kobe is another giant variety of *Lespedeza striata* recently introduced from Kobe, Japan. It is quite similar to Tennessee 76.

So far, only one variety of *Lespedeza stipulacea* has been found.

This was brought from Korea a short time before Kobe was introduced, and is known as Korean lespedeza. It is a much more rapid-growing type than the others, and matures seed much earlier. In size of plant it equals the Kobe and Tennessee 76.

Lespedeza is not a practical crop to grow where the shortness of the season prevents its reseeding. All varieties of *Lespedeza striata* seed so late that they cannot be depended upon to reseed themselves much farther north than the latitude of Kentucky. Korean lespedeza, however, probably reseeds itself over most of the Corn Belt. During the past few years this lespedeza has attracted much attention, especially in Kentucky, Tennessee, and other states in the middle South, and the acreage devoted to its production has increased remarkably.

Importance and Uses. Lespedeza unquestionably is one of the most valuable legumes for the South. Some believe it the most valuable. The introduction of the Korean variety has greatly increased the territory over which the crop may be grown successfully, and it seems quite certain that lespedeza will become an important pasture crop in the Corn Belt as well as in the South. The Korean and the other large-growing sorts are proving excellent hay crops in the South, and especially useful where it is not practical to use lime. It is as a pasture crop, however, that lespedeza is extremely valuable. It provides a legume that grows successfully with the grasses or other legumes. Its ability to reseed itself even when pastured closely makes it a permanent constituent of pastures once it has been seeded. Most of our pasture crops give an abundance of spring pasture, but little during the heat of summer and early fall. Lespedeza, however, makes most of its growth during the summer and fall, thus supplementing other pasture crops.

Lespedeza has the widest possible soil adaptation. It grows well on acid soil, but better on soil containing lime. It succeeds on poorly drained soil and, in connection with redtop, is one of the best pasture crops for wet bottom land. Probably no other legume makes so much growth on very thin land without any soil treatment, as lespedeza. It is, therefore, of great value for seeding on rough, worn land where little or no money can be spent for soil treatment. For hay production, lespedeza should be sown on productive soil or on well-fertilized soil. If the crop is cut when in bloom or shortly after, lespedeza makes an excellent quality of hay.

As closely as can be estimated, lespedeza, chiefly Korean, alone

or in combination with grasses, occupied over 3,000,000 acres of land in Kentucky in 1935 and 1936, which is at least three times the total acreage occupied by all other legumes. Most of this immense acreage has been developed during the past 10 years and much the larger part within the past 5 years. Apparently there has been no decrease in the production of other legumes; hence the 3,000,000 acres of lespedeza represent a net gain of this amount in the legume acreage of the State.

Seed and Seeding. Lespedeza seeds abundantly, especially Korean; consequently the seed can be produced at a very reasonable price. Cheap seed contributes greatly to the value of a forage crop. Commercial lespedeza seed is in the hull and weighs 25 pounds to the bushel. Dodder often is present in commercial seed, particularly seed of Korean. This is a very noxious weed and especially serious where the crop is grown for seed production. Consequently, the seed grower should avoid purchasing seed that contains even a small percentage of dodder. Lespedeza may be sown on winter grains or with spring oats. If a full stand is desired the first year, 15 to 20 pounds an acre should be sown. In connection with other forage seeds, 5 to 10 pounds an acre are sufficient. A light seeding, 5 pounds to the acre, gives a stand sufficiently thick to provide a heavy stand the following year from reseeding. Light seeding often is practiced when the price of seed is high.

When seeding a mixture of grass and lespedeza, the grass should be fall sown, if possible, so that it will become established by spring. Not more than 10 pounds of lespedeza seed should be sown with grass.

Korean lespedeza seed germinates very quickly and, since the young plants are quite tender, it is not advisable to sow this variety until late March or early April. Where the crop reseeds itself, so much seed is produced that a good stand usually is obtained, even if many of the plants are killed. This precaution is not necessary with other varieties of lespedeza, the seed of which may be sown at any time during the winter or early spring. Inoculation is advisable in areas where the crop has not been grown previously.

Seed Production. The production of Korean lespedeza seed has become an important industry in Kentucky. Weed control is the chief problem of the seed grower. Seeds of most weeds can be cleaned out of the unhulled seed, but several cannot be removed

completely. Dodder is one of these and, since dodder thrives on lespedeza, growers have had considerable difficulty in keeping this weed out of their fields. As advised in a previous paragraph, the seed grower should make every possible effort to obtain dodder-free seed for sowing. Even this does not always avoid infestations, for dodder seed may be in the soil. This weed is a parasite. The seeds germinate and the young plant attaches itself to the lespedeza, or other host, and draws its nourishment from the host plant. The slender, yellow vines reach out in all directions and soon cover a wide space. The seeds are almost exactly the size and shape of red clover seeds, but under the microscope show a pitted surface. They are produced in great abundance. If the plants are discovered before they have started spreading, they may be destroyed without the destruction of much of the lespedeza. The field should, therefore, be watched closely, and whenever a dodder plant is discovered the infested area should be sprayed with kerosene or crude oil and burned. After dodder has spread widely, its eradication becomes almost impossible.

Tall weeds should be clipped off with a mower fitted with a weed wheel. This is a small wheel attached to the end of the cutter bar, which holds the bar at any desired height. Care should be taken not to clip the tops of the Lespedeza plants when clipping weeds.

The crop is ready to cut when the seeds are in the hard dough stage. If cut before this stage, the seed is likely to be light and shriveled. Cutting is done with a mower. It is best to rake into windrows at once and leave there until dry. Threshing is done with a grain separator so adjusted as not to hull many of the seeds. Some seed shatters, and growers sometimes attach a seed pan to the cutter bar, to catch shattered seed. Both wooden and sheet-iron seed pans are used. They are made the length of the cutter bar and about three feet wide. The top of the wooden pan is slatted, and the sheet-iron pans have a perforated cover. As the cut material passes over the pan, the shattered seed drops thru the slats or perforations and is caught in the pan. The seeds of other varieties of lespedeza shatter so readily that a large percentage can be saved by the use of seed pans, and this is the method of saving seed commonly used.

Lespedeza Hay. It is somewhat difficult, in growing lespedeza for hay, to provide for reseeding. Perhaps the best plan is to cut

Korean for hay about the middle of August at which time it is beginning to bloom. Usually new shoots are produced, and these will make enough seed for reseeding. The other varieties may be left until some seed has ripened, without a serious reduction in the quality of hay produced. Another plan is to leave narrow uncut strips between swaths, for reseeding.

Vetch

There are several species of vetch, but one, hairy or winter vetch, is adapted to Kentucky. Winter vetch is a vining legume, provided with tendrils like the garden pea. It is sown in the summer or fall in Kentucky, and matures its seed crop in June and July of the following year. Winter vetch is very winter-hardy, and adapted to a wide range of soil conditions. It is not only an excellent winter cover crop, but valuable for soil improvement. The high cost of the seed and a tendency for the plants to volunteer in grain fields and give trouble in harvesting the grain have kept vetch from becoming more widely used. Farmers who do not raise fall-sown grains should consider the use of vetch for sowing in corn or other cultivated crop for a winter cover.

For the use of vetch to be practical, some method of saving seed on the farm must be practiced. This is not a difficult task, however. Perhaps the best plan is to cut for hay each year a crop which has ripened considerable seed. This can be beaten out with a fork while feeding the hay, and saved.

Questions on Lesson XIX. 1. What species of sweet clover are grown in the United States? Describe each. Which are most valuable? 2. What county in Kentucky found sweet clover so useful? Describe the climatic range of sweet clover. What are its soil requirements? 3. For what purposes is sweet clover of most value? Tell how you think sweet clover can help the agriculture of Kentucky. 4. When is it practical to use small amounts of lime in producing sweet clover? How fine should limestone be ground? Are phosphate fertilizers necessary for raising sweet clover in Kentucky? 5. What is scarified sweet clover seed? When should scarified seed be used? When should unhulled seed be used? What precautions are necessary in pasturing sweet clover in order not to injure the crop? Give a good pasture mixture including sweet clover. 6. What do you think of sweet clover as a hay crop? How is the seed crop saved? Have you ever examined the roots of sweet clover? What kind of root has the plant? 7. Name the varieties of *Lespedeza striata*. What is a variety? What is the species of Korean lespedeza? What is Japan clover? How does Korean lespedeza differ from the varieties of *Lespedeza striata*? 8. Discuss fully the importance and uses of lespedeza. 9. What amount of lespedeza seed should be sown to the acre? When should Korean lespedeza be sown? Why? 10. Discuss fully the production of Korean lespedeza, giving special attention to the control of dodder. What is dodder? Of what value is winter vetch?

LESSON XX

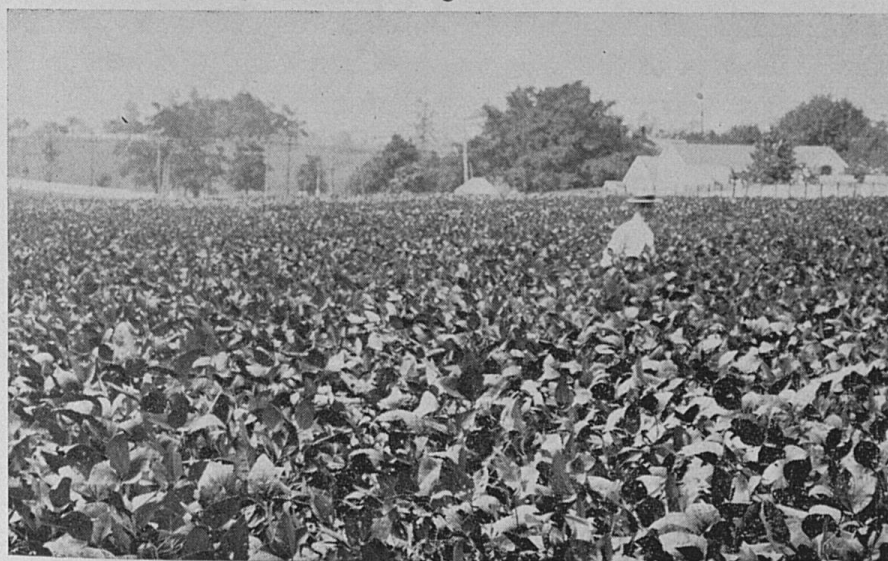
SOYBEANS AND COWPEAS

Soybeans

The soybean has been for many centuries one of the most important crops of eastern Asia, particularly in China and Japan. The plant is a tender annual, growing from one to five feet high. The stem is usually stiff and, in thin stands, well-branched. In a few varieties, however, there is a tendency to vine. The flowers are quite small and are clustered in the axils of the leaves. They are either white or purple. The entire plant is covered with short fuzz, or is pubescent. The pods are short and contain two or three beans each. It is determinate in growth; that is, the plant and all the seeds ripen at the same time. Very great differences in size, shape and color of seed occur among the numerous varieties of soybeans. The largest-seeded sorts contain about 1,500 seeds to the pound, while the smallest contain 8,000 or more. The size of the seed is no indication of the size of the plant produced or the length of time required for maturity. Some of the earliest and most dwarfed sorts have large seeds, while some of the latest and largest-growing varieties have small seeds. The seeds vary in shape from nearly round to much flattened; some resemble lima beans in both shape and size. The most common seed-coat colors are yellow, greenish yellow, black, brown, and green. There are also varieties with mottled and banded seeds. The inside of the seed, or the embryo, is green in all green-seeded varieties, in some of the black-seeded ones, and in a few of the brown-seeded ones. In all others it is yellow.

Uses. In China and Japan the soybean is grown chiefly for the seed which, prepared in various ways, is an important food product. In addition, immense quantities are utilized for the extraction of oil of which the seeds contain 15 to 20 percent. Soybean oil is used in the manufacture of soaps, paints, varnishes, butter and lard substitutes, and for various other purposes. China, particularly the division known as Manchuria, now under the control of Japan, produces a large surplus of beans and oil, and these are among the most important export commodities of that country. The residue after the extraction of oil is known as bean cake or, when ground, as soybean meal. It is an excellent high-protein feed similar in composition to cotton-seed meal and linseed meal.

The soybean is grown extensively in America both for hay and for seed. It is generally regarded as the most dependable and satisfactory of the annual legumes for hay production. However, none of the annual legumes is so satisfactory as the clovers and alfalfa for hay. Soybeans are more expensive to raise, leave less nitrogen in the soil, and the hay is more difficult to cure. Consequently, where clover and alfalfa can be grown successfully, the soybean is used chiefly as an emergency crop in the event of the failure or partial



A fine crop of soybeans.

failure of the other hay crops. In the Cotton Belt, annual legumes thrive much better than clover and alfalfa, and they are extensively grown for hay as well as for pasture and soil improvement. The cowpea has long been the standard legume of the South, but the soybean has replaced it to considerable extent for hay production, especially on soils of the better class. It is less easily injured by cool, damp weather, and is more drouth-resistant; consequently is more dependable. In addition, the hay is more easily handled and cured. For thin soils or for soil improvement, the cowpea seems usually to give better results than the soybean.

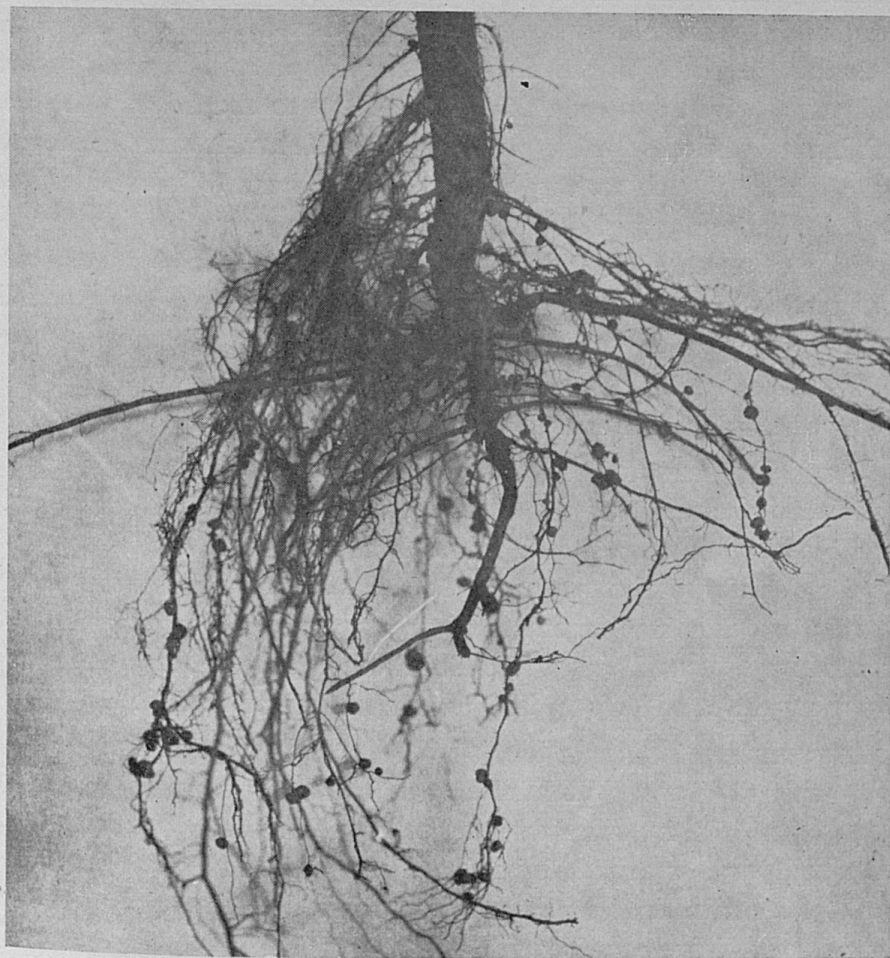
Importance. The soybean was introduced into the United States more than a hundred years ago, but as late as 1906 a prominent agricultural authority stated that it was grown only to a limited extent despite very favorable reports regarding its value by many

of the experiment stations of the country. Only a few varieties were available at that time but, in 1907, the United States Department of Agriculture began the introduction of new varieties on an extensive scale. Many of these proved far superior to the older varieties and, largely as a result of these introductions, the soybean rapidly became more popular. During the past 15 years the acreage has increased to a remarkable extent, particularly in the Corn Belt and in a few of the Southern states. More than $4\frac{1}{2}$ million acres are now grown annually. The crop must, therefore, be regarded as of considerable importance. About $2\frac{1}{2}$ million acres are devoted to the production of seed, and the other 2 million acres are utilized for hay and pasture. A large proportion of the seed is produced in Illinois, Missouri, Indiana, North Carolina and Ohio. Oil mills have been established in these states, and part of the seed is sold to the mills for the extraction of oil. Approximately one hundred thousand acres of soybeans are grown in Kentucky, chiefly for hay but to some extent for hogging down, for seed and for soil improvement. A relatively small amount of seed is produced. Kentucky farmers find the hay crop more profitable than seed production.

Climatic and Soil Adaptations. Soybeans can be grown successfully in any climate suitable for corn or cotton. As a matter of fact, some of the earliest-maturing varieties probably can be grown farther north than corn. Soybeans grow well in almost any type of soil of fair productivity. They can be grown on more acid soil than red clover, but respond to the use of lime. Also, they grow on wetter soil than most other legumes.

Varieties. The United States Department of Agriculture has introduced more than one thousand varieties of soybeans, chiefly from China, during the past twenty-five years. In addition, many distinct varieties have been developed by selection from those introduced. Only a relatively small number of these have become commercially important. Since very little soybean seed is produced in Kentucky, growers must depend largely upon seed produced elsewhere. Southern varieties are late-maturing but give heavy yields of hay, as a rule. Some of them do not reach the proper stage to cut for hay until the middle of September or later, when weather is less favorable for curing the crop. The most important southern variety is Mammoth, and this is still grown extensively in Ken-

tucky. In recent years the Mammoth has not given good results in all parts of the state, particularly in the Bluegrass region, but in most sections it yields as much hay as any other variety, or more, especially on poor soil. Mammoth produces very coarse hay unless seeded heavily, and animals to which it is fed usually reject the coarser portions. The Mammoth has large, yellow, nearly round



Nodules on the roots of a soybean plant.

seeds. Other varieties similar to Mammoth in most respects are Southern Hollybrook, Tar Heel Black, Oototan, and Biloxi. A more recently introduced variety, the Laredo, matures somewhat earlier than those named, and is much better for hay because it has very fine stems. The black seeds are very small and only a half bushel to three pecks are necessary to seed an acre, as compared with two

bushels of Mammoth, so that the acre cost of seeding is not, in reality, very high. It unquestionably is one of the best hay varieties.

Most early-maturing varieties such as are grown in the central Corn Belt produce heavy crops of seed but give a small yield of hay, except on fertile land. Among such varieties are the Manchu, Black Eyebrow, and Ito San. Three newer varieties, slightly later maturing than the Manchu, have recently become popular in the North. These are Harbinsoy, Illini and Mansoy. Unlike other early varieties, the plants of these varieties grow tall and in trials in Kentucky have given good yields of hay. Next to the Laredo the most satisfactory varieties for hay production in Kentucky are the medium early varieties, such as Virginia, Wilson Black, Wilson Five, Midwest, Haberlandt, and Sooty. The Virginia probably is the most popular of these. It has brown seeds. Wilson Black is next most popular. It has medium sized black seeds. Haberlandt is especially good for hogging down.

Since the soybean is grown mainly for hay in Kentucky, most of the discussion of cultural methods relates to hay production.

Land Preparation. In preparing land for soybeans, all trash, especially cornstalks and stubble, should be covered completely. Trash on the surface interferes with drilling and makes it impossible to cultivate the young beans. Broadcast cultivation with a harrow or other implement is of great value in producing a clean crop of hay. A well-pulverized, level seed bed should be prepared. Dragging the land before drilling the seed is advisable.

Inoculation. Inoculation is very important in getting good results with soybeans. When the land has not grown soybeans previously, artificial inoculation is necessary. The most effective method is to drill dry, screened, inoculated soil thru the fertilizer attachment of a grain drill when sowing the seed. About one hundred pounds of soil are required for each acre. The next best method is to sift dry, screened, inoculated soil over the moistened seed at the rate of a half peck per bushel, and stir until each seed is coated with the soil. Commercial cultures usually are effective, but perhaps not quite so safe as the use of rather large amounts of well-inoculated soil.

Seeding. For hay, soybeans usually are drilled solid, like wheat. A rather thick stand is desirable because weed growth is checked more effectively than in a thin stand, and hay with finer stems is

produced. The rate of seeding required to give a thick stand depends upon the size. Mammoth, Manchu, Haberlandt, Biloxi and Mansoy should be seeded at the rate of 2 bushels an acre. Virginia, Wilson, Harbinsoy, Illini. and other varieties with seed of medium size, should be sown at the rate of a bushel and a half an acre, while varieties with very small seeds, such as Laredo, Peking and Wilson Five, should be sown at the rate of 3 pecks to a bushel an acre. A grain drill is the best implement for sowing soybeans, even when they are sown in rows for cultivation. The oats runs should be used for all except the smallest-seeded varieties, for which the wheat runs should be used. The easiest way of finding the proper setting of the drill is to adjust the feed so as to space seeds of tall-growing kinds about three inches apart in the drill row, and those of medium and small kinds about two inches apart. Such spacing gives approximately the proper rates for seeding. In drilling soybeans, the drill should run just deep enough to place the seed in moist soil. It is better that a few seeds escape covering rather than to cover all very deep. Deep drilling followed by a heavy rain which crusts the soil usually results in a poor stand. The planting season for soybeans for hay extends from May 1 to July 1. For seed, the beans should be planted not later than June 15. Generally the most convenient time for planting is from the middle of May to June 1, or after corn planting is finished.

Cultivation. Harrowing soybeans when the plants are up well is highly advisable. When the seed bed has been prepared as recommended, the plants are injured very little by this method of cultivation, and weeds are destroyed very effectively; in fact it is difficult to produce clean soybean hay unless the crop is cultivated during the early period of growth. A weeder is satisfactory if the soil is not crusted, and a rotary hoe, a comparatively new implement, is perhaps superior to the harrow for broadcast cultivation.

Stage of Maturity for Harvesting. Soybeans should be cut for hay when the seeds are about half grown, say about the size of BB shot if the hay is intended for dairy cattle or sheep. Cutting at an earlier stage of maturity gives good hay but small yield. For beef cattle and horses hay of the greatest feeding value is obtained when the seed is allowed to become almost mature before cutting the beans. They should not stand until the leaves drop, however. It is

possible to cut beans at this stage with a binder and to cure them in small shocks.

Curing Soybean Hay. Difficulty in curing is the greatest disadvantage of the soybean as a hay crop. At least five or six days of favorable curing weather are necessary before the hay can be housed safely. Much difference of opinion exists among growers as to what is the best method of handling the curing process. At the Kentucky Experiment Station the following method has been found most practical. The beans are cut with a high stubble and left to cure in the swath for about two days. They are then raked into small windrows with a side-delivery rake. If the leaves have dried so much that they shatter readily, the raking is done early in the morning. The windrows are turned over the fourth or fifth day. With favorable weather, the hay usually is sufficiently cured to take up the sixth day after cutting. If rain occurs after the beans have been windrowed, the windrows are turned as soon as dry on the outside. The leaves become matted together by rain and quickly darken and rot if the windrows are not stirred. If a side-delivery rake is not available, a sulky rake may be used, but very small windrows should be made. A better grade of hay is made by raking as soon as the beans are wilted. More time is required to cure the hay, however, and the chances of getting it wet before housing are increased. Some growers prefer to cock the hay after raking, but this adds considerably to expense. Cocked hay is especially troublesome to handle if it becomes thoroly wet. The cocks must be spread and then rebuilt after the water has dried off.

In the South, curing frames are used extensively for curing both soybean and cowpea hay. The best form of curing frame is the pyramid. Three or four stakes about five feet long are fastened together at the top and spread at the bottom to form a pyramid. Cross pieces are fastened near the bottom, to hold the hay off the ground. The thoroly wilted forage is cocked over the frames very carefully and sometimes a forkful of grass is placed on top.

Soybeans or cowpeas pack down closely if cocked when only slightly cured, and the leaves mat together so that moderate rain penetrates but little. It rarely is necessary to tear down the cocks for drying, even after heavy rain. A very fine quality of hay is produced by the use of frames, at a cost not much greater than that of the usual methods of curing in cocks. For the farmer who has only a small acreage of beans or peas the use of curing frames is

entirely practical. Much soybean hay is cured entirely in the swath. It becomes badly bleached and weatherbeaten, but it is claimed that animals eat it readily.

Producing Soybean Seed. For seed, soybeans often are sown in rows and cultivated like corn. However, many growers drill them broadcast. In the South the seed crop is grown chiefly in rows. The beans, when perfectly ripe, are harvested from the rows, with a machine known as a soybean harvester. In the Corn Belt nearly



A soybean seed crop in shock.

the entire crop is harvested at the present time with small combines. This is far the best method of harvesting; in fact the only method by which heavy seed losses can be avoided.

Fertilizing. One hundred and fifty to two hundred pounds of superphosphate to an acre or equivalent amounts of other phosphate fertilizers may be considered the most practical fertilization for soybeans in Kentucky, wherever the soil is deficient in phosphorus. It may be safely drilled in with the seed. On acid soil, lime is of benefit to the crop.

Cowpeas

The cowpea has long been the most important legume in the South. It really is not a pea, but a bean. The native home of the cowpea is believed to be Africa. It has been widely cultivated thru-

out the warmer portions of the Old World for many centuries. The cowpea is particularly adapted to the South, as it requires warm weather for its best growth, and a long growing season for maturity. Cool, wet weather checks its development and may stunt the plants permanently. It is adapted to practically all types of soil, provided they are well drained. It never should be planted on cold, wet soil. The cowpea occupies much the same place in the agriculture of the South as the soybean, but is perhaps more widely used for planting with corn, either for seed production or soil improvement.

Varieties. These differ in habit of growth, shape and color of the seed, and length of growing season. Some have an erect habit of growth, with little tendency to vine, while others vine freely. The Whippoorwill is the best-known variety and is popular thruout the South. It grows fairly erect, matures early, and is productive of seed. The mottled, reddish seeds are of medium size. The iron variety has yellow seeds and is distinguished for its immunity to cowpea wilt, a common disease in the South, and to root knot, a knotting on the roots caused by a small worm known as the nematode. It has been crossed with other varieties, and the new varieties obtained also are resistant to wilt and root knot. Two of these are Brabham and Victor. The Iron is a trailing variety. The New Era and Groit are early varieties with a bushy habit of growth. In the South numerous varieties are known under a single name given solely on account of the color of the seed. Some of the names are Clay, Black and Red Ripper. Whippoorwill, New Era and Groit are the best varieties for Kentucky. For cooking, the so-called "Black-Eye" variety (or varieties) is extensively grown.

Culture. The cultural methods followed with the cowpea are practically the same as with the soybean. Cowpeas should not be planted until the weather is warm, or not earlier than May 15 in Kentucky. Planting may continue until July. Broadcast cultivation of cowpeas is not advisable because the young plants are very tender. Cultivation is not so necessary as for soybeans because cowpeas smother weeds much more effectively than soybeans. Artificial inoculation is not often needed for cowpeas.

Cowpeas should be cut for hay when some of the pods have ripened. Shock curing is almost necessary for cowpeas, for the hay is damaged badly by rain and the leaves drop readily. As stated

previously, frames are used largely in the South for curing cowpea and soybean hay.

The cowpea continues to bloom and produce seed until killed by frost. If the ripened pods remain long on the vines, the seed may rot; hence it is the custom to harvest the seed crop whenever the first setting of pods has ripened. The seeds crack easily, and special pea threshers are used. Yields are much smaller, as a rule, than the yields of soybeans. Much of the commercial cowpea seed is obtained from beans planted in corn. The pods are handpicked. Hand-picking is practical also in many instances where the peas are grown alone.

The only fertilizer used on cowpeas, as a rule, is some carrier of phosphate. While the crop is tolerant of soil acidity, liming acid soils usually increases yield to a marked degree.

Questions on Lesson XX. 1. Describe the soybean plant. How do the seeds of different varieties differ in appearance? Does a large-seeded variety produce larger plants than a variety with small seeds? 2. For what purposes is the soybean used? What is bean cake? How does the soybean compare in value for hay production with alfalfa or clover? In what ways is the soybean superior to the cowpea for producing hay? 3. Why has the soybean only recently become popular? What is the average acreage of soybeans in the United States? How many acres are grown for seed? What is the acreage in Kentucky? Why is it used chiefly for hay in Kentucky? 4. Describe the climatic and soil adaptations of soybeans. Are they well adapted to Kentucky? Give an intelligent discussion of the varieties of soybeans grown in Kentucky. 5. What can you say about preparing the seed-bed for soybeans? Why is inoculation important with legumes? Describe methods of inoculation. 6. What are advantages of a thick stand of soybeans? How may you determine the correct setting of the drill for different varieties of soybeans? Why should the seed be covered shallow? 7. Why are soybeans cultivated and how? At what stage should soybeans be cut for hay? Discuss curing soybean hay. Make a drawing showing your idea of a pyramid curing frame. 8. Why are soybeans often grown in rows in producing seed? How is the seed crop harvested in the South as a rule? What machine has recently proved so satisfactory for harvesting soybean seed? Why do you think it is very satisfactory? 9. Why is the cowpea well adapted to the South? For what purposes is the cowpea grown in the South? Do you think the cowpea is as valuable as the soybean for Kentucky? Why? 10. Discuss varieties of cowpeas. Which variety is most popular in Kentucky? Describe methods of producing cowpea seed.

LESSON XXI

THE GRASSES

In usefulness to man, the grass family is easily the most important group of plants. We have already learned that all the grain crops — corn, wheat, oats, etc. — are true grasses (Lesson III). In addition, the grasses are the most important pasture crop plants and only slightly less important than legumes for hay production. In this lesson the grasses used chiefly for pasture and hay are briefly considered. Most of these are perennials, altho annual grasses, including the cereals, are used to some extent for both hay and pasture. In addition to furnishing feed for domestic animals, the perennial grasses are of great importance in soil conservation. The dense network of hair-like roots produced by these grasses is very effective in preventing soil erosion by any agency and leaching of plant food from the soil. After heavy sod is plowed the binding action of the grass roots continues until decay is well advanced. Grasses introduce large quantities of organic matter into the soil, which improves its physical condition and, on decay, liberates plant food for the crops which follow the grass.

Important Grasses for America. All the important perennial grasses grown in the United States, except in the lower Cotton Belt, were introduced from Europe. While America has many native grasses, most of them are adapted only to the Western Great Plains region. None of them has proved of much value under cultivation. Only a few of the many European grasses succeed very well in this country, probably because of the wide differences in climate. In fact, only four, timothy, Kentucky bluegrass, redtop and orchard grass, are worth growing except in the most northern tier of states. In the latitude of Kentucky or what, for convenience, is called the Middle South, only orchard grass can be considered well adapted to the prevailing climatic conditions. It is true that Kentucky bluegrass thrives exceptionally well in the central limestone region of Kentucky, perhaps better than any other place in the country. The soils of this region, remarkably rich in lime and phosphorus, are so favorable for the growth of bluegrass that it thrives in spite of the climate. Timothy, also, succeeds well on all productive soils, but does not persist so long as in more northern districts. Redtop shows its best adaptation on wet, cold, bottom land. As stated, orchard grass is well adapted to the Middle South and grows well on a great variety of soils.

In the South Atlantic and Gulf States grasses of European

origin succeed so poorly that they are seldom sown. In those states Bermuda grass, Johnson grass and carpet grass, all tropical species, are the most important grasses.

The common perennial grasses differ little in feeding value, whether utilized for hay or pasture. However, there is much variation in palatability, which means how well animals like the grass. Bluegrass is greatly relished by all kinds of livestock, while redtop is not so well liked. Likewise, timothy hay is more palatable than redtop or orchard grass hay. In choosing pasture mixtures it is not advisable to include grasses and legumes which differ greatly in palatability because, in such a mixture, the animals seek out the most palatable and graze it to the neglect of other constituents.

Timothy. This grass is unquestionably native to the Old World, where its natural distribution is very wide. However, it was first cultivated in America, where it received the name, "timothy." The name is supposed to be derived from Timothy Hanson, who introduced the grass into Maryland from New England. Apparently timothy was first cultivated by a man named Herd, living in New Hampshire. It is possible that he obtained the seed from Europe. For many years timothy was commonly called Herd's grass in the New England States, a name which now is frequently applied to redtop. Timothy seems to be better adapted to the climate of the Corn Belt and eastern United States than any other grass except Kentucky bluegrass, and thruout this area it has always been by far the most important hay grass. Perhaps no other hay grass combines more good qualities than timothy. It yields well; the hay is easily cut and cured; and its late maturity brings its harvest at a time when it interferes least with other farm work, particularly the cultivation of corn and the harvesting of wheat. Furthermore, the haying season with timothy may extend over a considerable period of time without greatly affecting the quality of the hay produced. This is a distinct advantage because it often is impossible to harvest a hay crop within a brief period. Undoubtedly the low cost of seeding timothy and the ease of getting a stand have also contributed greatly to its popularity. Probably timothy yields more seed than any other perennial grass, and it is harvested easily and cheaply; hence the seed is relatively cheap. Timothy seeds are plump and sound and germinate better and more quickly than the seeds of most other grasses. The low cost of seeding makes timothy particularly desirable in short rotations such as are prac-

ticed in the Corn Belt, where fields seldom remain in grass for more than two years. Commonly it is sown in connection with red clover, which usually predominates the first year after seeding. The clover disappears largely the second year, leaving only the timothy.

In spite of its many advantages, timothy is losing its popularity in the United States. There are several reasons why this is occurring the most important of which is the great reduction in the number of horses used in this country. Since timothy hay is of value chiefly for feeding horses, this has resulted in a tremendous decrease in demand for the hay. In addition, much less timothy is now fed to dairy cattle than formerly, since farmers have learned that legume hay is greatly superior for milk production. Therefore, the legume acreage has increased at the expense of timothy. Still another reason is the need for better and more productive pastures than those provided by timothy, as a result of the increase in the dairy industry in this country. Undoubtedly timothy always will be of great importance, but in the future it probably will be utilized chiefly for sowing with legumes for the production of mixed hay.

Timothy is best seeded in the fall with winter grains, but it is also seeded successfully in the spring, both in the winter grains and with spring-sown grains. The rate of seeding, when sown alone, varies from 10 to 15 pounds to the acre. In mixtures with clover, 6 to 8 pounds an acre are sufficient.

Timothy is harvested for seed with a grain binder, when the seeds are in the stiff dough stage. After drying in small shocks for a week or more, it is threshed with a common grain separator. Average yields are about 6 to 8 bushels an acre, altho 10 to 12 bushels are obtained in many instances. The legal weight of the seed is 45 pounds to the bushel.

Kentucky Bluegrass. Kentuckians should be especially interested in knowing something about this grass which was called Kentucky bluegrass because it was first grown extensively in the famous Bluegrass region of the state. This also resulted in Kentucky being known popularly as the Bluegrass State. In some of the northern states this bluegrass is known as June grass. Many believe that Kentucky bluegrass is native to Kentucky. Probably this is not true. However, it was introduced into Kentucky at a very early date, in some way, possibly before permanent settlers arrived.

Kentucky bluegrass has much the same climatic range as timothy, but under especially favorable soil conditions it survives hot weather better than the latter. During hot, dry periods in mid-summer it often is difficult to find a green spear of grass in bluegrass pastures in Kentucky; yet there never has been a drouth severe enough to destroy the grass except in small areas where rock



Kentucky bluegrass at its best.

is close to the surface. When the drouth is broken the grass sends up new shoots and in an incredibly short time the fields are again mantled with green. As a matter of fact, after a drouth the grass seems to grow faster, and the fields look greener than at any other time.

Kentucky bluegrass occupies a place among pasture grasses in the United States relatively as important as that of timothy among hay grasses, which means that it is decidedly our most important pasture grass. It is somewhat more particular in its soil requirements than timothy, however, especially in its southern range, where it is confined chiefly to soils of limestone origin with a high content of phosphorous. It is not adapted to poor soil in any part of the country. The Kentucky Experiment Station has found that most soils outside of the Bluegrass area will produce good bluegrass where lime and phosphate are supplied liberally.

Some of the characteristics which make Kentucky bluegrass such a valuable pasture grass are as follows: (1) It is permanent,

actually improving with age if properly managed; (2) it makes a smooth, even, tough turf that withstands tramping without injury; (3) it is nutritious and palatable to all kinds of grazing animals; (4) it starts growing in early spring and continues growth until freezing weather occurs—in mild winters it remains green thruout the entire winter; (5) the dry herbage is palatable and nutritious, and in its more southern range it provides pasture during much of the winter. The chief disadvantages of the grass are the rather low yield of forage and its tendency to become dormant during hot, dry weather. The long season of pasturage provided partly compensates for these disadvantages, however, especially in Kentucky.

Kentucky bluegrass is the standard lawn grass of the country. Even in regions poorly adapted to it, good lawns can be maintained by giving them special care. It is used thruout the country, except in the far South for public parks, and is the approved grass for golf fairways.

Bluegrass grows slowly the first year after seeding, and it is desirable to sow with it some more rapid-growing grass or legume. In the Bluegrass region of Kentucky, the usual method in establishing pastures is to sow the bluegrass seed in the fall, on winter grain, and in the spring to add a few pounds of red clover. Much better results are obtained if the grain crop is pastured than if allowed to mature. On lawns, redtop or rye grass is sown with bluegrass. Both these grasses are quickly crowded out by the bluegrass after the latter becomes established. Fall seeding is decidedly preferable to spring seeding. However, seeding very late in the fall is not advisable. The customary rate of seeding for pastures is about 15 pounds to the acre. This amount of seed should give a thick initial stand. Bluegrass produces running root stocks and spreads rather rapidly; consequently it is possible to obtain good stands by sowing a small quantity of seed. A much longer time is required, however, than if it were seeded abundantly. As a matter of fact, in all bluegrass regions the grass will establish itself naturally in fields not disturbed for several years. This self seeding is due to the distribution of seed from roadsides, fence rows, etc. A large percentage of the bluegrass pastures in most parts of the United States have been self-seeded. Good pastures can be obtained so much more quickly, however, by sowing seed, that it does not pay to depend upon natural seeding. In establishing lawns, 50 to 100 pounds of seed to the acre are sown.

The important bluegrass-seed producing areas are in central Kentucky and in western Iowa and Missouri. The seed is obtained as a by-product from pastures, and the production of seed is therefore a secondary consideration. In Kentucky, most of the seed is gathered on the larger farms, where the acreage of grass is large. During the spring the growth of grass is luxuriant, and all the pasture is not needed at that time. Therefore, the cleaner fields are not pastured, or at least only lightly, until after the seed is gathered. Where it is necessary to pasture fields, the chances of getting a good yield of seed become uncertain. However, in favorable years, fields pastured only moderately may give very good yields of seed. If the spring is dry fields that have been pastured seldom are worth harvesting.

Bluegrass seed is harvested by stripping machines which comb the seed heads from the standing seed stalks. It is cured either in the open or under cover, in large windrows which, during the first few days, must be turned at least three times daily, to prevent heating. The cured seed, known as rough-dried seed, must be cleaned before it is ready for the ultimate consumer. Machinery for cleaning bluegrass seed is much more elaborate and costly than the machinery used to clean other farm seeds. The seeds are held together by hair-like filaments, and special rubbing cylinders are necessary to break up the filaments and loosen the chaff. Because of the cost, only the larger dealers operate cleaning plants; in fact there probably are not more than a dozen plants in all the producing areas. Since producers cannot clean the seed, they must sell it to dealers who have cleaning machinery or to those who can command the services of such machines.

Yield of Kentucky bluegrass seed varies greatly from year to year. The average yield over a period of years is probably about 8 bushels an acre. Often, however, yields of 30 to 50 bushels an acre are obtained. The legal weight of the seed is 14 pounds a bushel, and this weight is used for green, rough-dried or cleaned seed. Cleaned seed weighs more than 14 pounds, however. Generally two grades are made, one weighing 19 pounds to the bushel and one 21 pounds. Bluegrass seed seldom gives a good germination test until several months after harvesting. It germinates slowly, 28 days being allowed for the completion of the germination test in seed laboratories. Good seed should give a germination of 70 to 80 percent.

Orchard Grass. Orchard grass is so named because it thrives in orchards or other shady places. In England it is commonly called cock's-foot. It is native over most of Europe and occurs also in northern Africa and part of northern Asia. This extensive distribution indicates a wide climatic adaptation. Orchard-grass does not produce rootstocks or stolons and is therefore strictly a bunch grass. Consequently it does not occupy the ground completely, as does bluegrass. It is deeper rooted than timothy and bluegrass, which perhaps explains its greater drouth and heat resistance. Usually it does not grow quite so tall as timothy, and the stems are less leafy. It is one of the earliest-maturing grasses, the flowers being produced in early June at about the same time as those of red clover. The seed head is a one-sided panicle.



An orchard-grass seed crop, in shocks.

Orchard grass is not grown extensively in the United States. It is most important in Kentucky, Virginia, Tennessee and Missouri, or the so-called Middle South, which, as explained, is south of the region of best adaptation of timothy and bluegrass. In more northern regions orchard grass has been regarded chiefly as a hay grass, but for this purpose it is distinctly inferior to timothy. As a pasture grass it ranks next to bluegrass in value and where climate and soil are not well adapted to the latter it is far superior. Except in the Bluegrass region, orchard grass is decidedly the best pasture grass for Kentucky. It furnishes pasture very early in the

spring and is less affected by hot, dry summer weather than any of the other grasses commonly grown in the state. It continues growth until late in the fall. Contrary to the statements of many writers, orchard grass is a long-lived grass under pasturage, unless it is kept pastured very closely thruout the season, treatment which only bluegrass can stand, and then only under favorable soil conditions. The deep-rooting habit of orchard grass makes it one of the best grasses to use to prevent soil erosion. It is particularly useful for planting with alfalfa on steep hillsides, as the latter crop does not prevent erosion when grown alone.

Orchard grass sown in late fall may not survive severe winters. If sown in September, however, there is little danger of winter killing in Kentucky. If not sown in the fall, February seeding is preferred. When sown alone for hay or pasture, the rate of seeding should be 15 to 20 pounds to the acre. In mixtures, 8 to 10 pounds is sufficient. A thin stand of orchard grass produces more seed than a thick stand; hence, when the crop is grown primarily for seed, only 8 to 10 pounds to the acre should be sown.

For pasture it is rarely advisable to sow orchard grass alone. Lespedeza is especially valuable for growing with this grass while, on limed land or land containing lime naturally, the addition of sweet clover is desirable.

Orchard-grass seed is harvested when the heads become straw-colored. If left until fully ripe much seed may be lost by shattering. The crop is cut with a grain binder leaving as high a stubble as practical so as to avoid including low-growing weeds, particularly sourdock. Small bundles should be made and only three or four bundles placed in each shock. The shocks should be tied firmly with bands of straw, one placed near the middle and one near the top. When thoroly dry the seed is threshed with a grain separator. The average yield is approximately 10 bushels an acre but much larger yields are common. The legal weight of the seed is 14 pounds to the bushel. Kentucky produces a large proportion of the domestic seed crop, but considerable quantities are produced in Clark County, Indiana, and in several counties in northern Virginia. The largest-producing counties in Kentucky are Oldham, Jefferson, Henry and Shelby. Large quantities of seed are imported into the United States, chiefly from Denmark. In order to compete successfully with foreign seed American growers must give more attention to keeping their seed fields free of noxious weeds, particularly wild onion, field daisies and sourdock or sorrel.

Redtop. Because it succeeds well on wet soil, redtop is especially important in parts of western Kentucky where the area of wet bottom land is large. Redtop also thrives better on very acid soil than most other grasses. In habit of growth redtop somewhat resembles Kentucky bluegrass. It grows taller than the latter, however, and flowers about 5 or 6 weeks later. While used quite largely for hay it is most valuable as a pasture crop. Redtop does not persist very long in pastures except in moist soils but it is very useful for including in mixtures on all types of soil because it provides grazing quickly after seeding. The seeds are perhaps the smallest of any of the important grasses and Kentucky farmers rarely sow more than 5 pounds of re-cleaned seed per acre, even when the crop is sown alone. In spite of the small size of the seeds they are plump and give a high percentage of germination; hence it is easy to obtain a stand. Redtop seed is produced chiefly in southern Illinois. Formerly the seed crop was harvested with a binder and threshed. Now much of it is stripped with bluegrass seed strippers. Unlike bluegrass, the seed is easily cleaned.

Bermuda and Johnson Grass. Bermuda grass was introduced into the United States from the West Indies more than a century ago and has since spread over the entire Cotton Belt. It has also spread to some extent as far north as Pennsylvania in the east and farther west to the Ohio River. It is of importance, however, only in the Cotton Belt proper. Unlike the European perennial grasses the above-ground parts are killed by frost. Bermuda grass is permanent when once established; in fact it is so permanent that it is difficult to eradicate and gives much trouble in cultivated fields. However, it is a wonderful pasture crop for the South because of its ability to withstand extreme heat and its wide soil adaptability. In Kentucky it does not grow large enough to be of much value. It can be eradicated in this State by close pasturing followed by late fall plowing.

Johnson grass is a perennial grass sorghum introduced into this country from southern Europe. It is widely distributed thruout the Cotton Belt and patches of it are found in many places in Kentucky. It is almost impossible to eradicate Johnson grass in more Southern latitudes and it is one of the worst weed pests in the world. While utilized extensively for hay it is never intentionally sown. In Kentucky it usually is killed by fall plowing, following close grazing thruout the summer.

Sudan Grass. Sudan grass is a grass sorghum resembling Johnson grass in appearance very closely. It does not have running rootstocks, however, and never survives even mild winters. Sudan grass is used as an annual hay crop and for this purpose has largely replaced the millets. In Kentucky it is proving of exceptional value



Sudan grass makes a rank growth on good land.

as an emergency summer pasture crop. Sown in late May it is ready to pasture by the first of July and provides grazing until killed by frost. It grows very fast and under favorable conditions an acre will furnish grazing for two or three dairy cattle. Its ability to continue growth during the hottest weather and its drouth resistance together with its high yield of forage, are the features which make it valuable.

Sudan grass should not be sown before May as it is injured by cold, damp weather. Twenty-five to thirty pounds of seed per acre should be sown for pasture.

Pastures and Pasture Management for Kentucky. Leaving out of consideration the mountain area in Kentucky, most of which is adapted only for raising timber, there is much land, so steep that it ought never to be plowed but which provides good pasturage if properly managed. A large proportion of the rest of the farm land is more or less rolling and cannot be cultivated intensively without serious damage from erosion. There are many thousands of acres of only moderately rolling land in the state where erosion has progressed so far that profitable farming is no

longer possible. In order to prevent the continuation of this tremendous loss these rolling lands must be utilized more for pasture and hay crops and less for cultivated crops. Sloping land ought to be plowed only when a stiff sod can be turned under. If the land is immediately put back into grass after the cultivated crop is harvested, erosion can be largely avoided. Such a system of farming necessitates keeping land in pasture or hay crops for four to five years.

It is not true, as many farmers believe, that pastures are not profitable. As a matter of fact, good pastures are as profitable as cultivated crops. About 75 percent of the very fertile bluegrass lands of Central Kentucky are kept in pasture which is certainly good evidence that the farmers of that region obtain good returns from their grass fields. At the same time these lands are kept in a high state of productivity and little erosion has occurred.

Pastures to be profitable must provide a large amount of grazing and to do so the land must be kept productive. Grass is not a good poor-land crop by any means, and until this is realized we cannot expect much improvement in the pastures of the state.

Much of the land outside the Central Bluegrass Region must be treated with lime and phosphate before it will raise legumes successfully and legumes are necessary to provide nitrogen for the use of the grass. Experiments on some of the poorest land in Kentucky have demonstrated that good pastures can be obtained very quickly by giving the land an application of limestone and phosphate and sowing a mixture of grasses and legumes. A still better plan is to apply the limestone and phosphate and raise a crop of sweet clover or sweet clover and lespedeza to plow under before attempting to establish the pasture. These legumes make good growth on the poorest land when limestone and phosphate are used in liberal amounts. In starting a pasture on thin land it may be expected that legumes will supply much of the grazing for the first few years. Gradually, as the nitrogen supply is built up, the grasses become established and finally we have a pasture in which both grasses and legumes thrive. Good bluegrass pasture can be produced any place in the state as has been shown on the soil fertility fields maintained by the Kentucky Experiment Station in various parts of the state. Perhaps, however, it is better, for a time, at least, to use grasses not so exacting in their soil requirements as bluegrass. Orchard grass is an excellent pasture grass and in connection with lespedeza makes a highly productive pasture. On wet

land redtop ought to be utilized for mixing with lespedeza. A seedling mixture that can be recommended is orchard grass 15 pounds, redtop 3 pounds and lespedeza 5 pounds per acre. Such a mixture will give a pasture that lasts for 5 to 10 years. If greater permanency is desired a few pounds of bluegrass may be added. As the other grasses die out, the bluegrass will gradually replace them.

Pastures ought not to be kept closely grazed constantly but should be given an opportunity at least once a year of making considerable growth. Constant close grazing starves the grass just as keeping weeds cut off closely finally destroys them. Kentucky ought primarily to be a livestock state and it can become a very important livestock state if we learn to produce good pastures. At the same time erosion will be controlled and the productivity of our soils increased.

Questions on Lesson XXI. 1. Why is the grass family the most important group of plants? What is a perennial grass? An annual grass? How do perennial grasses aid in soil conservation? 2. What was the origin of most of the grasses grown in the United States? Which ones have proved best adapted to this country? Why does Kentucky bluegrass thrive so well in Central Kentucky? Which of the important grasses is best adapted to the climate of Kentucky? 3. What was the origin of the name, timothy? Give several reasons why timothy has always been a popular hay grass. Why is timothy less popular now than formerly? Should we raise timothy in Kentucky? If so, for what purposes? 4. Why is Kentucky called the Bluegrass State? What characteristic makes Kentucky bluegrass such an excellent pasture grass? You have a badly worn farm that you want to get in grass. Would you sow Kentucky bluegrass? Give reasons for your answer. 5. Describe methods of seeding bluegrass. You have a thin but even stand of bluegrass in a certain field. Is it advisable to reseed this field? Give reasons for your answer. 6. Where is Kentucky bluegrass seed produced? How are pastures managed in Kentucky where bluegrass seed is to be harvested? How is bluegrass seed gathered? Why is it all sold to dealers? What is the weight of bluegrass seed to the bushel? 7. How does orchard grass compare with bluegrass as a pasture crop? In your section of the State would you use orchard grass or bluegrass? Give reasons for your answer. What other pasture crops would you sow with your orchard grass? 8. Describe fully methods followed in producing orchard-grass seed. You have a field of orchard grass that you wish to harvest for seed. You note in the spring that a good many weeds are present. Can you suggest a cheap method of checking the growth of these weeds so they will not produce seed? What weed seeds are most likely to be found in orchard-grass seed? 9. On what kind of soil is redtop most useful? Is redtop best adapted for hay or pasture? Where is redtop grown chiefly in Kentucky? Where is the seed produced? How is it harvested? 10. How would you eradicate Bermuda grass if it had invaded one of your fields? Would this plan work as well with Johnson grass? Suppose you lived in south Georgia. Would these methods of eradication prove successful there? Why? Discuss the value of Sudan grass as an emergency pasture crop. 11. Discuss pasture management for Kentucky.

