Circular 616

BURLEY TOBACCO PRODUCTION

By Ira E. Massie, George A. Everette and J. H. Smiley

UNIVERSITY OF KENTUCKY
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By IRA E. MASSIE, GEORGE EVERETTE, and J. H. SMILEY

Tobacco is Kentucky's chief cash crop. In most years it accounts for one-third to one-half of the cash receipts from farming for the state as a whole. It can be grown in a short rotation under favorable conditions with good soil-management practices.

Because of its high value per acre ($1,000 to $2,000 per acre in recent years), tobacco is particularly important on small- and medium-size farms, of which Kentucky has a very large number. Much of the land in the state is hilly and rolling and erodes easily; hence, it should be kept in sod crops most of the time. A crop like tobacco makes this possible.

The total acreage planted in tobacco in Kentucky (usually around 200,000 acres per year) is only about 2 percent of the total cropland of the state. It accounts for the use, however, of about 25 percent of the productive farm labor, or about 10 million man-work hours per year. About 20 percent of all the tobacco grown in the United States and nearly 70 percent of the burley are grown in Kentucky. Of the Kentucky crop, 85 to 90 percent is burley. Tobacco income amounts to 35 to 50 percent of the total agricultural income in Kentucky annually.* This publication is concerned with the production of burley, but much of it applies also to other types of tobacco grown in the state.

Change in tobacco usage

For the past 20 years there has been a rapid increase in cigarette consumption and a steady decline in the use of other tobacco products. At present, around 80 percent of all tobacco produced and manufactured in the United States is made into cigarettes. Such changes in consumption have had their effect on the kind of tobacco manufacturers want for cigarettes. There has been a steady decline in the production of non-cigarette tobaccos and a correspondingly large increase in burley and other types of tobacco that are suited to cigarette manufacture.

Filter-tip cigarettes make up slightly over 60 percent of the total production compared with about 6 percent 15 years ago. The increase in filter-tip cigarettes has materially changed the demand for burley

* Milton Shuffett, Department of Agricultural Economics.

tobacco. There is an increased demand for leaf and tip grades if they are ripe even though they have considerable body. Demand for the light colory grades continues. Lower quality grades of all groups, from flyings to leaf, are needed to meet cigarette manufacturers' needs. These grades are bringing farmers nearly as much as choice and fine qualities.

The Plant Bed

Prepare enough plant bed area to have a surplus of strong, vigorous plants (Fig. 1). Provide 100 feet of bed, 9 feet wide, or 75 feet of bed, 12 feet wide, for each acre of burley to be set. For dark tobacco, pre-

Fig. 1.—Plan for a surplus of strong, vigorous plants.

pare 50 feet of bed, 9 feet wide, or the equivalent, for each acre to be grown.

By seeding at the rate of 2 level teaspoons of seed to a bed 100 x 9 feet—or 2½ teaspoons for a bed 100 x 12 feet—you can have strong, sturdy plants that will stand transplanting well and grow rapidly in the field.

CHOOSE A FERTILE, WELL-DRAINED SITE

Select fertile, well-drained land high in organic matter, preferably with a slight southern or eastern slope, free from shade, especially in

the forenoon. An ideal place for growing plants is in an open field and near a supply of water. Avoid sites too near tobacco barns or other sources of tobacco trash and areas infested with bullnettles, groundcherries, or plantains. These weeds are likely to carry mosaic.

ESTABLISHING THE BED

Regardless of how plant beds are to be treated, first break the ground 3 or 4 weeks before, pulverize thoroughly to a depth of 4-6 inches, and level it off. Break the bed site in the fall if the land is in sod. Many farmers prefer to prepare beds in the fall, particularly if beds are to be steamed or treated with chemicals. Burning in the fall is preferable to spring preparation.

In breaking, begin in the middle of the bed and throw furrows on each side toward the middle until breaking is completed. This will make the bed higher than the surrounding ground and will help keep outside water from flowing over the bed.

KILL WEED SEED IN THE PLANT BED AREA

Tobacco plants are so small when they first emerge they cannot stand the competition of a heavy growth of weeds. Weeding the bed is a slow, tedious, and laborious job and is likely to injure the young tobacco plants. Wildfire and mosaic often occur following weeding.

The best way to prevent weeds in the plant bed is to kill the weed seed in the plant bed site before sowing the tobacco seed.

Don't attempt to destroy weed seed in plant bed sites when the soil is wet, regardless of the method used. Neither chemicals nor heat penetrates wet soil; consequently, if the soil is wet, you will get poor results. Also, soils burned or steamed when wet may become so hard that the tobacco plants can't grow well. For wildfire control, fall treatment is better than treating in the spring.

Weeds may be killed by steaming, burning, methyl bromide gas, calcium cyanamid, or by drenching. Except for calcium cyanamid, you can use any of these soil treatments either in the fall or in the spring. Use calcium cyanamid for bed treatment only in late summer or fall. Usually fall treatments result in slightly poorer weed control than do similar treatments in the spring, but the prevalence of suitable weather, better working condition of the soil, and higher soil temperatures in the fall are factors which usually more than offset that disadvantage.

Burning

When burning, have the soil thoroughly prepared and dry enough for good tillage. Use enough wood to heat the soil to a depth of 3 to

4 inches. Usually 30 minutes burning with fairly large wood will provide enough heat to kill weed seed near the surface. Burning with a small amount of brush for 10 minutes is worthless. Burned beds may be seeded after the soil cools.

Heavy burning or burning the same site year after year, especially on soils low in organic matter and with poor soil structure, often results in areas in the bed with few or no plants. Burning releases an excess of manganese, a minor element toxic to young plants. When an excess of soluble manganese occurs, young tobacco plants are seriously retarded in growth, and in extreme cases killed.

Steaming

Steaming is one of the most effective methods of treating plant beds to kill weed seed and to control leafspot diseases. When using steam, prepare the site thoroughly. At each "set" leave the pan in position for approximately 25 minutes, with the steam pressure in the boiler at 100-125 pounds. Steaming may be done in fall or spring whenever the soil is dry enough for working. You can seed any time after the soil becomes dry enough to rake.

Plant bed sites with low organic matter and poor soil structure may suffer from manganese toxicity following steaming as they do from burning.

Methyl Bromide

When using methyl bromide gas, the soil should be plowed and worked thoroughly at least 2-3 weeks prior to treatment and again just before treatment. Cover the bed with a gas-proof cover and seal the edges with soil; insert tubing (plastic) at three points in a 100-foot bed one at each end and one in the center. An evaporating pan or tray should be placed under the cover at the end of each tube. Then 1 pound of methyl bromide is released for each 100 *square feet* of bed. Use 9 pounds for a bed 100 x 9 feet, and for a bed 100 x 12 feet use 12 pounds. The methyl bromide gas is heavier than air, therefore it will move to the lowest side of the bed. Release methyl bromide on high side.

HOT METHYL BROMIDE

When using hot methyl bromide, proceed as directed above until ready to release the gas. Have a bucket or other container with 5 gallons or more of hot water at a temperature of 150°-160° F. (as hot as the hand can stand). Puncture the can with the applicator in the upper position (Fig. 2) instead of in the lower position as used in

the conventional method. Then, submerge the can at once in the container of hot water, leaving only the punctured area above the water. The methyl bromide is released as a gas, instead of a liquid, thus evaporating pans in the bed are not needed. If you use the hot-gas method, treatment may be made with a lower soil temperature. The time of treatment may be shortened to 4-6 hours. It requires about 5 minutes for the gas to evaporate from a 1-pound can. In using hot methyl bromide, release two-thirds of the gas through tubes placed at the corners of the bed and one-third through tubes placed at the side of the bed.

Remember, methyl bromide is a poisonous gas, so be sure to follow the precautions on the label carefully.

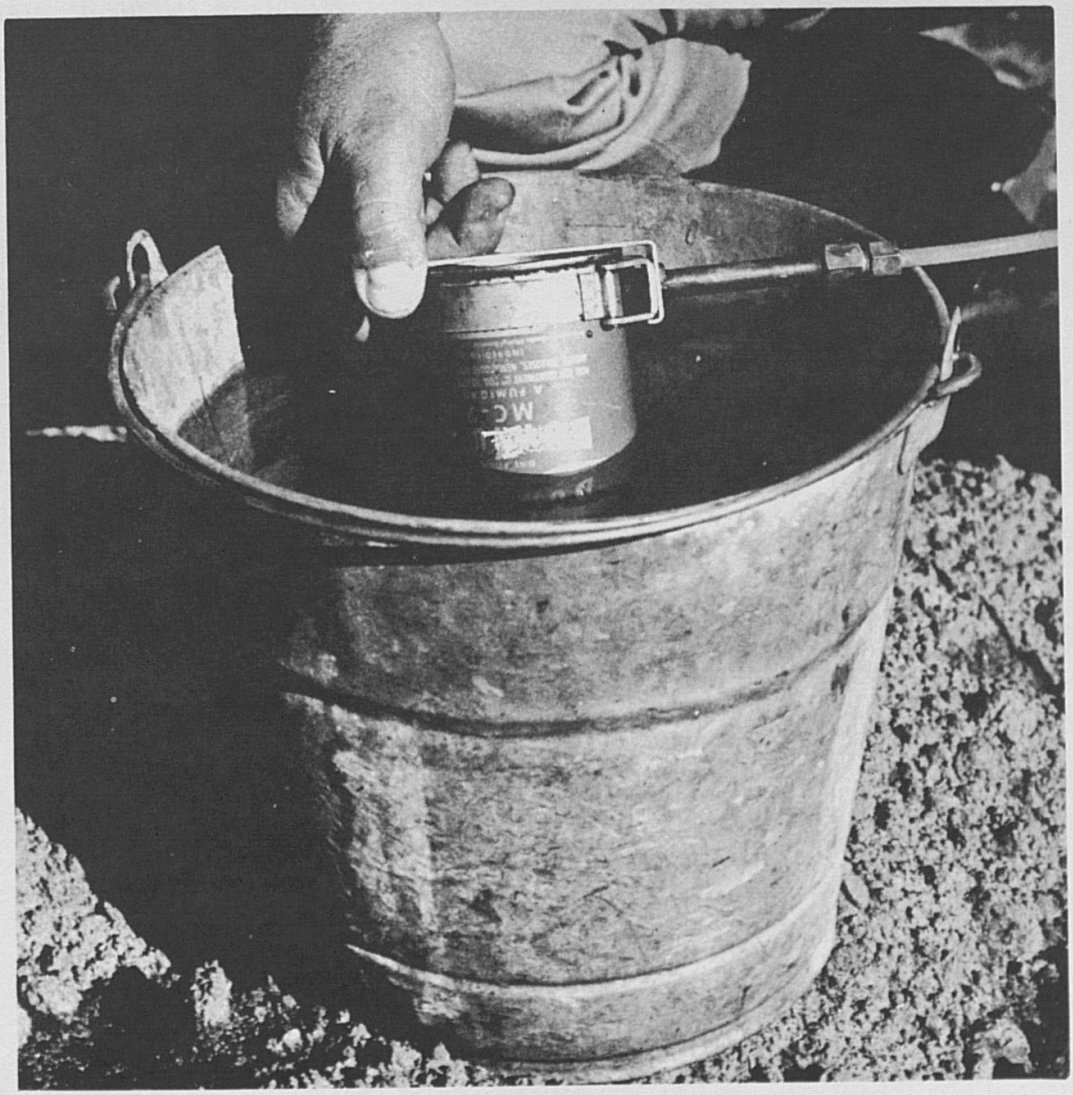

Fig. 2.— Immersing the 1-pound can of fumigant in a hot water bath hastens the vaporization of the material.

COLD METHYL BROMIDE

The soil should be thoroughly pulverized and just about as moist as it can be safely worked. The soil temperature should be 50° F or warmer. Cover the bed with gas-proof covering and seal edges with soil, then release 9 pounds of methyl bromide gas for a bed 100 x 9 feet, and 12 pounds for a bed 100 x 12 feet into shallow pans using a specially designed applicator or plastic trays with pins for puncturing cans. Leave the cover on the bed for at least 24 hours, preferably 48 hours.

Drenches

Plow 4 weeks before drench application for effective weed control. Advance plowing permits the soil to firm down thereby forcing out much of the air. Drench materials rapidly change to gases after application, and they destroy weed seed by contact. To be effective, the gases must be concentrated in the soil. This concentration is possible only when soils have lost much of the air which is always found in freshly plowed land.

When using Mylone in plant bed preparation, the soil should be broken and thoroughly disked about 4 weeks before time of treatment. As with other treatments, the soil temperature at a 2-inch depth should be at least 50° F. Enough moisture should be available so that the weed seeds can be easily penetrated by the Mylone gas.

Use 15 pounds of Mylone on 100 square yards of bed area. Application may be made by hand or with a small garden or lawn fertilizer spreader. Even distribution of the material is necessary. Follow this with enough water to penetrate the soil to a depth of 2 inches.

Recent experiences have shown that better results can be obtained by sprinkling the bed with 10 gallons of water after Mylone has been broadcast. Cover immediately with 2, 3, or 4 milliliter plastic cover. The Mylone is converted to a gas, and it is retained in the soil for a longer period of time.

You may use Mylone either in the fall or spring. Apparently, best results are obtained by using the material in the fall. When using Mylone in spring prepared beds, wait at least 3 weeks before seeding. At seeding time rake the plant bed area lightly to break the crust.

When using Vapam in plant bed preparation, the ground should be broken and thoroughly disked about 4 weeks before treatment. Soil temperature should be 50°F or warmer when you treat the bed. In extreme dry weather when the ground is dusty, a light application of water to the bed area a few days before treatment followed by a

light raking or disking helps the solution penetrate the soil. Either break up or rake off all clods from the bed site.

Use 2 gallons of Vapam in 100-125 gallons of water. Stir and sprinkle over 100 square yards of bed area. Follow immediately with 100 gallons of water to seal the material in the soil. You may apply the material with a power pump or sprinkling can. Use enough solution to penetrate the soil 2½-3 inches. Vapam undergoes a chemical reaction in the soil, releasing a gas which kills weed seed.

Recent tests have indicated that best results can be obtained when 1½ gallons Vapam are mixed with 10 gallons water and evenly sprinkled on 100 square yards bed surface. Cover immediately with a 2, 3, or 4 milliliter plastic cover. Leave the cover on the bed overwinter. Remove at seeding time. The soil is now moist and in excellent condition for seeding the bed.

Fall-prepared beds may be seeded as soon as weather permits in the spring. When using spring-prepared beds, wait 3 weeks or longer after Vapam is applied before seeding. Since Vapam is retained in some soils for a considerable period, it is desirable to rake the plant bed area *lightly* to break the crust 1 week before seeding. Vapam is poisonous. If you use Vapam observe the safety precautions on the label.

Chemical injection equipment is being used to inject liquid drenches into the soil. This method is being handled primarily by custom operators. Results have been variable. It appears to be a very popular way to treat the soil for weed control. The operator of the equipment can inject the drenches into the soil to desired depths. A roller is used to seal the soil following the treatment with this type equipment (Fig. 3).

In addition, polyethylene film (plastic) cover is being used to trap the gases. These covers are left on the bed for 5 days or more. In some cases, the covers are left on the bed over winter. This practice protects the soil and permits you to seed when you wish. When the cover is removed the soil is ready for instant working. If gases are trapped, the cover should be removed at least 3 days prior to seeding. Thicknesses of 2 mil, 3 mil, and 4 mil are being used with success.

Enide 50W is now registered for use on tobacco seed beds. Treatments on most beds have been successful. However, there are a few cases of plant injury and reduction in stands. Until more data is available, Enide is recommended for trial use only. Enide should be used only at seeding time with at least ½ inch of water either before or after seeding the bed. A low pressure or back-pack sprayer at 3 to 5 gallons of water per 100 square yards is best.

Use 3 ounces Enide 50W or 1 cupful per 100 square yards on light soils or 4½ ounces Enide 50W or 1½ cupsful per 100 square yards on heavier soils. Never use Enide for fall-treated beds, and do not mix Enide 50W with other chemicals before application.

Calcium Cyanamid

Use calcium cyanamid only on soil that drains quickly. The soil must be thoroughly pulverized and contain enough moisture for good tillage. Apply ¾ pound of calcium cyanamid and 2 pounds of 20-percent superphosphate to the square yard and mix with 3 inches of soil. Rake the surface smooth. Apply ¾ pound more of calcium cyanamid to the square yard and rake lightly. Water the bed, using 300-500 gallons for a bed 100 feet long. At seeding time prepare the surface with a hand rake, but don't stir soil deeper than 1 inch.

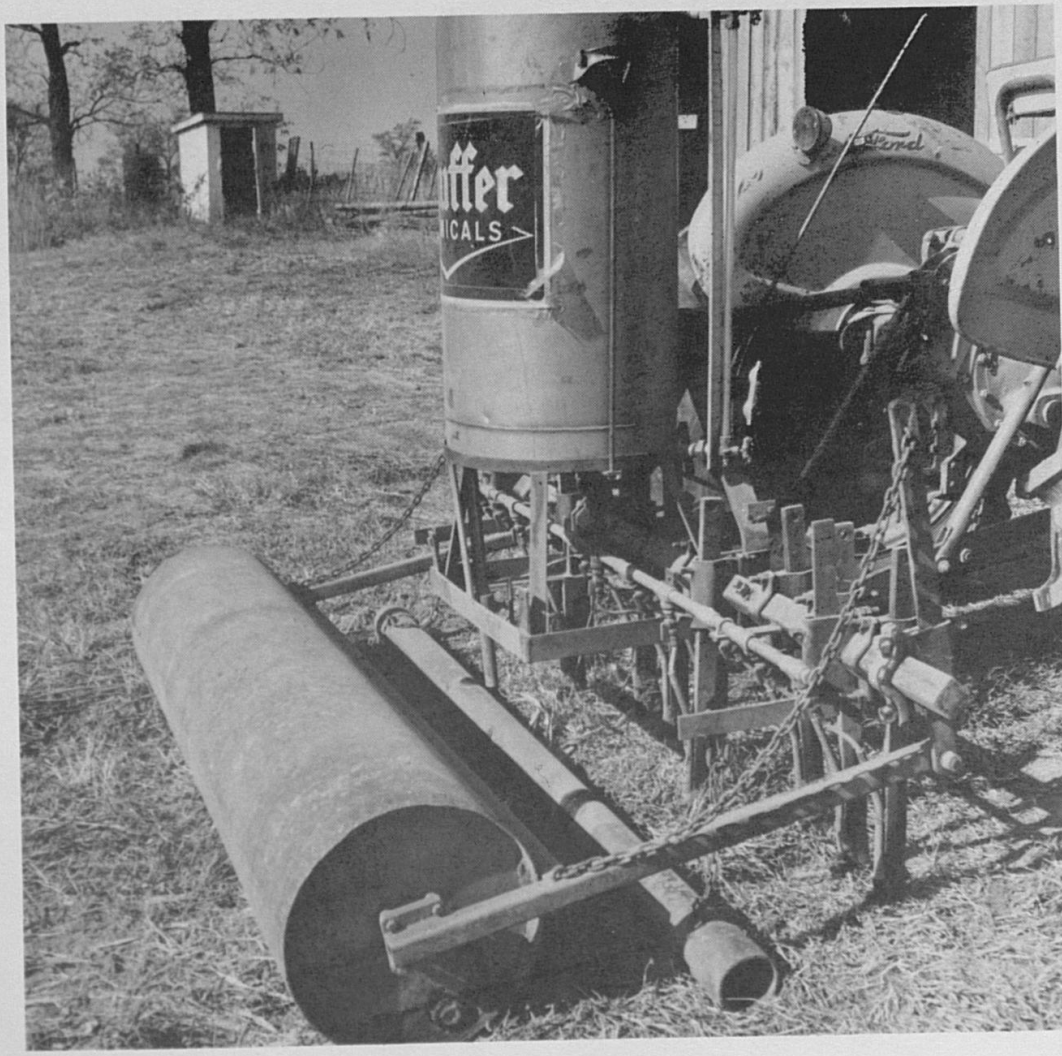

Fig. 3.—Equipment to inject chemicals into the soil is a popular weed-control method. A roller is used to seal the soil following treatment.

Recommended dates for using calcium cyanamid are August 10-October 15. Beds treated with calcium cyanamid should be seeded March 20 to April 1. In case the plants begin to turn yellow, water them heavily. *Do not use nitrogen.*

FERTILIZE FOR VIGOROUS GROWTH OF PLANTS

A tobacco bed 100 feet long and 9 feet wide should have about 30 pounds of a mixed fertilizer such as 4-16-4, 4-12-8, or a similar analysis. For a bed 12 feet wide, apply about 40 pounds of the same fertilizer.

CAUTION: Don't use too much fertilizer. If you use much more than the amounts given above, soluble salts may rise to the top of the soil in dry weather and cause the plants to yellow and die.

The first visible symptom of over-fertilization is the yellowing of the seedlings. You will see a grayish-white substance covering the soil around the yellow plants. Examination of the seedlings will show that their roots are very poor. The roots are so poor that when the plants are touched, they are loosened from the soil.

The only remedy for over-fertilized tobacco plant beds is heavy watering. You should apply about 500 gallons of water per 100 square yards of bed about every 4 or 5 days until the soil, when dry, no longer shows the grayish-white crystals and the tobacco seedlings have established new roots and have started to grow. If the weather continues dry, you must water at least once each week.

Fertilizer injury should not be confused with the yellowing of the seedlings due to nitrogen starvation or manganese toxicity. When the tobacco plants turn yellow during seasonable weather, and if they have a good root system and there is no grayish-white covering of the soil, then this yellowing is probably due to nitrogen starvation. Nitrogen-starved plants should be treated with some form of nitrogen. Dissolve 10 pounds of nitrate of soda or 5 pounds of ammonium nitrate in a 50-gallon barrel of water. Remove the cotton and sprinkle the nitrate solution evenly over the bed, with a sprinkling can, at the rate of 5 gallons to 18 running feet of bed 12 feet wide, or 24 running feet if the width is 9 feet. To prevent burning, follow at once with an equal amount of clear water to rinse the solution off the leaves. If a tobacco plant bed top dresser is used, follow the manufacturer's directions.

SOW THE SEED AS SOON AS WEATHER PERMITS

Sow 2 level teaspoons of cleaned and tested seed to each 100 feet of bed 9 feet wide, or 2½ level teaspoons of seed for each 100 feet of bed 12 feet wide. Seeding may be done as soon as weather permits,

which is usually the last half of February or in March. Seeding should be completed by April 10.

A tobacco seed distributor will do the best job in broadcasting the seed evenly. If you don't have a seed distributor, mix fine sand, screened wood ashes, or a small amount (10 pounds) of commercial fertilizer with the seed. If you use a seed distributor, don't mix the seed with other materials. Going over the bed at least three times helps to evenly distribute the seed if you are sowing by hand. Immediately after seeding, cover the bed with a good grade of tobacco cotton.

BOX THE PLANT BED

Boxing the bed helps control cutworms and fleabeetles. Use 1-by 6-inch material, stretch a good grade of tobacco cotton over the top of the boards, and fasten to the sides. (Fig. 4). If boards are not

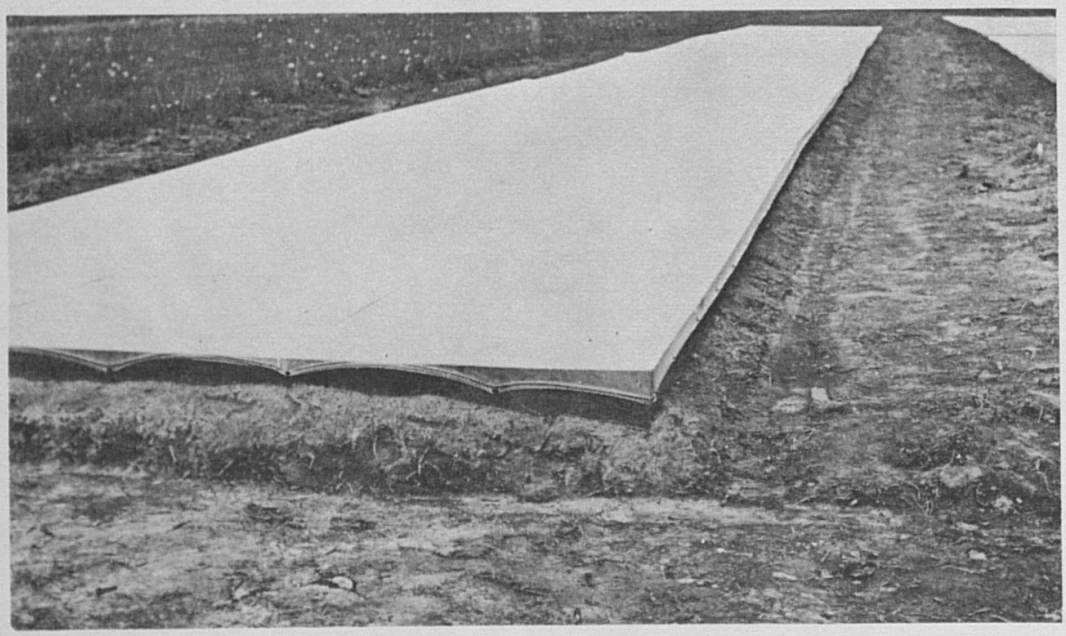

Fig. 4.— Plant bed properly boxed and ditched.

available, use uniform logs. Tall bottles turned upside down and stuck in the soil will keep the cotton off the ground and prolong its life.

IF HEAVY FREEZES OCCUR

Small tobacco plants, while injured by cold weather, are rarely killed unless the soil freezes enough to be honeycombed. Then the plants may be lifted or heaved out of the soil and they will die. If heavy freezes occur, remove the canvas as soon as the soil thaws.

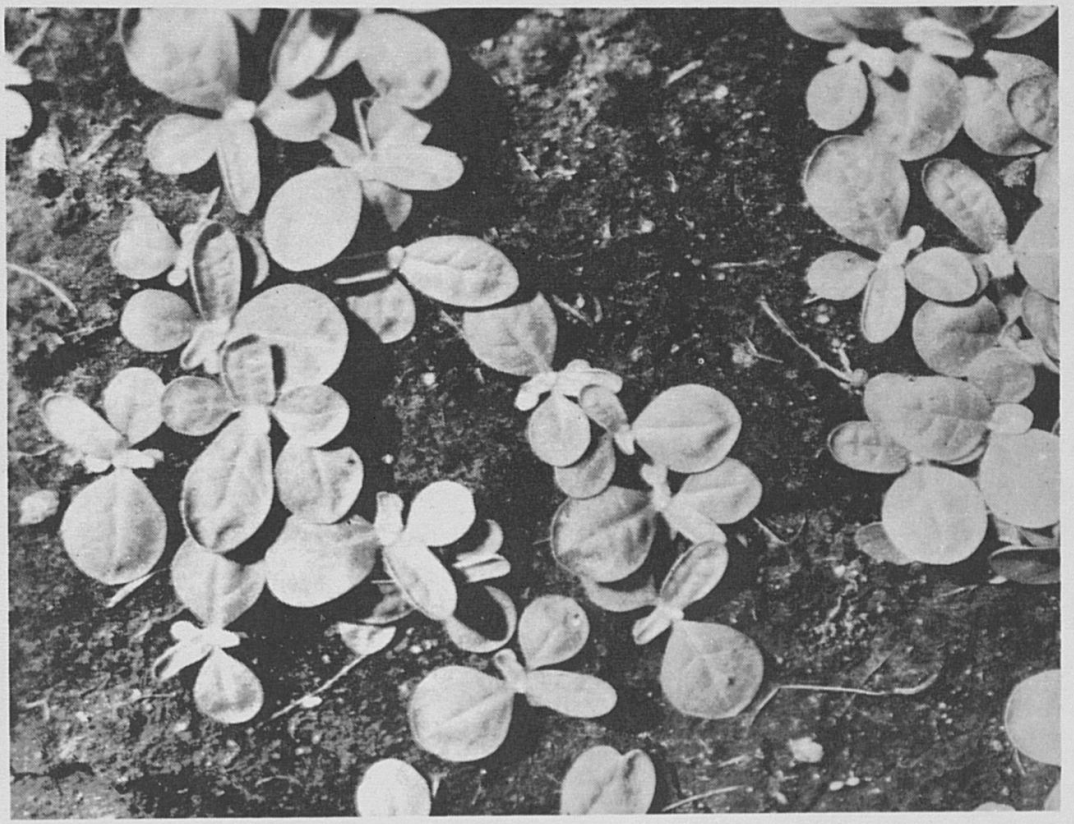

Fig. 5.— Cold injury to tobacco plants in the plant bed.

Tramp or roll the soil, disregard the plants, and then water the bed thoroughly.

Following cold, windy weather most of the plants in the bed may be affected with cold injury. As they develop, the bud leaves of such injured plants are white, and the partially developed leaves are white and smaller than normal (Fig. 5). With warmer weather the affected leaves appear mottled, with somewhat the appearance of milk mosaic.

PLANT DISEASES

Control Blue Mold

Blue mold is not considered a serious yearly threat to tobacco beds in Kentucky. Occasionally blue mold can occur early in the bed season and become a serious threat. If blue mold appears early in your neighborhood, treat the bed with Ferbam or Zineb either as a spray or dust twice a week and after each rain from the time the disease is first reported in the neighborhood until the plants are set. Use 3 tablespoons of Ferbam or 2 of Zineb to 1 gallon of water, and apply 4-6 gallons per 9 x 100 feet of bed. If using dust, apply 2-3 pounds of the proper dilution per 9 x 100 feet of bed. Beds severely injured

with the blue mold should be nitrated to hasten recovery. Removing the cover during the day is helpful.

Danger of Blackleg in Wet Seasons

Blackleg occurs in the plant bed during wet periods when the plants are about ready to be set. Blackleg is a bacterial soft rot attacking leaves that touch the ground and spreading from them into the soft, tender stalk (Fig. 6). The stalk may rot off completely, or the disease may spread up one side, splitting it open. The rotted areas usually turn black. Frequently the plants in an area up to 3 feet in diameter are damaged. Slightly affected plants when set in the field grow normally if set in rather dry soil, but if the setting season is wet, it is not advisable to use plants from an affected bed.

Tobacco Anthracnose Control

Anthracnose in plant beds has caused losses in Kentucky the past few years. The fungus that causes anthracnose is a pathogen of grasses and clovers and is well distributed where tobacco is grown. Anthracnose probably gets in the plant beds by water that flows over the beds from the outside. Plant beds well ditched and raised above the surrounding ground should be safer than beds on the level.

Anthracnose causes numerous small spots on tobacco leaves which at first are reddish brown but later turn papery-white, sometimes giving the plants a silvery appearance. Brown, elongated spots also appear on the undersides of leaf midribs and veins causing the leaf to pucker or break. Several spots on a small leaf often merge into a single dead area, killing the entire leaf. The disease may be unusually severe in wet weather, killing large as well as very small seedlings. If not killed, the plants remain yellow and stunted as long as the disease remains active. Although anthracnose is checked by clear, dry weather, it can remain active in a wide temperature range.

The following recommendations for anthracnose control in plant beds have proved effective:

Spray or dust the beds with a fungicide such as Ferbam, Polyram, or Zineb, starting when the plants are about the size of a dime. Sprays should be applied at about 100 pounds pressure to insure coverage of both sides of the leaves. Dust should be applied with a hand-powered crank duster for good coverage. Plants should be well covered with either the spray or dust. Spray or dust two or three times a week until setting.

The antibiotics, such as streptomycin used for wildfire control, are of no value for anthracnose control.

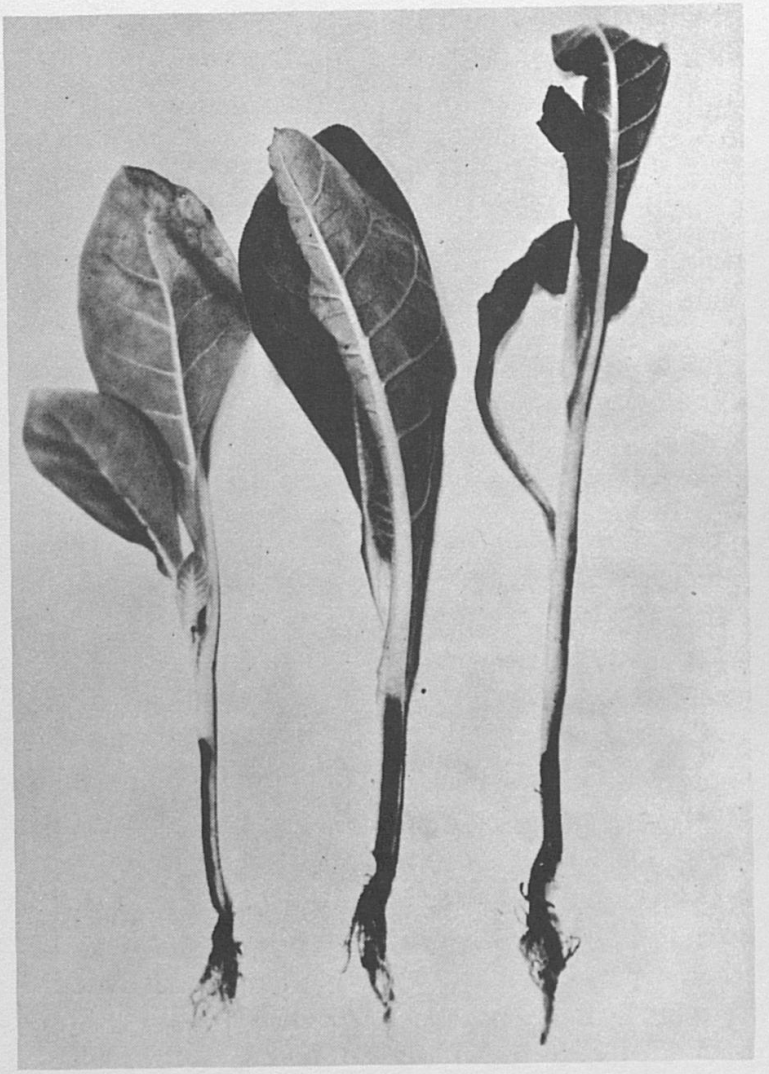

Fig. 6.— Blackleg of tobacco occurs in the plant bed as a soft rot when the plants are about ready to set.

OTHER DANGERS TO PLANT BEDS

Liverwort

Liverwort—a dark green, fleshy, flattened, rosette plant—is now appearing on some tobacco beds which were covered with plastic during the winter (Fig. 7).

It is not known why liverwort appears so abundantly in plant beds which were covered with plastic. Apparently, the plastic provides a favorable environment for the germination of spores and growth of liverwort.

Liverwort can be killed by sprinkling the bed through the cotton with a bluestone-lime mixture (3 pounds bluestone powder, 4 pounds hydrated lime in 50 gallons of water) applied at the rate of 1 quart

per square yard or 50 gallons to 200 feet of bed 9 feet wide or 150 feet of bed 12 feet wide.

Directions for preparing bluestone-lime are as follows: Dissolve 3 pounds of bluestone in a bucket of water. Mix 4 pounds of hydrated lime into a thin paste with water in another bucket, and pour it into the water in a barrel or other container, holding about 46 gallons of water. Then, while stirring vigorously, pour in a copper sulfate solution. The bordeaux may be prepared in a wooden barrel or 60-gallon oil barrel and may be applied to the bed with an ordinary sprinkling can. It is best to wash out the containers before use, so that the sprinkler will not become clogged. The mixture should be stirred every time a portion is removed from the barrel.

Fig. 7.—Liverwort in a tobacco plant bed.

2, 4-D Injury

Tobacco injury from 2, 4-D is common in plant beds. It usually results from the use of a pressure sprayer that has been used in the past for 2, 4-D. Occasional injury is caused by spray drifting across the plant bed or from the ester form volatilizing and drifting onto the bed. Fumes of 2, 4-D have been known to drift from ½ to ¾ mile.

When small plants are sprayed with extremely small amounts of 2, 4-D, the young leaves may grow together giving a vase or cup-like

effect. Older plants may develop thick leaves with prominent midribs (Fig. 8). If injury is relatively slight, the older plants will usually grow out normally when set.

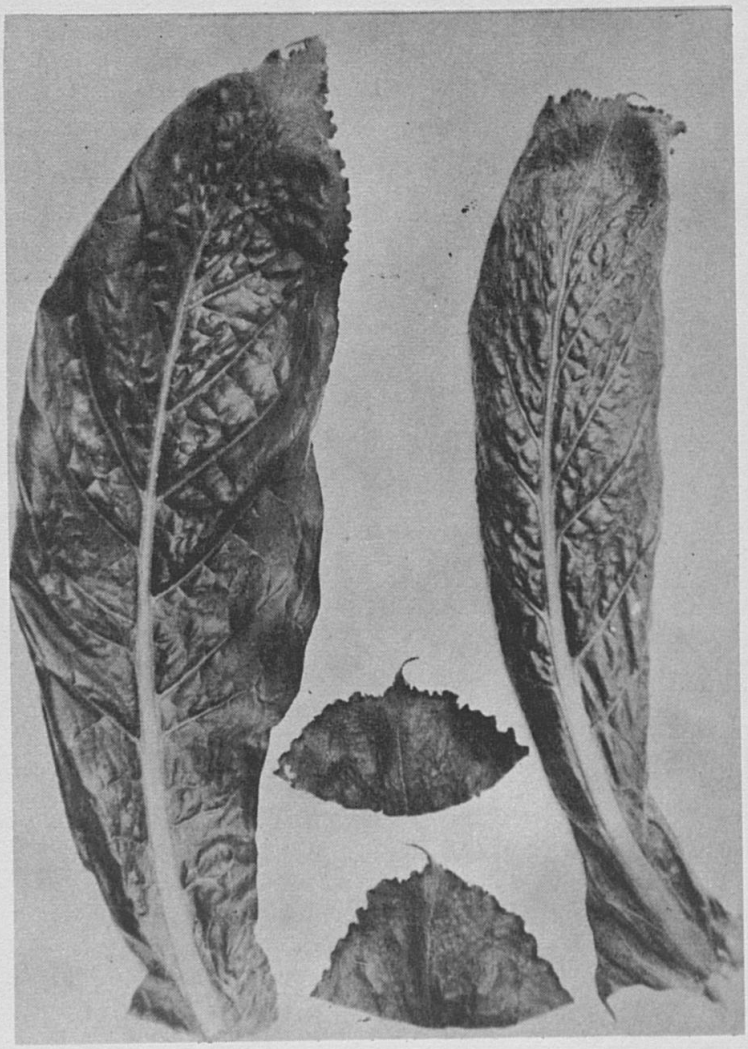

Fig. 8.— Typical 2, 4-D injury on leaves of burley tobacco.

WATER THE PLANTS IN DRY WEATHER

Often droughts occur in Kentucky in the spring. In a dry period, watering is necessary for the production of good plants. The need for water is determined by the type of soil on which the bed is situated, the time the bed was plowed, and the time and method of preparation. It is important to use water before injury starts rather than wait until damage occurs.

Water is necessary for the germination of tobacco seed and for the normal growth and development of plants. Growing plants evapo-

rate large quantities of water from the soil; therefore, in dry weather, beds must be watered for germination and plant growth. Without water, growth will be checked and plants injured or killed in extreme cases. You must start watering early to provide for normal growth and development of strong, thrifty plants (Fig. 9).

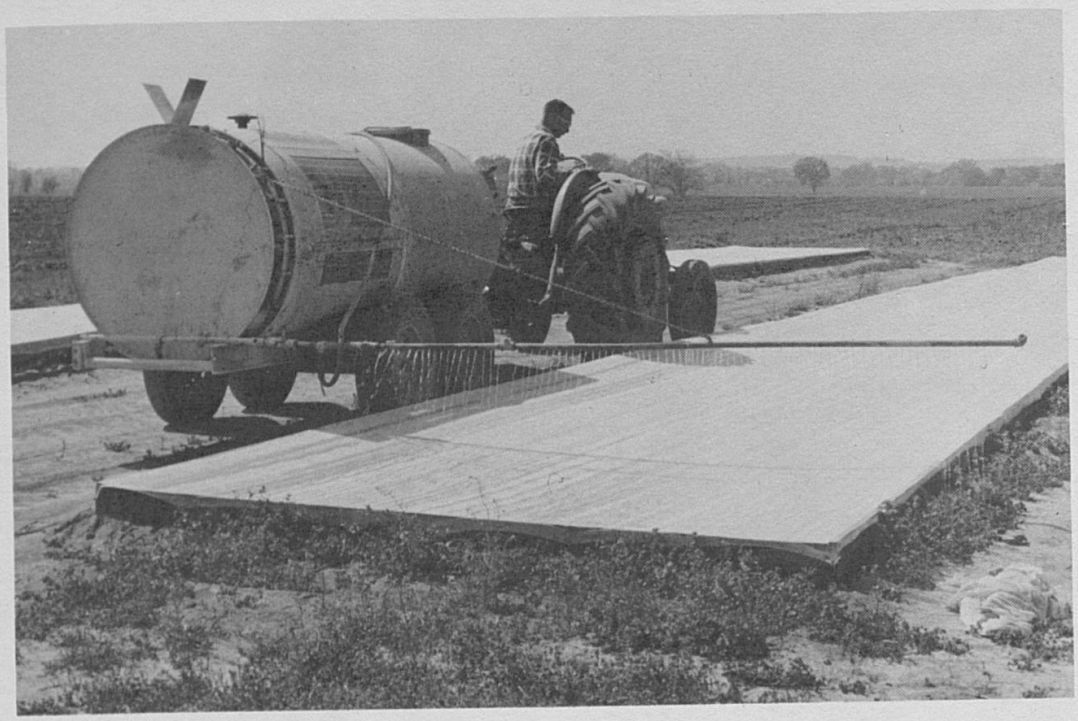

Fig. 9.—Watering plant beds is necessary for the germination of seeds and the growth of young plants.

Thorough watering every 4-5 days is better than a light watering every day or two. A barrel of water to 100 square feet of plant bed provides the equivalent of ¾ inch of rain. To provide an inch of water for a bed 9 feet long, use 1 barrel for each 9 running feet, or 11 barrels for 100 feet; for beds 12 feet wide, use 1 barrel to 7 running feet, or 15 barrels to 100 feet.

Water beds in the afternoon or evening to reduce losses from evaporation and to allow water to soak into the soil overnight. If weather is hot, remove the canvas to prevent scalding of the plants. Be sure to keep canvas on beds in dry weather to reduce water losses from evaporation and to insure continued growth of the plants.

In dry weather during April and early May, small tobacco plants ¼ to 2 inches across often turn yellow and die or when touched, break off at the surface of the ground. Usually the area in the bed where this occurs has a white coating over the surface soil particles made up of salts carried to the surface by evaporating water. These salts

injure the small roots of the plants and prevent growth of new roots from the crown. Such a condition is usually brought about by applying too much fertilizer to the surface of the bed before sowing. If the season is continuously wet, no harm will result, but if the season is dry even for short periods, plants in large areas of the bed may die. Injury similar to over-fertilization sometimes follows the use of calcium cyanamid for weed control.

If too much fertilizer has been used, or if the bed has been treated with calcium cyanamid and the plants are yellowing in a dry period, water the bed heavily to dilute the salts and carry them into the soil.

PLANT BED INSECTS*

Fleabeetles, grubworms (green June beetle larvae), cutworms, and slugs can be destructive to tobacco in plant beds, and control measures may be needed for any or all of these pests. Aphids are not so common as the other pests, but control measures may be necessary in the bed to prevent infestations from being carried into the field.

The first insect usually found in plant beds in the spring is the grubworm. This large white grub overwinters as a nearly full-grown larva several inches below the surface of the plant bed. In the spring, the grubworm tunnels near the surface making small, winding, mole-like runs. Unlike most other white grubs, it feeds mainly on humus and probably does not feed on the roots of the tobacco. Its burrowing damages the plants by uprooting them. Because this insect is attracted to soils rich in manure, plant beds should not be made in areas where large amounts of manure are present nor should manure be added to plant beds. Green June beetle grubs can be distinguished from other white grubs by their distinctive tunnels and their habit of crawling on their backs (Fig. 10).

Small brownish or blackish beetles, called fleabeetles because they hop like fleas, are often serious pests in plant beds and on newly transplanted tobacco. The adult beetles overwinter in trash or debris around tobacco fields and plant beds. They start feeding as soon as the tobacco plants break through the ground and chew small, round holes in the tobacco leaves (Fig. 11). Large populations of these beetles can kill small plants.

Several kinds of cutworms attack tobacco in the beds and in the field. Most of these large, plump, hairless caterpillars feed mainly in the late evening or during the night (Fig. 12). In the daytime, they

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* Richard Thurston, Research Entomologist, cooperating.

Fig. 10. — Green June beetle larvae often destroy plants in the bed. The dark spots are holes from which the worms emerged.

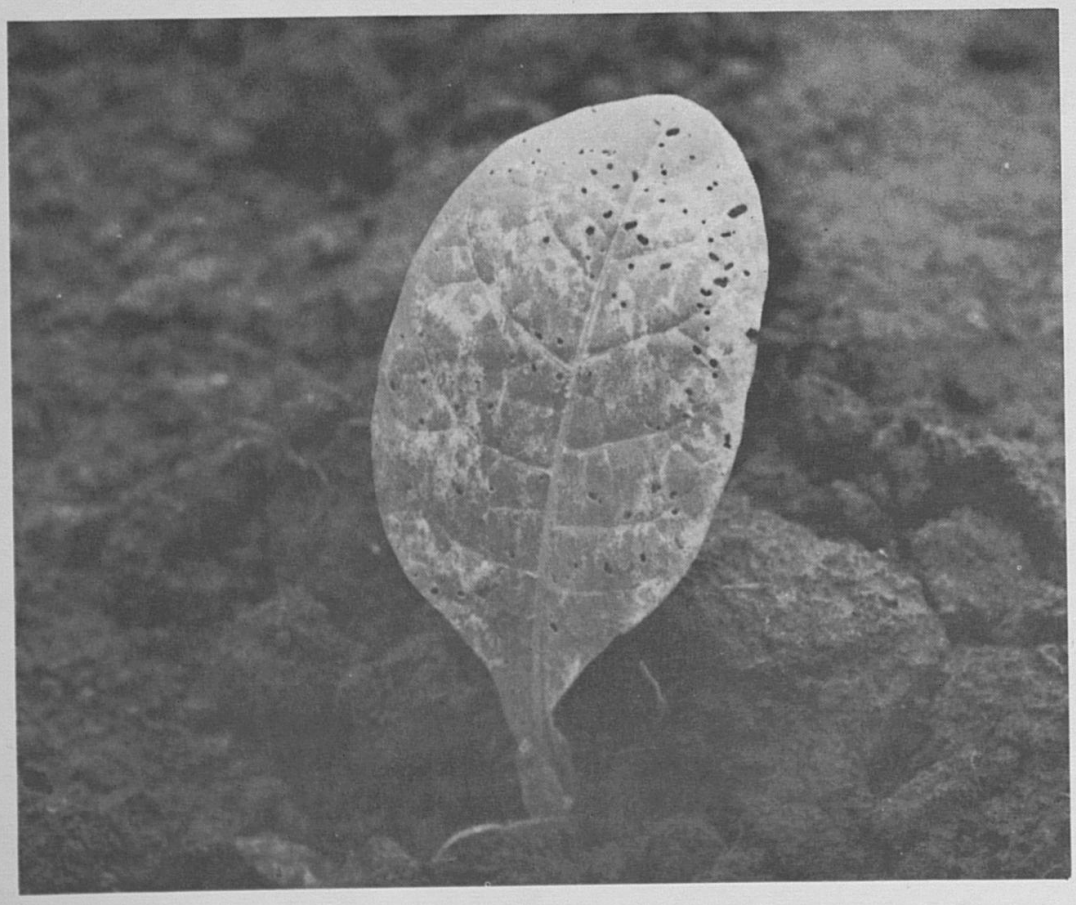

Fig. 11.— Fleabeetle injury in young plants soon after setting.

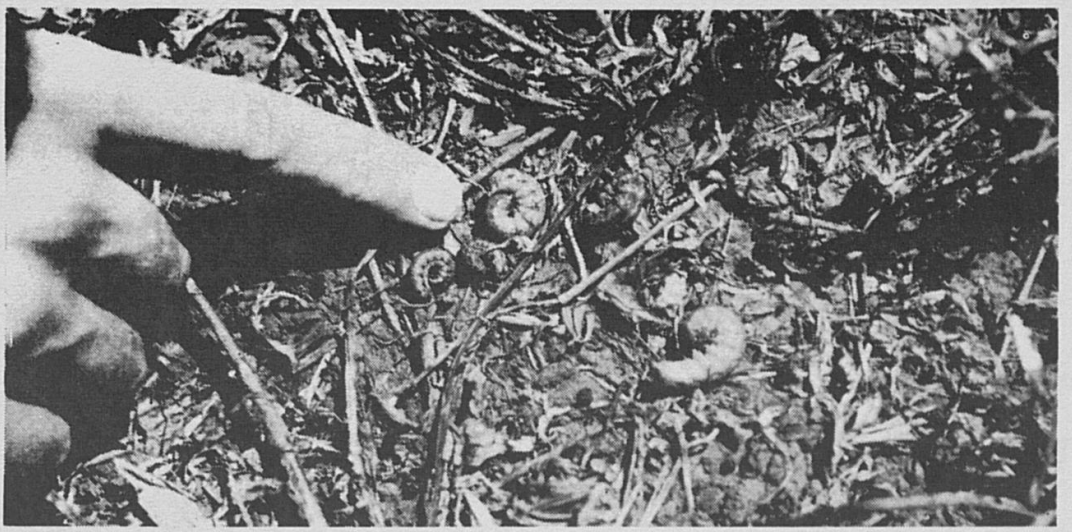

Fig. 12.— Cutworms may move into plant beds from adjacent stubble.

are usually found under debris or clods, or they may be found coiled up in soil an inch or two beneath the surface. Cutworms will chew holes in the leaves, cut off whole leaves, or cut off the tobacco stem close to the ground (Fig. 13). Because they hide in the daytime, cutworms may do a great deal of damage before you notice them unless you check the plant bed every few days.

Although slugs are not insects, they chew large ragged holes in the leaves much like many insects. These pests also do their feeding

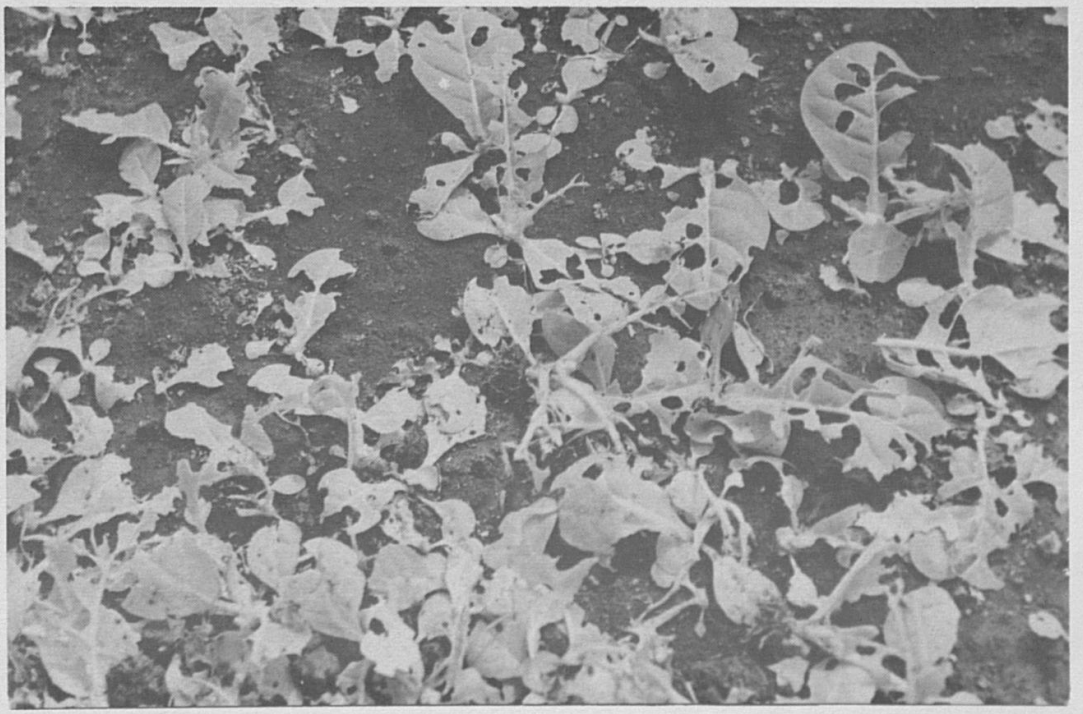

Fig. 13.—Cutworm injury in plant beds.

mainly during the night and are difficult to find during the day since they hide under stones, debris, boards, etc. Often they will hide a considerable distance from the plant bed during the day and migrate to the bed in the evening leaving a slimy, glistening trail on the soil and the plants.

Up to the present, the green peach aphid has not been damaging to tobacco in the bed in Kentucky. But these aphids (plant lice) may be carried from the bed to the field on newly transplanted tobacco, and serious infestations may develop. Aphids will usually be found on the underside of the leaves, inserting their piercing mouth parts into the leaf and sucking out the plant sap. Unlike the chewing insects and slugs, they do not make holes in the leaves. They stunt the plants and make the leaves curl and cup downward along the edges. The wingless aphids do not move about very much but remain on the leaves. These soft-bodied greenish insects are, however, sometimes difficult to find because of their small size (1/16 inch) and because they remain mostly on the underside of the leaves.

In the past few years an increasing number of instances of injury to plants by the application of insecticides has occurred. Most of these have come from the application of emulsion concentrate sprays to young plants or heavy applications of such sprays directly to the growing bud. Only dusts or wettable powder sprays should be used on plant beds or newly set tobacco (Fig. 14). *Do not use emulsion concentrate sprays on small plants.* With any of these

Fig. 14.—Dusting to control insects.

kinds of insecticides, however, the correct rate should be used. An over-dosage could result in burning and killing of the plants.

Publications which give a more complete description of diseases and other insects attacking tobacco in the plant bed are available at your county extension office. Your extension agent can also furnish you with current recommendations on insect control.

SUMMER MANAGEMENT OF PERMANENT PLANT BEDS

When setting is completed, the plant beds should be plowed to destroy the remaining plants. The soil should be thoroughly prepared to provide a good seedbed, and seeded to cowpeas, soybeans, or some other broad-leaved legume to provide a dense covering during the summer. Corn appears to be a very good cover also. Fertilizing the legume ahead of seeding with a mixed fertilizer, containing phosphate and potash coupled with inoculation of the legume seed provides for maximum growth of the crop and reduces the need for using chemical fertilizers on the plant bed in the spring. This program provides for highly fertile soils for growing the plants and prevents fertilizer injury to the young plants. Spring-plowed beds are also certain to be contaminated by the wildfire bacteria unless they are thoroughly steamed or methyl bromide gas has been used.

Permanent plant beds with a heavy growth of summer legume are helpful in controlling weeds, keeping the soil fertile and in good tilth, and in preventing wildfire in the plant bed and in the field.

ROTATION OF PLANT BED SITE

Often on permanent plant bed sites, soybeans are seeded too late to produce sufficient growth or add enough organic matter to maintain good soil structure before time for fall weed control treatment. A better method, particularly on the heavier soils, is to use a 2-year rotation of bed sites. Prepare a new bed site and seed soybeans in early May to take advantage of good early moisture for full growth. Seed the old plant bed site to soybeans as soon as setting is completed. Plow under soybeans on both plant bed sites in August about the time the early soybeans are in full bloom so that they will have time to partially decompose before treating the new bed in late September or early October for weed control. Seed the old bed site to a small grain cover crop. In the spring the small grain cover on the bed site can be plowed at the same time the field is being plowed for the tobacco crop. This bed site is then seeded to soybeans in early May, thus continuing the rotation.

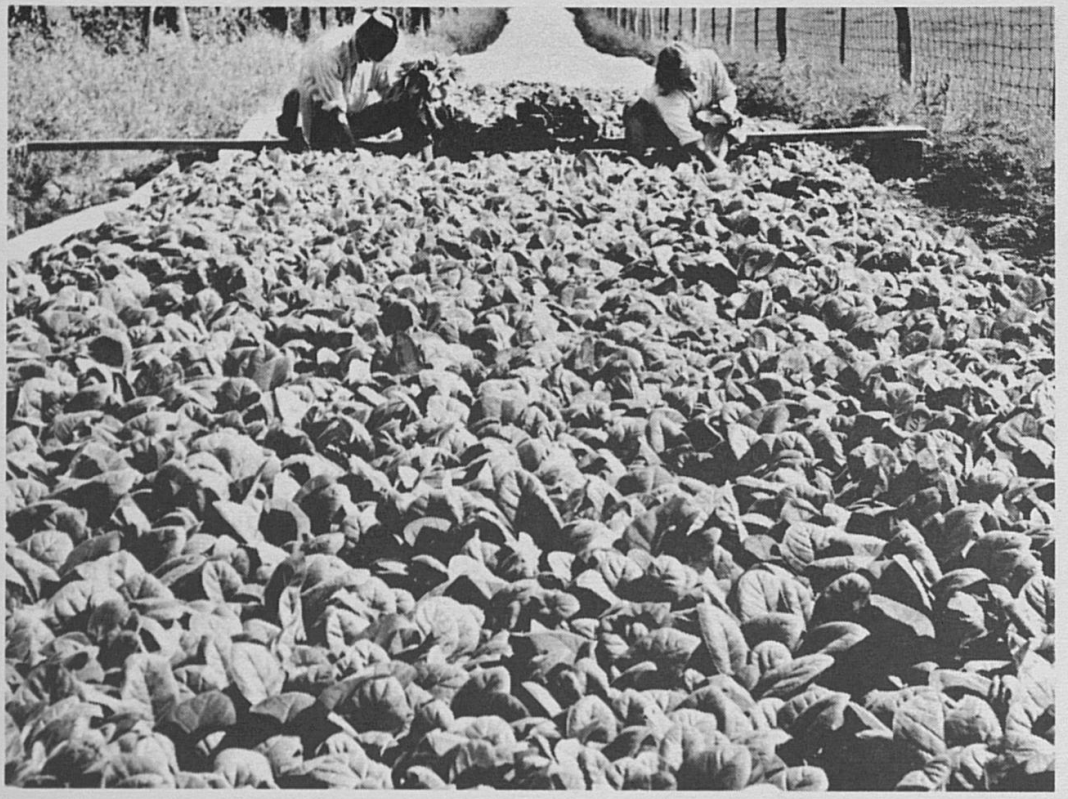

Fig. 15.— With a little effort and proper management, a surplus of strong, sturdy plants can be produced on your farm.

Disease-Resistant Varieties

With more intensive culture of tobacco, particularly frequent use of the same land, tobacco diseases become a serious problem. Black root rot, fusarium wilt, mosaic, wildfire, black shank, and other diseases affect all the old burley varieties. Disease-resistant varieties of burley have been developed that have been helpful in reducing losses from certain diseases but not from all.

Black-root-rot-resistant varieties have helped reduce losses from this destructive disease. However, with the practice of growing several burley crops in succession on the same land, the need for more highly resistant varieties is evident.

VARIETY SELECTION

Selecting a tobacco variety that best meets the needs of your farm is most important. If your present variety is satisfactory in yield and net return, stay with it. A variety that produces a "flashy" crop for one grower may not produce the same kind of crop for you. However, try a stick row test every year with one of the new varieties. Superior

ones may be on the market, so don't wait too long to try a new variety. Information on the newest varieties is available at your county extension office.

Hybrids

The Kentucky Agricultural Experiment Station made male-sterile Burley 21 seed available to seedsmen in 1959. The purpose was to encourage the production of hybrids that carried levels of disease resistance not available in standard varieties. Seed producers have used the male-sterile Burley 21 as the foundation of the present burley hybrid program.

The names of the two parents used in making the hybrid will be the name of the hybrid and will be printed on each package offered for sale. When discussing or listing a hybrid, the female parent should always be first. For example, the hybrid MSB21 x L8 means that MSB21 is the female parent and L8 is the male parent. We have not found any reciprocal differences in any of the burley hybrids. In other words, no differences have been found in yield or quality in MSB21 x L8 or MSL8 x B21.

Most hybrids offered for sale will be half Burley 21. This should improve smoking qualities and acceptance of the leaf. MS Ky 12 x L8 should be more useful than MS B 21 x L8 where black root rot or fusarium wilt is a problem.

A hybrid may carry a lower degree of resistance to a certain disease than the more resistant parent. For example, the Burley 21 x Ky 10 hybrid will have less black root rot resistance than Ky 10 but more than Burley 21.

BLACK SHANK RESISTANCE

If black shank is present, seed the field to a grass and/or legume, clean equipment, and move to a new field. If, however, you are not able to control black shank by crop rotation, you'll have to use one of the resistant varieties.

Two types of black shank are found in Kentucky. Race 0 is the most common, while race 1 is found only on a few farms. Some varieties are resistant to only one race and other resist both types.

Burley 21 x L8, for example, is highly resistant to race 0; however, it has little or no resistance to race 1.

It's no easy job to tell one race from the other. For the first year, the safest plan is to grow a variety moderately resistant to both races, such as Burley 37. However, because other varieties may yield more and are resistant to more diseases, you'll want to try stick rows of these better varieties to see if you have black shank.

If your stick rows of, say, Ky 12 x L8 or Burley 21 x L8, don't become diseased, this means you have the common race. Then, next year you can plant your entire field in one of these hybrids.

If neither the resistant varieties nor the L8 hybrids control the disease, stop using that field for at least 1 year. If you return to that field, plant Burley 37, 11A, or 11B.

The Seed Bed*

A well-fertilized sod of a deep-rooted grass and legume, when turned under, results in an easily crumbled soil readily penetrated by tobacco roots. Such a soil furnishes a large reservoir for water and results in a rapidly growing, early-maturing, highly-yielding tobacco that is highly satisfactory to the manufacturers.

Heavy fertilization of tobacco land year after year has increased income over growing burley tobacco on old, depleted sod land. However, continuous tobacco frequently results in deteriorated soil structure, increased danger of manganese toxicity, and increased losses from such diseases as black root rot and black shank. Long continuous culture of the same land for tobacco tends to lower yields and produce lower quality leaf with harsh smoking characteristics.

You should not contrast yields obtained under continuous culture to those obtained on unfertilized, worn-out sod land. Rather, you should find out what tobacco will do following a well-fertilized sod.

IMPORTANCE OF PHYSICAL PROPERTIES

Fertilizers alone will not insure maximum profits from your tobacco crop. Besides having plenty of available plant nutrients, your soil must have good physical properties if highest returns are to be obtained.

It is desirable that sand, silt, clay and organic particles in your soil be combined into units called aggregates. If these particles remain together when wet, they are said to be water stable and the soil remains porous allowing water and air to move through the soil readily. The grouping of the individual soil particles into aggregates forms secondary soil particles (Fig. 16). If these soil units are not water stable, they separate into individual grains of sand, silt, and clay when wet and appear like the material in Fig. 17. The fine clay and silt particles will seal off the openings to movement of water and air.

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* Harold Miller, Extension Specialist in Soils, cooperating.

Under these conditions much of the water will run off instead of going into the soil to be used by plants.

Most of the dry matter of a plant is made up of three elements—carbon, hydrogen, and oxygen. These elements are obtained from the air and water. The air is taken in through the leaves, but the roots must also have air or the plant will die. The water used by the plants comes from the soil. In the ideal tobacco soil, air and water move readily. When dry, the soil rapidly absorbs water from rainfall. When the soil is saturated, water gradually moves out and lets air enter.

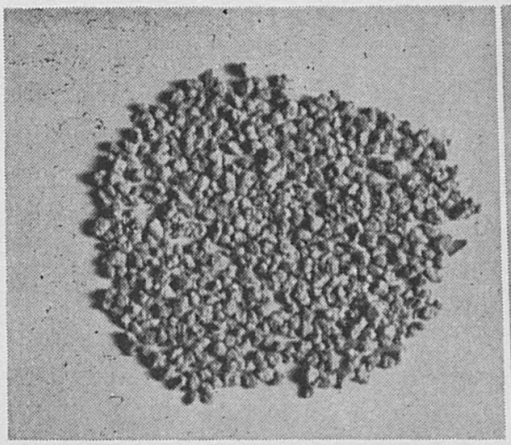

Fig. 16.— Units of soil material consisting of sand, soil, clay and organic particles. These units are called aggregates, and make the soil more permeable to water and air.

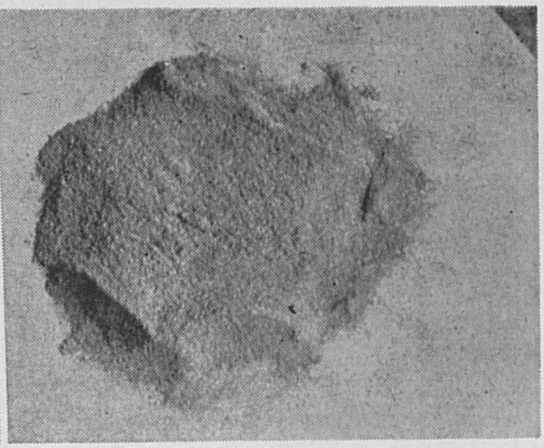

Fig. 17.— Same soil as shown in Fig. 16 with the aggregates broken down into the sand, silt, and clay fractions slows down the movement of water and air in the soil.

HOW TO IMPROVE PHYSICAL CONDITIONS OF YOUR SOIL

Poor soil structure cannot be corrected rapidly. On eroded slopes where the top soil has been lost, many years of costly treatment are required to restore full productivity. More fertilizer is needed on each crop to produce satisfactory yields. All this increases cost of production.

The most practical and economical method of maintaining or improving the physical condition of your soil is to grow good grass-legume sods. The fibrous root system of the grass will permeate the soil thoroughly, while the larger roots of the legume penetrate the soil profile to greater depth. When such sods are plowed under for tobacco, the old root systems die and add organic matter to the soil. The channels left in the soil as these old root systems decay aid in water and air movement during the growth of the tobacco crop. The return of farm manures and crop residues, control of erosion, and

drainage where land tends to be wet help further to improve the physical condition of soils.

Since you can't rapidly improve the physical properties of soil, make your plans for your tobacco field at least 3 or 4 years in advance. Select the area and establish a good grass-legume sod with proper liming and fertilization practices on the pasture and hay crops.

Proper fertilization of the sod will, in addition to improving soil structure, increase the fertility of the soil and provide more feed for livestock. When a dense sod with an extensive root system (Fig. 18) is plowed ahead of tobacco, the soil will take up and hold the water which is so essential to plant growth. Plan for two consecutive tobacco crops and a cover crop before returning it to a meadow field. Tobacco should not follow an unproductive pasture having a restricted root system.

Fig. 18.— A dense grass-legume sod improves physical properties of the soil.

Fertilizing Your Tobacco*

NITROGEN

Need for Nitrogen

Lack of nitrogen reduces the yield and lowers the quality of burley tobacco. However, an oversupply of nitrogen delays maturity and also lowers quality.

A deficiency of nitrogen is first indicated by light green leaves. When the defficiency becomes severe, the lower leaves become a uniform yellow. If the deficiency is not corrected by adding nitrogen

* W. O. Atkinson, Research Specialist.

fertilizer, the yellowing moves progressively up the plant and the lower leaves become nearly white, dry up, and waste away. Cutting such tobacco early to save lower leaves reduces yield and causes the immature leaves to cure red. If you do not cut nitrogen-starved tobacco until the upper leaves are mature, the high-priced lower leaves will be lost unless they are primed.

Amount to Use

Though it is difficult to make specific recommendations for nitrogen applications, we can set up some guideposts on the use of nitrogen for burley.

When good grass and legume sod containing at least 50 percent legumes are turned under for burley tobacco, you can use 75 pounds of nitrogen per acre from commercial fertilizer or manure for satisfactory yields. As the proportion of grass to legume in the sod increases, you will need to increase the application of nitrogen. You may need 125 pounds of nitrogen per acre where the growth of grass is still good but where no legumes have been in the sod for several years. However, where a good stand of grass has been maintained for 6 to 10 years or more—even though the legumes have largely disappeared—not over 75 pounds of nitrogen would be necessary per acre. Where the pasture growth is mainly broad-leaved weeds, broom sedge, and cheat, or where vegetation has repeatedly been eaten down to ground level, you may need 130-150 pounds of nitrogen per acre for good production. Under general farming conditions, burley tobacco should not be produced on land so low in fertility as to require the addition of more than 150 pounds of nitrogen per acre. Such land should be brought into a good state of productivity through cropping to grass and legumes with proper fertilization and liming before it is used for burley.

Sources of Nitrogen

Experiments with sources and amounts of nitrogen show that, while there are several good sources of nitrogen for burley, the amount is more important than the form in which it is applied. When properly used, nitrogen from any of the common fertilizers, farm manure, or legumes is satisfactory.

PHOSPHORUS

Need for Phosphorus

A deficiency of phosphorus produces a poor quality burley. In the field, phosphorus deficiency in the tobacco plant is characterized by slow growth, narrow leaves, increased space between the leaves

on the stalk, and delayed maturity. In cured tobacco, phosphorus deficiency is reflected in low quality and a corresponding smaller percentage of tobacco that can be used in the manufacture of cigarettes.

Practically all land in Kentucky outside the Bluegrass Region needs fertilizer containing phosphorus for tobacco production. In the Bluegrass Region most of the soils are medium to high in phosphate. On soils testing high in phosphorus, you will not need phosphate fertilizers for tobacco, but phosphate probably will pay on the medium-phosphate soils and will always pay on the low-phosphate soils. Soils that are high, medium, and low in phosphorus may exist on the same farm and can be detected only by a soil test. Relative to crop needs, phosphorus is the cheapest of the three major fertilizer materials and should be applied liberally for burley unless soil tests indicate that adequate amounts of available phosphorus are present. When there is sufficient phosphorus in the soil, additional amounts do not affect yield or quality.

All of the phosphorus applied for a tobacco crop will not be taken up by the crop; some of it will be fixed in the soil and become unavailable for immediate use. The amount that is fixed will vary with different soils. Some of the phosphorus will be used by soil organisms in breaking down the organic matter turned under and will be temporarily unavailable; some will become available for future crops. The amount removed by tobacco is relatively small in comparison with the amount added to the soil. However, it is necessary to have a large supply available in the soil in order that the tobacco crop can obtain the phosphorus it needs during its relatively short growing period.

Chemical tests[1] on soil samples properly taken from fields to be used for growing burley tobacco furnish valuable information on soil phosphorus content and the possible need for this nutrient.

Amount to Use

When you grow burley in a rotation, apply phosphorus in accordance with soil needs as indicated by the soil test and the cropping and fertilizing history of the field. The amount of phosphate fertilizer recommended for some typical soil test situations and materials from which phosphate may be obtained for the immediate crop are given in Table 1.

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[1] For a nominal charge, these tests will be made (also tests for potassium and lime needs) in your county soil testing laboratory or, if your county does not have one, at the Kentucky Agricultural Experiment Station, Lexington. Your area extension agent can supply you with instructions for taking soil samples.

Table 1.—Materials That May Be Used to Supply Needed Phosphorus*

Soil Test for Phosphorus	Pounds per Acre Needed		Pounds per Acre of Superphosphate to Use		Pounds per Acre** of Mixed Fertilizer
	P_2O_5	P***	20%	45%	5-10-15
Low range	200-300	88-132	750-1000	333-444	1500-2000
Medium range	100-200	44-88	625-750	277-333	1250-1500
High range	0-100	0-44	0-500	0-222	0-1000

* Where manure is used on tobacco land, assume 5 pounds of phosphoric acid (P_2O_5) per ton available to the tobacco crop. The phosphorus needs can be reduced by this much per ton of manure applied.

** Potash in mixed fertilizer for tobacco to be in the sulfate form.

*** P_2O_5 is converted to P by multiplying the P_2O_5 figure by 0.44.

Use of Rock Phosphate

Experimental work indicates that you can supply the phosphorus needs of burley tobacco through the use of rock phosphate, provided it is properly used. Rock phosphate when used alone to supply the phosphorus for a burley tobacco crop should be applied at least 2 years ahead of the tobacco. If you apply it the same year that tobacco is to be grown, enough superphosphate should be used to supply the phosphorus for that crop. Rock phosphate applied just ahead of a tobacco crop will be of little, or no, value to the tobacco crop the year in which it was applied. However, the succeeding crops in the rotation will benefit from it as it slowly becomes available. Rock phosphate, to be fully effective, should be used in amounts to provide about three times as much phosphorus as would be contained in superphosphate or other manufactured phosphorus-containing materials. Repeat the treatment at 4- to 6-year intervals.

Remember, phosphorus in rock phosphate becomes available more rapidly in soils that are moderately acid than in slightly acid or neutral soils.

For more information on the use of rock phosphate, see your area extension agent.

POTASSIUM

Need for Potassium

Lack of potassium is a common cause of low quality tobacco. A deficiency of this element causes the leaves to become distorted or puckered between the veins, the edges to curl under, and a bronze yellow color to appear at the tip and forward edges of the leaves. As the deficiency becomes more severe, the yellowing spreads, and parts of the yellowed area may die and fall out. Cured leaves from plants deficient in potassium are heavy, dark, lack finish and elasticity, and may have a stubby appearance owing to the tips of affected leaves having fallen off in the field. All leaves on the plant may grade

Fig. 19.—Potassium deficiency in burley tobacco.

red. A good supply of potassium imparts general vigor to the plant and improves the burning quality and finish of the leaf. By the time the burley plant shows potassium deficiency the quality of the plant has already been lowered.

Amount to Use

Apply potassium for burley tobacco unless it is known that the crop will not respond. The amount to apply will vary with past cropping and fertilizer practices. A soil test is essential for determining the amount of potassium a soil needs. Additional potassium may not increase the yield but may increase the value of the tobacco by many dollars per acre owing to improved quality. The amount of potassium expressed as potash (K_2O) needed to obtain the necessary potassium will vary from 125 pounds on soils testing high to 300 pounds per acre on soils that test low in potassium. The amounts of potash recommended for some typical soil test situations and the fertilizer materials from which these amounts may be obtained are given in Table 2.

Table 2.—Materials That May Be Used to Supply Needed Potassium*

Soil Test for Potassium	Pounds per Acre Needed		Pounds per Acre of Potash from:	
	K_2O	K	50% K_2O	5-10-15
Low range	225-300	187-249**	400-600	1333-2000
Medium range	175-225	145-187	350-400	1170-1333
High range	125-175	104-145	250-350	834-1170

* Where manure is applied on tobacco land, assume that 10 pounds of K_2O per ton is available to the tobacco crop.

** K_2O is converted to K by multiplying the K_2O figure by 0.83.

Use of Muriate of Potash

Potassium chloride (muriate of potash) is not recommended for use on burley tobacco. However, where tobacco is grown in rotation with grass and legume sods, you can fertilize the sods with the less expensive muriate form. Do not use muriate of potash on land during the late summer or fall preceding the burley crop.

Burley tobacco that contains excessive amounts of chlorine is very difficult to dry once it has come into case, and when used in manufacturing it produces a harsh smoke.

MANURE

Animal manure is a good source of plant nutrients and is a valuable fertilizer for burley tobacco. The composition of manure varies greatly because of the kind of care used in its storage, the type or age of animal, and kind and amounts of feed. It is not practical to obtain an analysis of manure used on each farm, but averages for many samples can be used as an aid in determining the nutrient content. When good management practices are followed, each ton of manure can be considered to add 6 pounds nitrogen, 5 pounds P_2O_5, and 10 pounds K_2O per acre that will be available for crop use the first year of application. Appreciable amounts of calcium, magnesium, and many micronutrients also are found in manure.

Fig. 20. – Spreading manure on a cover crop before plowing is a recommended practice.

Manure contains about 4 pounds of chlorine per ton. Excessive chlorine in tobacco, as already mentioned, causes sogginess and poor quality in the finished product. For this reason, do not use more than 10-12 tons of manure per acre in fertilizing burley tobacco.

TOBACCO STALKS AND STEMS

Recent experiments have shown that present high yields of burley tobacco produce at least 2,000 pounds of stalks per acre. This means that Kentucky farmers have about 200,000 tons of burley stalks each year to dispose of after stripping is completed. Tobacco stems also are available in limited quantities where tobacco redryers are located. Both tobacco stalks and stems are good sources of nutrients for plant growth (Table 3) and may be used for fertilizing burley tobacco provided the following precautions are observed:

1. Do not use tobacco stems for fertilizing tobacco unless they have been sterilized at the redryer.
2. If a mosiac-susceptible variety of tobacco has been grown, do not use stalks from that crop on tobacco beds or fields.
3. Do not use stalks from black-shank-infested fields on tobacco land; you may use them on other field crops and pasture land provided water from these fields does not drain into tobacco land.

Table 3.—The Average Amounts of Available Nutrients in Burley Tobacco Stalks and Stems That Are Available the First Year of Application.

	Pounds Available per Ton				
Material	Nitrogen	P_2O_5	K_2O	Calcium	Magnesium
Stalks	30	10	70	15	3
Stems	25	10	140	60	6

USE OF FERTILIZER ON LAND USED MORE THAN 1 YEAR FOR TOBACCO

It is not a desirable practice, but when you must use land for burley production for several years in succession you need to modify your fertilizer practices.

Nitrogen

When you grow burley tobacco on the same ground year after year with a small grain cover crop but with no manure or tobacco stalks, an application of 110-130 pounds of nitrogen per acre should be sufficient. If the cover crop is small grain and a winter legume (vetch or crimson clover), the legume may add 40-60 pounds of nitrogen per acre. The fertilizer nitrogen application can be reduced by this amount. *For example:*

Cover Crop	Pounds of Nitrogen Needed per Acre	Nitrogen Could Be Supplied From Approximately
Small grain	100	300 lb ammonium nitrate or 10 tons of manure + 40 lb of nitrogen from straight materials or 2000 lb of either a 5-10-10 or 5-10-15 or 1700 lb of a 6-6-18 fertilizer.
Small grain and winter legume	50	150 lb ammonium nitrate or 8 tons of manure or 1000 lb of either a 5-10-10 or 5-10-15 or 850 lb of a 6-6-18 fertilizer.

If the land has been used for several years for burley and has been liberally supplied with manure, tobacco stalks, and commercial fertilizer there has been an accumulation of easily nitrifiable material, and the amount of nitrogen added can be reduced. Since there is no satisfactory soil test that you can use for determining the amount of nitrogen that will be available for your tobacco crop, you must decide for yourself the amount of nitrogen to use. This decision should be influenced by the past treatment of the soil, the appearance of the cover crop at the time of plowing-under, past response of the crop to nitrogen, and how the crop ripened the previous season. If the crop ripened quickly after topping and made good tan leaf, the nitrogen supply was at the proper level. If the crop ripened very slowly and was predominantly heavy red tobacco, there was too much nitrogen. If the growth of the cover is lush and a deep green, the land will need only moderate amounts (not over 50 pounds of nitrogen per acre).

Apply nitrogen fertilizers to the cover crop just before turning it under. If you apply nitrogen earlier in the spring a heavy growth of small grain is produced, but some of the nitrogen is tied up in the cover crop. This nitrogen will not become available to the tobacco crop until the small grain is decomposed. This may be late in the season when a large supply of nitrogen is undesirable.

If you use manure as the source of nitrogen, it is best to apply it just ahead of plowing; however, this is not always possible as it may be necessary to make applications several times during the winter. If so, it would be better to make a light application over the entire field each time rather than heavy applications over a portion of the field. The latter practice could result in a very uneven growth of the small grain and thus part of the cover crop would be ready to be turned under before the other parts were ready.

Where a winter legume is used, the early application of nitrogen to the cover crop is likely to stimulate the growth of the small grain to the extent of smothering out the legume; also, the rank growth of

the small grain may set up ideal conditions for the development of diseases which destroy the legumes. The amount of nitrogen fixed by the legume in the cover crop from the atmosphere will be reduced. The time to apply phosphorus and potassium is not so critical as for nitrogen.

Phosphorus

For the first crop, phosphorus additions would be in accordance with recommendations based on a soil test and the past cropping and fertilizing history. If the soil for the first year of burley production tests low in phosphorus, the application should be 200-300 pounds of P_2O_5 per acre. The second year an application of 100 pounds P_2O_5 per acre should be adequate. Each year thereafter the application should be about 100 pounds P_2O_5 per acre. On soil that tests medium, an application of 100-200 pounds P_2O_5 should be made for the first crop. An application of 60-80 pounds P_2O_5 per acre should be made the second year and each year thereafter until the soil tests high in phosphorus.

Potassium

Make the first application of potash on the same basis as for the treatment of land in a rotation, i.e., if the soil tests low, 225-300 pounds of potash (K_2O) per acre; if medium, 175-225 pounds; if high, 125-175 pounds. During the second year of burley the treatment should be at about the same rate or possibly more, depending on the original level of potassium and the growth of the crop the previous season. In order to determine the available potassium supply, test your soil at least every other year. As available potash accumulates in the soil, you can reduce the amount supplied by commercial fertilizers and manure.

EFFECT OF NITROGEN FERTILIZATION ON CULTURAL PRACTICES

The handling of burley from topping through the curing of the crop is not, strictly speaking, a part of fertilization; however, the burley tobacco fertilization program on the farm establishes the details of the cultural practices that should be followed. When excessive nitrogen has been applied, the crop must remain in the field longer to allow it to ripen. Cutting such tobacco green to save the bottom leaves will produce a few good leaves on the bottom of the plant, but the remainder of the leaves will be immature and of less value to the manufacturer. Where excessive nitrogen has been used it may be necessary to prime the lower leaves if they begin to "lose." If the bottom leaves continue to waste while the upper part of the plant

is still green, a second priming may be necessary. A proper supply of nitrogen aids in retaining the bottom leaves.

The burley grower should keep in mind that ripe tobacco is a necessity if a thriving burley industry is to be maintained. The ripeness of the crop should determine the proper cutting date. Under any fertilization system, do not top your burley tobacco until at least three-fourths of the plants are in bloom. Then top all the plants at one time. By topping all the plants at this time, you will obtain a more uniform ripening of the crop. You will also save labor since only one trip over the field is required for topping the crop. After topping, hold suckering to a minimum. Whenever it becomes necessary for you to sucker to prevent damage, leave the top sucker or two top suckers, thus retarding additional growth and nicotine production.

USE OF MIXED FERTILIZERS

When nitrogen, phosphorus, and potassium are needed, use a mixed fertilizer which contains all three. In determining the amount to use, estimate how much of each of these three plant nutrients is needed; then from the grades available select a fertilizer and a rate of application that will most nearly provide the nitrogen, phosphate, and potash desired.

Do not use mixed fertilizer high in phosphate and low in nitrogen and potash on medium-to-high phosphate soils because crop response on such soils will come almost entirely from nitrogen and potassium.

When using mixed fertilizers it is not always possible to obtain a mixture that will exactly fit your soil needs. In making the final selection, remember that if your soil is deficient in phosphorus or potassium you cannot produce a rapidly growing crop of high quality tobacco. If nitrogen is deficient the yield will be reduced, while an over-supply may be injurious to quality.

When you have determined the proper amount of fertilizer to give the needed nitrogen and this amount of fertilizer does not provide the necessary phosphate or potash, you can supply the shortage by the use of superphosphate or sulfate of potash. On the other hand, when you have calculated the proper amount of fertilizer necessary to supply the nitrogen and more phosphate or potash than was figured as necessary is included, the excess will not be harmful to your crop. In like manner, if the fertilizer is calculated to give the proper amount of phosphate and potash but does not give sufficient nitrogen, you can obtain the additional nitrogen from straight materials or from manure.

APPLYING FERTILIZERS

The two general methods of applying fertilizer are row and broadcast application. Each has a place in the fertilization of burley tobacco. Regardless of the method you use, put the fertilizer deep enough so that it will be in moist soil during dry periods and, hence, available to the plants. When applied along the row it should be close enough to the plants so that it will not be disturbed by later cultivation, yet not be directly in contact with the newly set plants.

Row Application

On productive land where small-to-moderate applications of fertilizers are used (less than 500 pounds per acre of mixed fertilizer), all may be applied along the row at or near the time the plants are set. On less productive land when larger amounts of fertilizer are used it may pay you to apply up to 500 pounds per acre along the row and the remainder broadcast. On soils of low productivity this amount of fertilizer along the row may aid in promoting rapid early growth of the plant; however, on such soils don't expect this amount to furnish the crop with sufficient nutrients during the later part of the growing season. Plant nutrients, particularly phosphorus, will be more effective on the immediate crop if you apply them at the row rather than broadcast.

Broadcast Application

When more than 500 pounds of commercial fertilizer is applied per acre, (see row application above) all or part should be applied broadcast, particularly for a more even effect on succeeding crops. On highly productive land you may apply all the fertilizer broadcast. Fertilizer applied broadcast may be plowed under with the sod if the plowing is done after the first of April or it may be disked or drilled in deep after plowing. However, even when carefully done, disking does not cut fertilizer into the soil to a depth of more than 3 inches. In dry years, this may not be deep enough for the plants to obtain full benefit from the fertilizer. When used alone, nitrogen is probably best applied broadcast and plowed under if the plowing is done after the first of April.

Sidedressing with Fertilizer

If nitrogen or potassium deficiency symptoms appear early in the growing plants, sidedressing with nitrogen or potash fertilizer gives good results. However, it is much more desirable to fertilize properly before setting since in topdressing considerable care must be taken

to keep the fertilizer off the plants. When the plants are not too large the fertilizer may be drilled on both sides of the row.

In sidedressing with nitrogen, the more common practice is to broadcast the fertilizer between the rows and work it into the soil by cultivation. Nitrogen is very effective when applied in this way. When sidedressing with nitrogen, however, be careful not to apply over 20-30 pounds actual nitrogen per acre, particularly when applied after the plants have made half their growth. Do not apply *additional nitrogen until there is evidence of nitrogen deficiency.* Even though the crop starts off slowly, it is not advisable to apply nitrogen as a sidedressing unless the tobacco shows definite nitrogen starvation. Slow growth, particularly early in the season, often is due to causes other than lack of nitrogen.

Potassium is so important to the quality of the burley tobacco crop that it also may be profitably applied to potassium-starved tobacco. Apply potash at any time from the time of setting until the crop is too large for cultivation. However, potash is much more effective when applied before or at setting. When sidedressing with potash, use 100-150 pounds per acre of actual potash. Potash is difficult to apply at the depth desired and to obtain thorough mixing with the soil. To attempt deep placement and good mixing after the plants are 12 inches or more tall would cause considerable root injury and further retard growth of the plants.

Sidedressing with phosphate for burley ordinarily is not effective enough to be practical.

MANGANESE TOXICITY

Manganese toxicity appears first as a light green or yellowish coloring between the larger veins of the leaf with, in some cases, a gradual development of numerous dead spots. The symptoms usually appear first in the growing points of young tobacco leaves. In many cases of manganese toxicity, the plants lose their toxic symptoms with good growing weather and then appear normal. Quality, however, may be lowered and the leaf will contain abnormal amounts of manganese. Liming with agricultural limestone at the rate of 1 to 2 tons per acre on the basis of a soil test after the tobacco crop usually prevents recurrence of the toxicity the following year in all but severe cases.

The development of soluble manganese in toxic amounts in the soil is usually due to an increase in soil acidity to the point that the soil tests strongly acid and also to poor soil structure. If manganese toxicity has become a problem, it would be better for you to lime

Fig. 21.– Manganese toxicity in burley tobacco.

the land properly following the tobacco crop and seed it to a grass-legume mixture for a few years rather than to attempt to crop it to burley tobacco continuously. Liming will reduce the available manganese, and the sod will improve soil structure so that within a few years the soil will be in better shape to produce good burley.

DON'T OVER-LIME

Excessive liming will reduce the availability of both phosphorus and potassium and most of the trace elements. Tobacco produced on such soil cures with the general characteristics of potassium-deficient leaf though it may not have shown bronzing of the leaves in the field. Potash fertilization that is adequate for normal-limed soil would be inadequate on over-limed soil.

Heavy liming may reduce soil acidity to a point where the minor nutrients that otherwise would be in good supply are changed to forms that cannot be used by the tobacco plant. Land where tobacco

is grown in rotation should receive only the amount of lime necessary for the legumes in the rotation, usually 1 to 2 tons per acre every 3 to 4 years, and this should follow the tobacco.

On soils that are moderately to strongly acid it may be necessary to apply 2 or more tons of agricultural limestone per acre in order to establish a good stand of grass and legumes to build the land for tobacco. Once the proper initial liming has been made, based on a soil test, and the rotation established, liming as indicated in the paragraph above should be sufficient.

Land in continuous tobacco culture should be moderately acid and should be limed as necessary to keep it from becoming strongly acid. Usually a fall application of 1-2 tons every 3 to 4 years should do this. Not only is liming necessary for satisfactory growth of the cover crops, but tobacco may be severely injured by large amounts of soluble manganese and aluminum in strongly acid soils.

Fig. 22. – A good method of spreading limestone evenly.

FOLLOW TOBACCO WITH A COVER CROP

Considerable soluble nitrogen (50-100 pounds per acre) forms in the soil during the fall after tobacco is harvested. Soluble nitrogen does not leach from most Kentucky soils during the summer but does leach out in most winters. Therefore, follow tobacco by a cover crop to prevent this leaching and to reduce soil erosion.

Use a cover crop of small grain or of small grain and winter legume.

On rolling-to-hilly land to prevent soil erosion it is very important that you use a small grain and that it be seeded rather heavily. The greater the slope, the heavier the seeding of small grain should be. When the small grain is seeded heavily in order to control erosion, you may use a winter legume with it, but the legume may not make enough growth to be profitable.

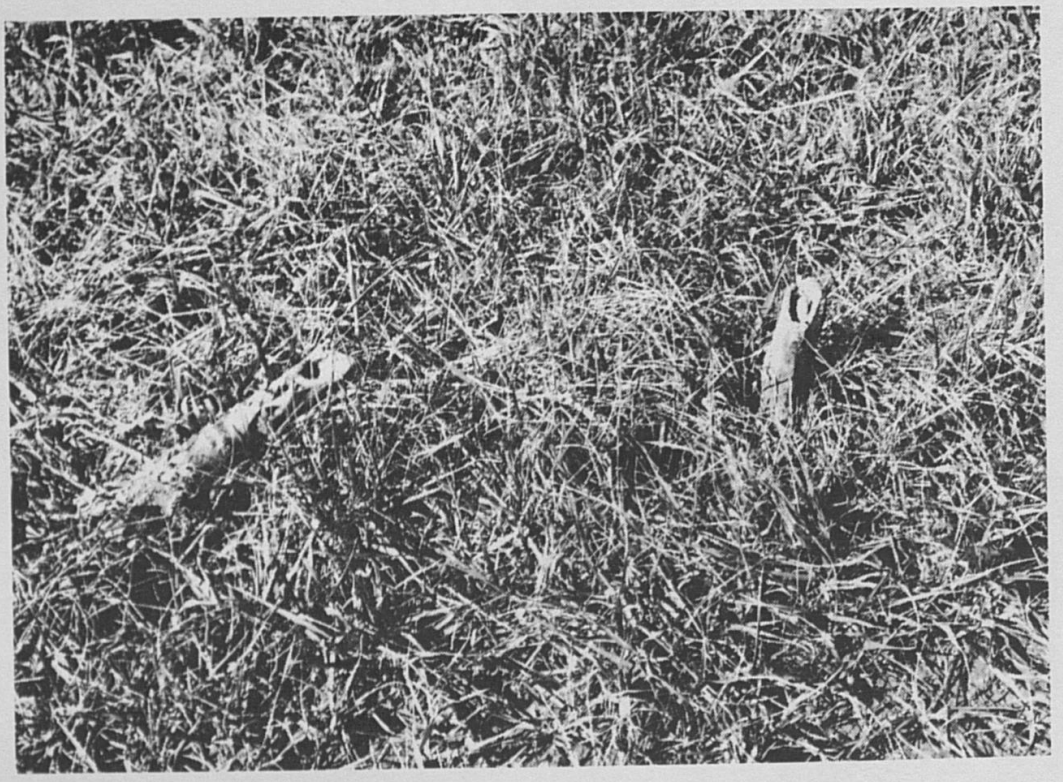

Fig. 23.— A good cover crop aids in maintaining soil structure and preventing soil erosion.

The kind of small grain you use will depend on which one best suits the overall farm plan for the crop—i.e., whether it is to be pastured and then turned under for green manure or to be turned under without pasturing or to be harvested for grain. Balboa rye is probably the most dependable small grain cover crop. Wheat and barley are good. However, barley requires a more fertile soil and an earlier planting date than rye or wheat and it is subject to severe winter damage in some years. Regardless of which small grain is used and whether pastured or not, the crop, if it is to be plowed under for tobacco, should be turned under by the time the small grain is 18-20 inches high. At this height, the small grain has its highest concentration of nitrogen; further growth merely adds strawy material which rots slowly. The rotting of such strawy material ties up much

more soil nitrogen than does the rotting of material turned at 18-20 inches; as a result, the amount of nitrogen available for the burley crop is reduced. Additional nitrogen which might be gained by longer growth of a winter legume would not provide enough additional nitrogen to compensate for the increased growth of the small grain.

BUILD SOILS FOR BURLEY

Soils of low-to-medium fertility should be built up for burley through the use of crop residues, farm manure, phosphate and potash fertilizers, liming, and by growing grasses and legumes. Good crops of burley are more certain on land so improved and only moderate amounts of fertilizer are required for burley on such land. On much tobacco land, not only has it been necessary to add the fertilizers

Fig. 24.—A good soil for growing burley tobacco.

normally needed; but also, enough additional plant nutrients to make up for the soil depletion by other crops grown in the rotation. A better plan in any soil-building program is to apply enough fertilizers to the pasture, hay and grain crops so that they will not deplete the soil but improve it and leave it in such condition that when tobacco follows in the rotation only moderate fertilization is needed.

GROWING THE CROP

Preparing the land

Thorough preparation of the land before transplanting is highly important in tobacco production. With short rotation, most tobacco land is now plowed in late winter or early spring. Break land in sods or cover crops before crop growth is excessive and at least 6 weeks before transplanting time. Work the land down with a heavy drag after turning the cover crops under to prevent too much drying of the soil. Disk or harrow the land, if weather permits, to provide a good seedbed. Don't plow or work the land when it is wet. Give the field a final working immediately before setting the crop, using a disk or smoothing harrow. If necessary, firm the land with a drag or cultipacker.

Transplanting

Transplanting may be done at any time after weather becomes favorable and plants are ready. Most of the crop in Kentucky is transplanted between May 20 and June 15. Early transplanting usually gives the best quality of tobacco. Make the rows 40-42 inches apart, and space the plants 16-18 inches apart in the row. This will provide for approximately 8,300 to 9,800 plants to the acre. Machine setting is preferable to hand setting, but can be practiced only on fairly level land. Normally, 5 to 7 barrels of water are required to one acre depending on the moisture content of the soil. Don't transplant when the temperature is higher than 90° F.

Set plants soon after pulling. Pull only well developed, stocky plants free of disease; protect them from wilting, and keep the roots from drying out before plants are set.

Dust beds with a suitable insecticide before pulling plants to prevent flea beetle damage to the newly set plants in the field.

Cultivation

The chief benefit of cultivation is to control weeds. Another benefit is to keep the soil surface loose so water run-off will be slowed down. Cultivation should be shallow and only as often as needed to break the soil crust and control weeds. Usually not more than two or three cultivations are needed. Small harrow-type plows, five-tooth cultivators, or small shovel cultivators are desirable implements to use. Quit cultivating when operations begin to damage leaves and prune roots.

Two herbicides, vernolate and diphenamid, are now cleared for use in controlling weeds in tobacco fields. You might try these materials on a few rows to see how they work on your farm.

IRRIGATION

Average annual rainfall in Kentucky varies from 42 to 46 inches. However, uneven distribution results in dry periods practically every year. Under drought conditions, plant growth is retarded and yield, quality and usefulness are often reduced. Irrigation provides a safeguard against drought from the time the crop is set until it is full grown. Irrigating gives the soil enough moisture to provide for good survival at setting time and for rapid growth in the early part of the growing season. This is a necessity for producing the thin, mild, useful grades of burley tobacco which are in great demand. In order for plants to make rapid growth, the soil must be able to supply large amounts of available plant nutrients in a short time. This is possible only when there is ample moisture in the soil.

Irrigation systems should be designed for a particular farm before best results can be obtained. Consideration should be given to the type of soil—sandy, silt, or clay loam, amount of labor available on the farm, acreages of crop to be irrigated, and amount of water needed. The engineering design must be such that irrigation water is not applied faster than the soil can absorb it. Sandy soils will take more water faster than a silt or clay soil. Application rates greater than the intake may cause soil erosion problems.

CONTROLLING INSECTS IN THE FIELD*

Wireworms, cutworms, and flea beetles may be serious pests of tobacco right after transplanting. Wireworms attack the roots and underground tobacco stalk. They usually bore into the stalk and hollow out the inside, sometimes tunneling the complete length of the stalk and killing the bud. Usually their damage is not severe enough to be harmful if healthy, stocky plants as big around as a lead pencil are used. The smaller the plants, the more serious will be the effects of their feeding. Wireworms are most numerous and destructive when tobacco follows sod and least numerous under continuous cultivation.

There are many species of cutworms, but the most destructive one on newly transplanted tobacco in Kentucky is the greasy or black cutworm. These plump, dark, hairless caterpillars cut off the stem at ground level killing the plant. Often they will follow a row of tobacco killing several plants in succession. During the day these worms are found an inch or so beneath the ground near the freshly

* Richard Thurston, Research Entomologist, cooperating.

attacked plant. Unlike wireworms, cutworms may be damaging to fields in continuous tobacco production.

From shortly after transplanting until harvesting, hornworms and budworms may cause serious damage to tobacco. Sometimes large numbers of these caterpillars are taken into the barn on newly cut tobacco. They may cause some damage by feeding on the curing tobacco. Control, as with flea beetles, is confined to insecticide applications in the field.

The large, green hornworms with white markings and either a black or red horn on the rear end eat heavily on tobacco leaves. They may strip the plant, leaving nothing but the stalk and large, main leaf veins. When young, they often feed on the middle part of the leaf like budworms, but when older they usually feed from the tip and edge of the leaf, scooping out large, even, crescent-shaped areas.

The smaller brownish or greenish budworms feed mainly on the developing bud leaves. Because of this habit, they are often undetected until they have caused considerable damage. Budworms do not feed from the leaf edge but chew holes in the middle part of the leaf. When the bud leaves expand, these holes expand also leaving large, even, open spaces between the veins. On large tobacco, budworms will feed on the mature leaves, on seed pods, and may bore into the stalk.

Several species of grasshoppers attack tobacco. They are especially numerous and destructive in hot, dry summers when they move in large numbers out of dried-up pastures or newly cut hay or grain fields in July and August. Because they move in and out of tobacco fields from near-by fence rows and surrounding fields, it is necessary to treat a strip 20 to 30 feet wide around the field, as well as the tobacco field itself, to get good control. Grasshoppers chew irregular, roundish holes in the leaf surface.

The green peach aphid may be found in the plant bed and throughout the growing season in the field, but it has usually been most numerous during the last month of the growing season. These small (1/8 inch long) soft-bodied, greenish aphids (plant lice) are the only serious pests of field tobacco which are not chewing insects. Aphids have long pointed mouth parts, somewhat like a mosquito's, with which they pierce the plant tissues and suck out plant sap. Their feeding can cause the plants to be stunted, the leaves chaffy and lightweight, and the honeydew that they excrete is fed upon by a black mold which discolors the leaf. Ky 12 and Ky 10 and hybrids with one of these as parents have been found to be highly susceptible to these aphids. If you grow these varieties, watch closely for aphids.

Control measures for insects attacking tobacco in the field change from year to year. Each year new recommendations are made which you may obtain from your county extension office.

CONTROLLING DISEASES IN THE FIELD

Many of the control measures for tobacco diseases are most effectively put into use before the crop goes to the field. Disease-resistant varieties, disease-free soil, plant bed treatments, proper soil fertility, and proper rotation all decrease the danger of disease injury in the field.

TOPPING AND SUCKERING

Topping causes the tobacco to spread and make more weight than if it is left untopped. Top all of the plants when two-thirds to three-fourths of them are in bloom. Top high and leave two top suckers. When the crop is ripe, remove the suckers and two top leaves and cut the same day if possible. In recent years sucker control materials have been successfully used on burley.

Harvesting and Curing

A good cured burley crop depends on whether you cut your tobacco at the right time, house it correctly, practice good barn management, and bulk it properly. Curing burley is more than just drying the leaves. You must control temperature, humidity, and air circulation if you hope to market good tobacco.

Many fine crops are injured by improper handling, inadequate housing, and lack of control over curing conditions. Furthermore, proper harvesting and curing can often improve some of the poorer crops. Remember, the care and good management you used from plant bed to cutting time must be continued in the barn if burley is to return profits.

CUTTING

Ripening does much to improve the quality of your burley tobacco. Priming the lower leaves once or twice, if necessary, helps you obtain the highest acre-returns from burley. Cut when nearly all the upper leaves show a distinct yellow tinge (Fig. 25). It usually pays to delay cutting until nearly all the upper leaves are ripe even though you don't prime. Added growth and improved quality of the plant during ripening more than make up for the loss of lower leaves. In very humid harvest seasons if no priming is done, nothing is gained by

delaying cutting beyond the time that the middle leaves show a distinct yellow tinge.

If late tobacco is cut, provide heat to speed up curing and prevent freezing in the barn. Put the plants directly on the sticks as they are cut, five or six plants to the stick. Leave the tobacco in the field on the standing stick (or on scaffold) long enough for it to wilt (your housing facilities will partly govern the length of time), but never longer than 3 days. Fully matured tobacco is not likely to sunburn. However, green tobacco usually cut when temperatures are high, often sunburns. Sunburned tobacco should be left sticking in the field for about 3 days so that the dew and the sun can remove the damage.

Fig. 25.— Cut burley when nearly all the upper leaves show a distinct yellow tinge.

HOUSING

Good housing practices are essential to control the curing of burley tobacco. Many crops that come from the field in fine condition are seriously damaged by poor housing facilities. One of the greatest building needs on Kentucky farms is the remodeling of tobacco barns.

Correct housing means filling each bent completely from top to bottom as the crop is put into the barn. Leave enough space under the lowest rails so you can use heat if necessary. Starting the fill on the

southwest side of the barn takes advantage of air movements in the early stages of curing. *Always* spread the stalks on sticks (Fig. 26). Make sure that the leaves are hanging down, not doubled up. Also, tip leaves should fall in between lower sticks, not rest on the butts of stalks below. Never hang fresh-cut tobacco under tobacco harvested earlier and partially cured. Water evaporating from the fresh tobacco will cause partly cured tobacco to darken.

If you don't have enough tobacco to fill your barn, don't jam all of it into a small area. Space it throughout the barn so air can circulate evenly through the tobacco. Air seeks the level of least resistance. It will accumulate in empty parts of the barn, while filled portions will not receive full benefit of air curing.

BARN MANAGEMENT

Locate the barn on an open, well-drained area for best ventilation. The best location is on a ridge, hill, or a high point in the field (Fig. 27). Valleys tend to be foggy. You will get better ventilation if the barn is placed so that a side faces the direction of the prevailing winds.

Provided that one side with its proper number of ventilator doors faces the prevailing winds, the structure's length and height will not noticeably affect air circulation within the barn. Width is the most important dimension affecting ventilation. Width determines (1) the distance the air must move as it passes through the barn and (2) the quantity of tobacco through which the air must pass. The wider the barn, the slower the air moves through it when actually greater air movement is needed because of the increased capacity for tobacco. *This illustrates why a shed added to a barn always lowers efficiency in air-curing tobacco* (Fig.28).

For economic reasons, barn dimensions must conform with sound construction practices and the extra profit you can expect from better tobacco. A standard barn is 40 feet wide and 60 feet or more long with a sidewall 20 feet high and a gable roof of ⅓ pitch. The only ventilators are full-length, sidewall vertical doors equivalent in area to at least one-third of the sides. Since larger tobacco now is being grown, some farmers are building barns with rails 6 feet apart vertically.

The more cracks and ventilators in the side of the barn, the more the air will pass through the housed tobacco and the closer tobacco can be spaced. Your curing barn, therefore, should have enough side ventilators for rapid exchange of air. Few old barns have enough side ventilators for best curing.

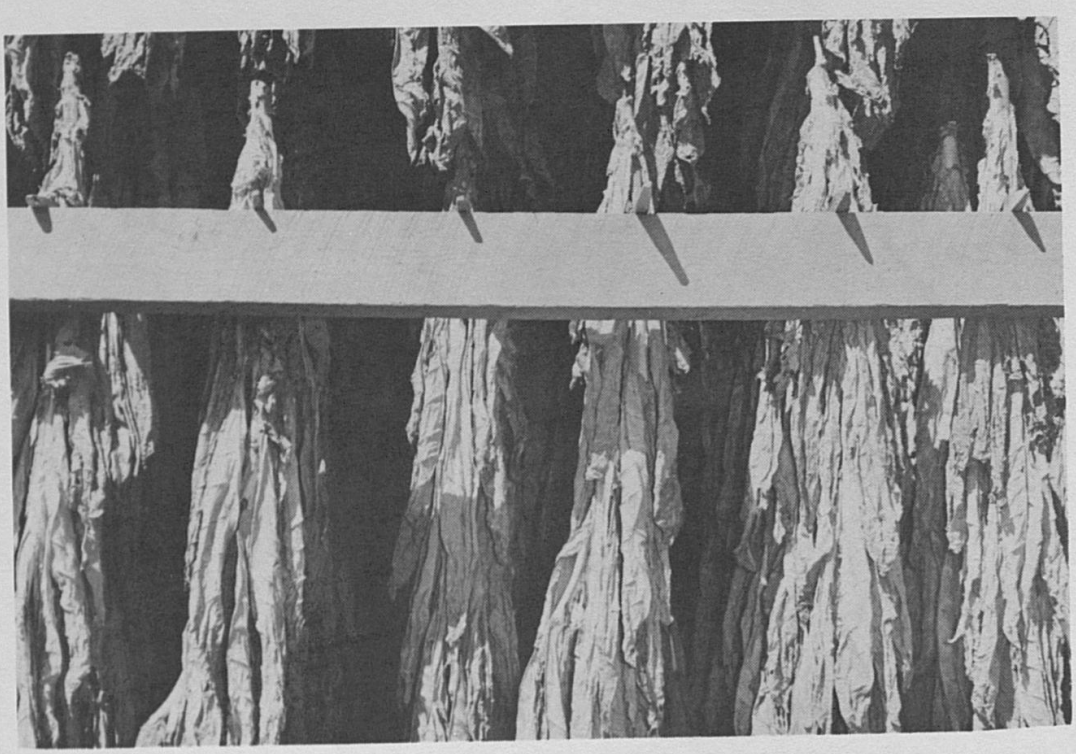

Fig. 26. — When sticks are spaced on a rail, air can move freely in and around the tobacco.

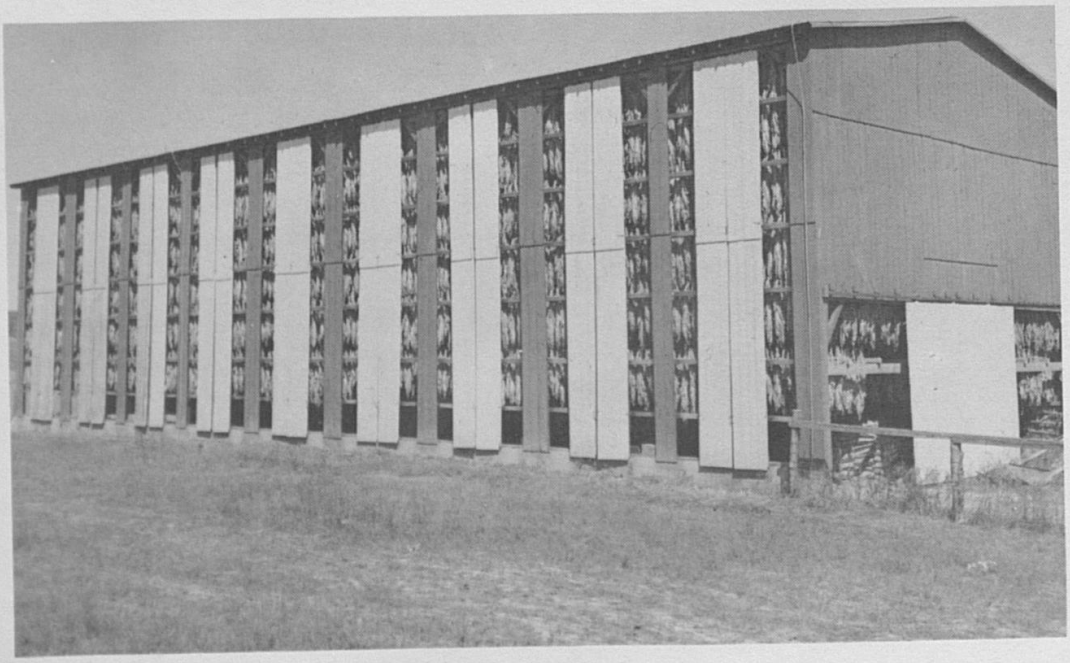

Fig. 27.—An open, well-drained area such as a ridge or hill is the best location for a curing barn.

When repairing old barns or building new ones, provide ample ventilators on the sides (Fig. 29). In barns 36-40 feet wide, hinge at least one-third of the boxing or side to permit opening and closing. Wider barns need even more ventilation. To make a third of the side in ventilators, start at one end and nail four boards, hinge two, nail four, hinge two across the side of the barn. To have half of the side open, nail two boards, hinge two, nail two, hinge two across the side.

Ventilators are not needed at the ends of burley barns unless prevailing winds strike the end of the barn and tier rails run parallel with the width.

If prevailing winds strike the side of the barn and tier rails are parallel to width, the barn should be remodeled and tier rails changed to run parallel to the length of the barn. Ventilators should then be provided on the sides. Research at the Kentucky Agricultural Experiment Station has shown that ventilators in the roof are also useless.

CURING

Curing occurs when temperature, humidity, and air bring about desirable changes in the chemical composition of the leaf. Curing is more than just drying; it is a living process during which respiration takes place, using up the plant's food reserves. Color and quality develop in the leaf during curing.

The final quality of cured burley tobacco is determined very largely by moisture conditions which prevail inside the tobacco barn during the curing period. High moisture causes tobacco to cure too slowly, producing red or houseburned leaf and heavy losses in weight. When tobacco stays in "brittle case," it cures too fast causing a greenish tinge, mottled, or piebald leaf with heavier yields of less useful tobacco. In fact, the characteristics on which buyers judge air-cured burley are severely altered by fast curing.

For good barn management you must know the approximate relative humidity inside the barn. Cured tobacco leaves are very sensitive to changes in the moisture content of surrounding air. They come in and go out of "case" as a result of such changes. Since "case" or "order" of cured tobacco is interpreted by the way the leaf feels, the relative humidity at various locations in a barn can be determined fairly closely by checking the condition or "feel" of cured leaf samples. Table 4 gives a satisfactory scale of moisture in the leaf. You can check relative humidity this way at any time during the curing season. When the samples feel "dry to low case," the humidity is about right for best curing.

Fig. 28. — You have little control over curing conditions in a barn such as this. Sheds placed on the sides of a burley barn cut off ventilation completely. Also, ridge ventilators are useless.

Fig. 29.—This old barn was remodeled to give maximum control over curing conditions.

Moisture can be controlled in burley barns fairly well through proper use of ventilators plus careful use of heat in humid weather.

Table 4.—Feel of Cured Tobacco Flyings in Relation to Relative Humidity*

Feel of Cured Leaf	Relative Humidity (Percent)
High case	90 to 100
Medium to high case	85 to 90
Medium case	80 to 85
Low to medium case	75 to 80
Low case	70 to 75
Dry to low case	65 to 70
Dry	60 to 65
Dry to brittle	55 to 60
Brittle	50 to 55
Fragile	less than 50

* From Kentucky Agricultural Experiment Station Bulletin 501, "Principles of Burley Tobacco Barn Operation."

Burley cures favorably when the temperature inside the barn ranges between 60° and 90° F provided relative humidity averages 65-70 percent in the barn over a 24-hour period. In normal weather during the tobacco-curing season in Kentucky, the outdoor temperature seldom goes above 90° or below 60° F for any great length of time. Therefore, favorable curing conditions depend largely on whether relative humidity can be kept around 65-70 percent.

Air Curing

Curing conditions in the barn may be varied by management practices. How well you cure your crop depends largely on how well you regulate humidity, how close you space sticks, the width of your barn, the size of your tobacco, and the amount of ventilation.

Small plants permit closer spacing than larger ones. With the same amount of side ventilation, a narrow barn will safely hold more tobacco per rail than a wider barn. Barns 36-40 feet wide are best for housing tobacco.

During some periods every year, relative humidity cannot be controlled by ventilators and heat should be used. Whenever tobacco remains in case for more than 24 hours, houseburning will start.

WHEN TO OPEN OR CLOSE THE VENTILATORS

During August and September, the air is usually dry during the day and moist at night. Generally, therefore, open the ventilators as soon as the dew dries in the morning and close them in late afternoon.

If you are not sure whether to open or close the curing barn, put a few cured leaves in a sheltered place such as an open shed near

the tobacco barn. When these leaves are damp and hang limp, the air is high in moisture, and the barn should be closed. In general, whenever these leaves feel drier than the tobacco inside the barn the ventilators should be opened. But when the tobacco inside the barn feels drier than those leaves outside, then keep the barn tightly closed (see Table 4).

During cool periods, open the barn to get the benefit of the warmer outside air. In cool weather the temperature may be 10° lower in a closed barn than outside because of cooling from evaporation. If no fire is used in curing, provide as much ventilation as possible until curing is nearly complete.

If the weather is very dry and your tobacco is curing too fast, close the barn in the daytime and open it at night. This method traps the cool, moist night air and keeps the drier, daytime air out of the barn.

If you primed, usually the primed leaves will need some heat in curing.

USE OF FANS

The use of fans in the present procedure of curing tobacco seems to be limited. Do not attempt to use fans for general air or heat distribution in the barn. When improper stick spacing or undesirable construction or location of the barn causes poor curing in limited sections within the barn, you might use fans to supplement the natural ventilation in these sections. Locate the fans to blow the air directly through the section of tobacco that is curing poorly. The locations and size of the fans are important, for too strong an air movement will bruise or shatter the tobacco. Operate the fans only long enough to overcome the curing stresses.

Controlling Humidity with Heat

Heat is used primarily to control humidity or moisture content of the air surrounding the tobacco in the barn. If too much heat is added, the moisture level of the air becomes too low, resulting in too fast a cure. If the weather dries the cured leaves each day without fire, then firing is a waste of fuel and time.

Always practice care and good management when using supplementary heat. Control the rate of heat to keep the temperature 85-90° F directly above the burner at the lowest level of tobacco. You should use enough burners so that the temperature does not vary more than 15 degrees throughout the barn. Make all temperature measurements at the lowest level of the tobacco.

Normally, the side ventilators of the barn are closed when heat is

being used. As the warm, dry air rises through the tobacco, it absorbs moisture released by the tobacco. The moist air must not be allowed to remain in the barn; therefore, *some ventilators will have to be partially opened to allow the moist air to escape.* It may be best to open the ventilators on the leeward side of the barn rather than the windward side. This will help prevent moist outside air from entering the barn, yet allow the moist inside air to escape.

FUELS AND STOVES

Coke long has given good results when used properly. The first precaution with coke is to be sure it has a low sulfur content—not more than 1 percent by laboratory analysis. The dealer selling coke for tobacco curing should provide a statement concerning the sulfur content of the fuel.

The next precaution is to use enough stoves with low or moderate fires rather than fewer stoves burning with high fires (Fig. 30). This will distribute the heat better and minimize hot spots. Do not use large coke stoves made from 55-gallon oil drums. They release too much heat near the stove, cause hot spots, and result in green or "off" colors being set in the tobacco.

Although coke is an inexpensive fuel, considerable labor is required to tend a coke-fired barn properly. Coke stoves must be started outside the barn and then moved in after the fires are started. They require attention at least twice a day. Shaking out ashes and refilling the stoves are rather hard work. Heat output is difficult to control and not uniform. Coke stoves usually burn the hottest shortly after being tended, then taper off to a rather small heat output before being tended again.

When properly used, 1 ton of coke on the average, will cure 1 acre of tobacco. Follow these suggestions:

1. Extremely hot fires will destroy the stoves and cause poor heat distribution.
2. After the curing season, remove the ashes and coke from the stoves. Coat them thoroughly with crankcase oil inside and out and store in a dry place. Coke stoves, when properly cared for, will last 10 years or longer.

Natural gas is an excellent fuel for use in tobacco barns. All natural gas supplied through commercial pipelines is safe for use in tobacco barns. Harmful impurities have been removed from the gas at scrubbing plants. Gas from most private wells is also pure enough for use in tobacco barns. The harmful impurity in natural gas is sulfur, usually in the form of hydrogen sulfide which is easily detected

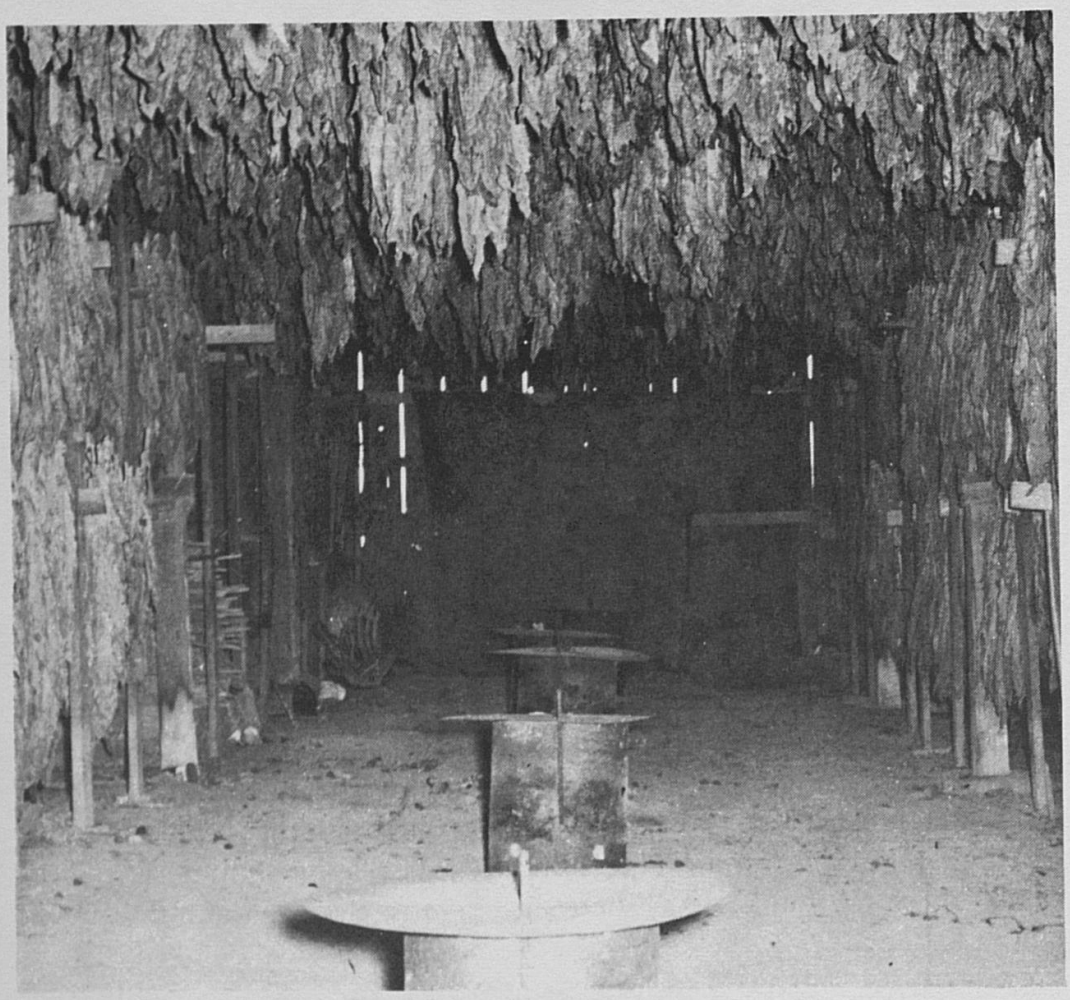

Fig. 30. – Use enough coke stoves to distribute heat better and reduce hot spots.

by its foul odor. Gas with as little as one part per million of hydrogen sulfide will have a foul odor. Therefore, any gas that smells "sweet" is safe for tobacco and even some gas that has a slight odor is safe.

Natural gas, where it is available, will supply heat to the tobacco barn for less cost than any other non-solid fuel that has proved satisfactory for tobacco.

Propane gas or LP gas contains practically no sulfur and is being used successfully as a fuel for heating tobacco barns. It costs slightly more than natural gas or coke, but the heat content is higher than that of natural gas. Propane, like natural gas, lights instantly, is easily controlled, and is a constant and uniform source of heat (Table 5).

Venting of propane gas stoves is not necessary under ordinary firing. Labor requirements for firing with propane are comparable to those for natural gas and both of them are much lower than coke.

When properly used, gas stoves will last 10 years or longer. However, after the curing season, store the stoves in a cool, dry place and the hose in a *dark*, cool, and dry place.

Table 5.—Combustion Data of Fuels Used for Heating Burley Tobacco Curing Barns

Fuel	Heating Value (B.t.u./Unit)	Water Relased in Combustion (Pounds Per Pound of Fuel)	Fuel Cost	B.t.u.s. for 1 Cent
LP Gas	92,000 B.t.u./gal	1.64	15¢/gal	6,150
Natural Gas	1,000 B.t.u./cu ft	2.25	80¢/1,000 cu ft	12,500
Coke	12,900 B.t.u./lb	0.22	$25/ton	10,320

GAS EQUIPMENT

Two types of gas burners shown in Figs. 31 and 32, will operate on either natural or LP gas. They require different orifices when using natural gas—check with your gas dealer.

The small gas unit (Fig. 31) has a maximum heat output of 30,000 B.t.u. per hour. Each stove will cure an area in the barn of about 12 x 12 feet. The larger unit (Fig. 32) has a maximum output of 75,000 B.t.u. per hour and will cure an area in the barn about 12 x 40 feet.

Automatic controls, available for all gas heaters, are very helpful in adjusting relative humidity in the barn. Hygrometers or humidistats will also help you determine relative humidity in the barn. These guideline tools ought to be used since they will help in curing your tobacco.

DISTRIBUTION OF HEAT

Heat distribution is a factor to be considered. Hot spots will frequently occur in localized areas directly above the stoves. These hot spots indicate poor heat distribution which, in turn, cause green or "off" colors in the tobacco. Hot spots are usually caused by burning too few stoves too hard. The result is too much heat immediately around and above the stove and not enough heat in the rest of the barn. Moving the stoves from place to place in the barn does not solve the problem. The hot spots are not eliminated and the tobacco that was near a stove and has dried out may absorb moisture from wet tobacco in another part of the barn when the stove is moved.

You get uniform heat distribution only by using an adequate number of stoves, each burning at a moderate rate. If you use coke, put at least two stoves per bent and sometimes three to a bent in an average-width barn (36-44 feet wide). In this manner, you will get enough heat and good distribution without having to burn the stoves too hard. In addition to better heating of the barn, the stoves will last longer when they are burned at a moderate rate. All stoves should have some sort of heat spreader.

When using the small gas burner (Fig. 31), you will need three stoves per bent in a barn 36-40 feet wide. Distribution of heat is regulated by the number of stoves per bent.

When using the larger gas burner (Fig. 32), use one stove per bent. Each arm is slotted so that heat will escape at the proper intervals, giving good heat distribution.

To check the heat distribution in the barn, use thermometers. Hygrometers, and/or humidistats, and the method described on controlling humidity with heat.

PROGRESS IN CURING

Rapid progress should be made in curing burley tobacco during the next decade. Research being conducted at the National Tobacco Research Center of the University of Kentucky, Lexington, should result in new handling and curing methods in the near future. You

Fig. 31.—This small gas unit has a maximum heat output of 30,000 B.t.u. per hour.

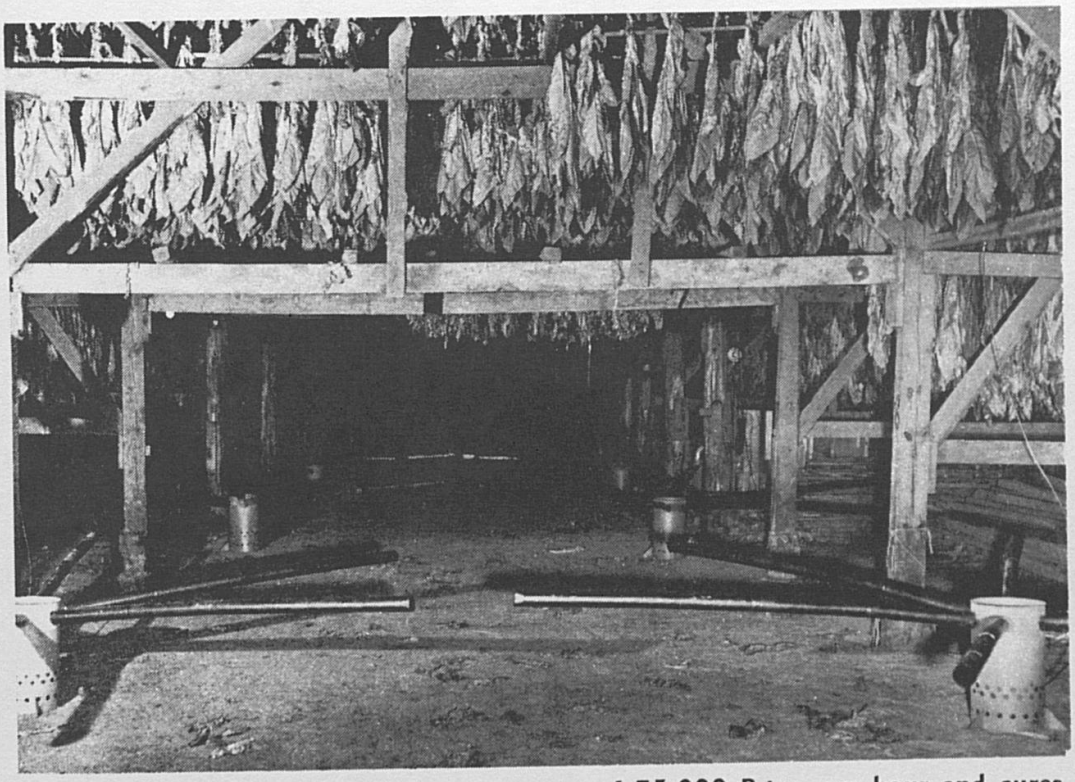

Fig. 32. — The larger gas unit has an output of 75,000 B.t.u. per hour and cures an area about 12 x 40 feet in the barn.

will probably see new methods of handling tobacco from the field to the barn. More mass handling will reduce the labor involved. New shapes and construction of curing barns, designed for mechanical handling, will make tobacco movement easier and more efficient. There will be more control of the air that comes in contact with the tobacco. In the near future, you may house your tobacco, start your automatic curing system and, with a daily check on the progress of the curing, forget about the tobacco. You will have more time for other farm chores and be assured of a consistant, high-quality cure each year. The barns of the future will be smaller and not so tall as the present-day barns. This will reduce the labor involved in handling the tobacco. As research uncovers new knowledge, many new advances in tobacco handling and curing will be seen.

BULKING, STRIPPING AND MARKET PREPARATION

When curing is completed and the midribs of the leaves are thoroughly dry, start stripping and sorting as soon as tobacco comes in "order" or "case." After tobacco is well cured, its color darkens and it loses quality rapidly if the crop is left hanging in the barn exposed to humidity conditions above 70 percent. It is important,

then, to take tobacco down and bulk it in the barn soon after curing is completed, probably after one or more sharp freezes. The freeze drives out extra moisture in the stalk and in the tip leaves of the plant.

In warm weather, however, don't bulk tobacco in high order; mold and rot may severely damage such tobacco. Also, in warm weather, make only small bulks. If the tobacco stalks are not fully dry, it is unsafe to leave tobacco in the bulk beyond 48 hours. Moisture from the stalk may enter the stem, causing stem rot.

When conditions become favorable for bulking, open barn ventilators to let moist air circulate freely. When tobacco is in good handling condition, the ventilators should be closed to avoid too high case. Make the bulk somewhere near the center of the barn and on a foundation of poles or tobacco sticks. Do not bulk directly on the ground. Rick tobacco with the tips of the plant overlapping in the middle and the butts on the outside. The bulk should be pressed down and weighted with tier rails and covered with a tarpaulin, old blankets or carpets to prevent drying out. Early in the fall, or when tobacco is in high case, keep bulks small. If the bulk is made properly and examined often, there is little or no danger of the tobacco heating or damaging before it is stripped. If tobacco in the

Fig. 33.— Bulking burley tobacco preparatory to stripping

bulk should become too dry to handle, spray warm water on the butts of the stalks to bring it back in order.

Stripping

Stripping tobacco is generally understood to mean removing the leaves from the stalk and sorting them into the various grades as they are removed. Stripping is the most important part of preparing tobacco for market. The objective in stripping tobacco is to bring together leaves of similar body, color, and quality in accordance with the use to be made of the crop. Since the different grades are used for various purposes in manufactured tobacco, it is highly important that they be uniform in body and color, especially color. Most burley growers strip their crops into 3 to 5 grades plus one or more different lots of damaged leaf.

Stripping room

Keep two things in mind when providing facilities for stripping tobacco—(1) arrangement for efficient use of labor in stripping and (2) adequate light to do a good job of grading.

Locating the stripping room about midway along the leeward side of the barn will save much travel in handling tobacco. It is much more convenient to have the stripping room attached directly to the barn; however, such an arrangement cuts down on ventilation to

Fig. 34.— Note the essential items in this stripping room—stripping table, good lights, press, stick rack, and heating stove.

some extent. The room should be large enough to accommodate the size crew you expect to use. Stripping tables should be just high enough to reach the closed hand of the taller worker when standing, and should be so arranged that flyings and trash are stripped just inside the door from the barn. The stripped stalks can then be thrown in a pile near the second door leading out of the stripping room. Provide suitable presses at a convenient place. (Contact your county extension office for information on time-saving ways to strip tobacco.)

Lighting the stripping room

Farmers using electric lights have been setting up temporary stripping quaters in the middle of the tobacco barn in preference to building a separate room. The temporary room can be enclosed with bales of hay or tarpaulins and heated with a coke stove if necessary. If this plan is used, be sure you guard against the fire hazard.

Adequate lighting is necessary for workers to sort tobacco according to grade and color, and to determine quality. It is necessary to have proper light as color distinctions often determine the quality of the tobacco. With poor light, much tobacco may seem uniform in color, whereas proper light conditions would reveal mixed colors. Provide the best light possible on the farm. Direct sunlight should be avoided. The stripping table and background surfaces reflect light onto the tobacco. Therefore, it is best to paint these surfaces a metal gray color with a flat finish to take advantage of all the light. The gray colors result in more light being reflected off these surfaces than where the stripping table and background is a natural color or a concrete block. Light may be supplied by:

1. FLUORESCENT LIGHTS—Have one for each worker. Hang these lamps above the table so the bottom of the fixture will be about 4 to 6 inches above the eye level of the stripper. Tilt lights toward the back wall to keep the glare from the light away from the stripper's eyes. Use a fixture with two 40-watt all electric tobacco tubes.
2. SKYLIGHTS—If you do not have electricity, skylights are the next best substitute. Skylights on the north side of the roof, directly over the stripping table, are satisfactory.
3. SIDE WINDOWS—The next best light is provided by side windows, located on the north side of the room in the side wall, with the bottom of the window sash 6 or 8 inches above the stripping table, and with the windows extending the full length of the table. Tilting the top of the windows 6 inches toward the table improves lighting conditions.

GRADES OF BURLEY

The U.S. Department of Agriculture has developed a system of grades for the various types of tobacco to make marketing and distribution of market and price information easier. These standard grades as they apply to burley tobacco are based upon a combination of three factors—groups, qualities, and colors—plus the occasional use of some special factors.

KEY TO STANDARD GRADE MARKS

U.S. Type 31—Burley

Group	*Quality*		*Color*
B—Leaf	1—Choice	L—Buff	V—Greenish
T—Tips	2—Fine	F—Tan	VF—Greenish tan
C—Lugs or Cutters	3—Good	FR—Tannish Red	VR—Greenish red
X—Flyings	4—Fair	R—Red	G—Green
M—Mixed Group	5—Low	D—Dark red	GF—Green tan
N—Nondescript		K—Variegated	GR—Green red
S—Scrap		M—Mixed	

SUMMARY OF STANDARD GRADES

35 Grades of Leaf

B1F	B1FR	B1R							
B2F	B2FR	B2R							
B3F	B3FR	B3R		B3K	B3M	B3VF	B3VR	B3GF	B3GR
B4F	B4FR	B4R	B4D	B4K	B4M	B4VF	B4VR	B4GF	B4GR
B5F	B5FR	B5R	B5D	B5K	B5M	B5VF	B5VR	B5GF	B5GR

21 Grades of Tips

T3F	T3FR	T3R						
T4F	T4FR	T4R	T4D	T4K	T4VF	T4VR	T4GF	T4GR
T5F	T5FR	T5R	T5D	T5K	T5VF	T5VR	T5GF	T5GR

24 Grades of Lugs or Cutters

C1L	C1F					
C2L	C2F					
C3L	C3F	C3R	C3K	C3M	C3V	
C4L	C4F	C4R	C4K	C4M	C4V	C4G
C5L	C5F	C5R	C5K	C5M	C5V	C5G

17 Grades of Flyings

X1L	X1F			
X2L	X2F			
X3L	X3F	X3R		
X4L	X4F	X4R	X4M	X4G
X5L	X5F	X5R	X5M	X5G

6 Grades of Mixed Group

M3F	M3R
M4F	M4R
M5F	M5R

7 Grades of Nondescript

N1L	N1F	N1R	N1G	
N2L		N2R	N2G	

1 Grade of Scrap

S

Special factors "W"[1] and "U"[2] may be applied to all grades. Tobacco not covered by the standard grades is designated as No-G.

[1] W—Unsafe order—Sound but containing excessive moisture which is likely to damage unless unusual precaution is taken.

[2] U—Unsound—Damaged under 20 percent.

Flyings—The first leaves stripped are those at the base of the plant. These are known as flyings and are recognized by their thin body and by a more considerable degree of injury than those leaves produced higher up the stalk, with the exception of tip leaves.

As flyings are removed they should be divided into lots according to quality, which is largely based on the percentage of injury and on color. Leaves of each quality are then tied into "hands" or bundles the size of a silver dollar. The tie-leaf wrapped around each hand should be of the same quality and color as the tobacco in the hand so that the heads will not contrast with the leaves. The hands of the different qualities and colors should be placed on separate sticks. The sticks of sorted tobacco are then pressed and bulked. The bulk should be carefully covered to protect the leaf from trash and dirt, preserve color, and prevent drying out.

Lugs are the group of leaves about the middle of the plant. They are larger than flyings, sounder in body, yet thin and light in color. Lugs are used almost entirely in the manufacture of cigarettes and are usually the highest-priced leaves on the plant. In stripping lugs, the most important thing is to keep the other grades out, particularly bright leaf.

Leaf—The leaf group includes all the heavier bodied leaves above the lugs. The color may vary from tan to dark red. Leaves on the tan—color side in this group are known to farmers as "bright leaf" and are more valuable than the darker or red leaves. Bright leaf is also used for making cigarettes; therefore, it is highly important to separate the leaf group into two grades on the basis of color. Leaves shorter than 16 inches in this group are known as tips and may make a third grade.

The cull or nondescript grades made will depend upon the amount of such tobacco in the crop and the size of the crop. Dark, patch-burnt leaves should usually be kept out of the clear, nondescript leaves if the size of the crop will justify it.

Pressing and bulking

Leaves should be tied into medium-sized hands (size of a silver dollar at the butts) as they are pulled, sorted, and placed on a stick by grades until it is filled with 12 to 14 hands. The filled stick should be put into a press to improve the appearance of the leaf. After the stick of tobacco has been pressed, it should be placed in the bulk on the stick and kept there until the crop is to be taken to market. It should be delivered to the warehouse floor on the stick. Marking the sticks by grades as they go into the bulk will make it easier to

Fig. 35. — Pressing improves the appearance of tobacco.

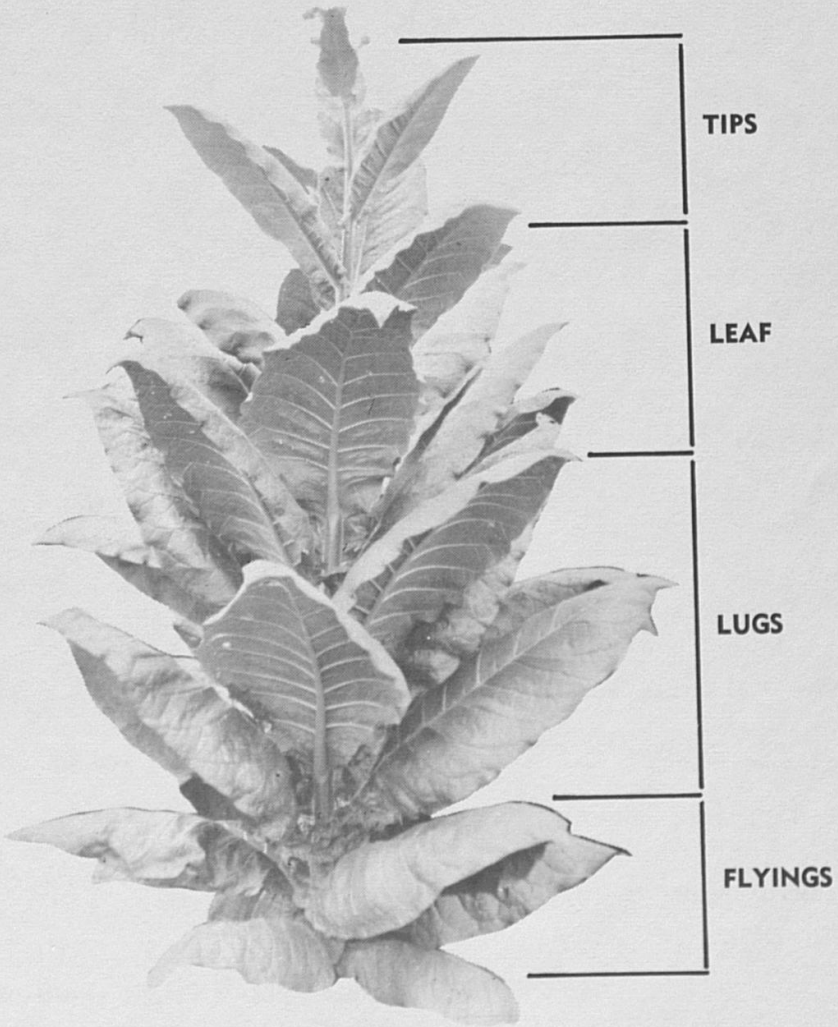

Fig. 36.—The approximate location on the tobacco plant where the different types of leaves grow.

handle the crop at marketing time. Usually it is desirable to separate the grades at the farm before loading, rather than on the warehouse floor.

The grade placed on the warehouse ticket will give the correct description of each lot of tobacco and the *Daily Tobacco Price Reports,* issued by the Tobacco Division of the Agricultural Marketing Service, will indicate the average selling price for each grade at the time the report was issued. Having this information, you can know when your tobacco is selling in line with the market price for its grade. You are entitled to this information so you can market your tobacco on a basis of fair competition.

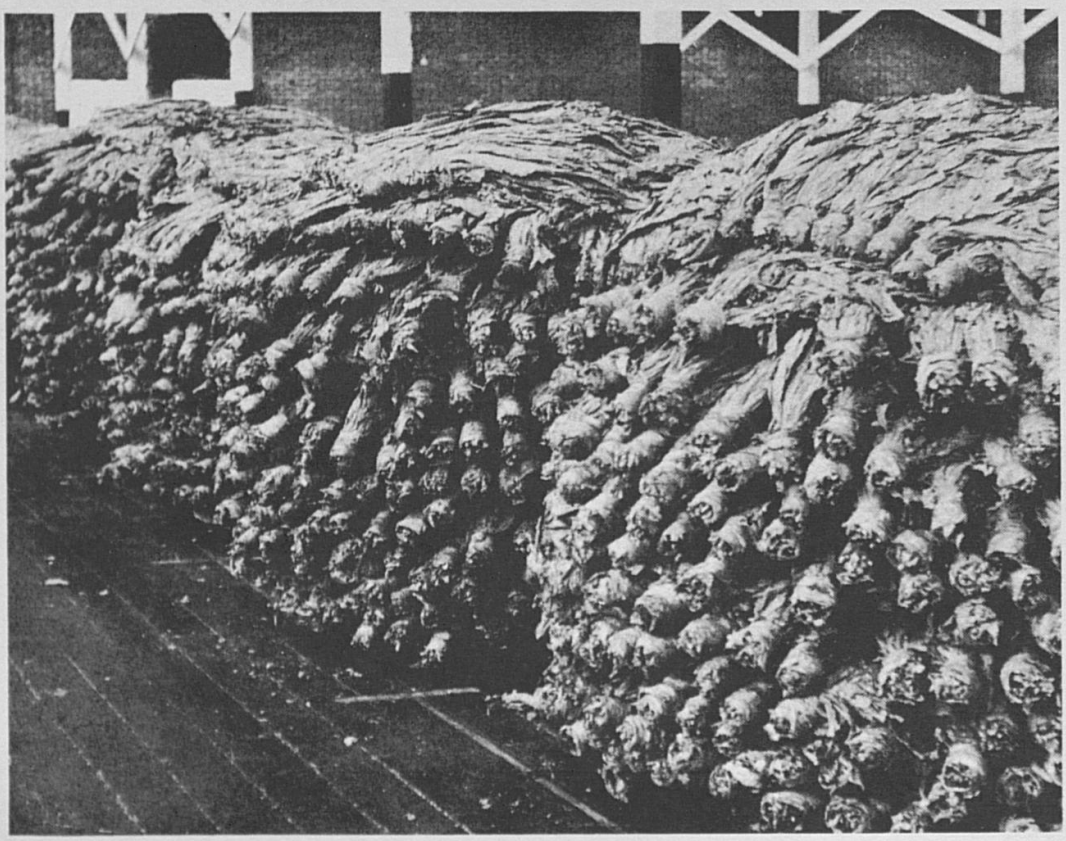

Fig. 37.—A tobacco crop on the sales floor ready for selling.

Be with your tobacco when it is sold. Obtain a copy of the *Daily Tobacco Market Price Report* from the grader or the warehouse. Compare the price offered for all grades with the price paid the day before for the same grades. If the price offered is not satisfactory as compared with the average auction price the day before for that grade, you may reject the bid and offer the *crop at a later date.*

Fig. 38.—Good burley tobacco being blended with other top quality tobacco—flue-cured, maryland, and turkish—which is about ready for manufacturing into quality tobacco products.

Tobacco Diseases*

CAUSES OF TOBACCO DISEASES

Tobacco diseases may be considered as abnormalities of the plant that cause reduced quality or quantity of the commercial product. This definition includes various malnutritional diseases caused by soil deficiencies, injuries caused by fungi, bacteria, roundworm, or nematodes, parasitic flowering plants such as broomrape, virus diseases, and "burning" of wilted plants. Insect injuries might be included, but are not discussed in this publication. If it is kept in mind that diseases may be produced by one or a combination of these causes, it will be easier to understand the reasons for the various control measures recommended and the changes which are made from time to time in these recommendations as new facts are discovered. A short

* By W. D. Valleau, E. M. Johnson, and Stephen Diachun, Department of Plant Pathology.

description of the organisms that cause disease may interest those unacquainted with the lower forms of life.

Fungi are plants of a low order, such as the mushrooms and various molds that grow in damp places. A common fungus familiar to all is the green mold sometimes seen on canned fruit. Certain forms of fungi are common causes of plant disease. They subsist either on the living plant cells as rust of wheat and other cereals, and mildews of various crops, or by killing the plant cells and living on the dead tissues as in fruit rots or the black root-rot of tobacco.

Bacteria are sometimes classed as one of the groups of fungi. They are single-celled plants. The individual cells are visible only with a microscope. A mass of them, however, may be readily visible to the unaided eye.

Virus diseases are caused by organisms so small that the individual particles cannot be seen with an ordinary microscope. However, their images can be seen and the particles photographed with an electron microscope. The virus content of the plant increases rapidly following infection but the exact method of reproduction is not known. The viruses are characterized by being able to multiply only in living cells.

Nematodes are roundworms that can sometimes be seen with the unaided eye. They are similar to the hookworm of the human and to roundworms causing trouble in many animals.

Parasitic flowering plants are plants such as broomrape, dodder, and mistletoe that have become adapted to obtaining food materials or nutrients directly from some other living plant instead of from the soil.

Physiological diseases, or those not caused by disease-producing organisms, often result from a lack of sufficient available nutrients or an excess of one or more of the compounds necessary for plant growth. The quantity of available nutrients in the soil is determined in part by the total content of the necessary minerals in the soil and the degree to which the land has been cropped and manured.

For example, alfalfa removed for hay reduces the available mineral content of the soil rapidly because of heavy yields produced, unless part of the nutrients is returned in the manure from feeding the crop. Legumes or legume-grass mixtures, if left on the land or turned under, tend to accumulate available nutrients. Close pasturing of grassland may reduce available nutrients, especially if the droppings are deposited in restricted areas, such as shady places in the field. Therefore, the fact that a bluegrass sod has not been plowed for many years is no assurance that it will make good tobacco land.

SOIL IN RELATION TO TOBACCO DISEASES

Growers are well aware of the desirability of selecting the most favorable soil for tobacco. The reasons for the selection or rejection of certain soils for tobacco are not always well understood but are usually arrived at by experience. The relation of soil to diseases will be discussed more fully under the specific diseases, but reference is made here to a few of the more obvious relations.

Soil Fertility

Tobacco makes an enormous growth in a very short period; consequently, a high level of available nitrogen, phosphorous, and potassium should be present in the soil when the crop is set. Lack of enough of any one of these nutrients results in slow growth, late maturing excessive firing, or may aggravate leaf-spot diseases of one kind or another.

Soil Reaction

Soil reaction or the degree of its acidity or alkalinity is an important factor. Experience has demonstrated that tobacco thrives best in moderately acid soil. The use of too much lime often seems to be a contributing cause of frenching. The black shank organism seems to persist much longer in limed soils than in acid soils. Certain minor elements like manganese are, in minute quantities, necessary for plant growth. In strongly acid soils these minor elements often are very soluble, and the amounts present may be enough to cause slow growth and leaf spotting. On such soil, an application of ground limestone may prove beneficial to tobacco.

Organic Matter

Organic matter, if well rotted and mixed with the soil, is generally beneficial to tobacco because it tends to increase fertility and reduce leaf-spot diseases. Manure is generally beneficial both to burley and to dark tobacco, but where successive crops of tobacco are grown in manured soil, black root-rot is almost certain to develop unless a highly resistant variety is grown. Strawy manure and cover crops which do not decay before tobacco is set sometimes cause root injury as a result of the production of temporary toxins. Leaf mold, turned under in newly cleared land, sometimes results in frenched tobacco if it is the first crop.

Crop Rotation

The grower should profit by experience and give careful study to selecting the crop to precede tobacco in a rotation. In spite of extensive studies on rotation for tobacco, it is not possible at present to re-

commend any rotation as being best for tobacco except that a well-fertilized, lightly pastured, grass-legume sod nearly always produces excellent tobacco. The burley industry was developed largely on the basis of a long-time, sod-tobacco rotation, and this is still good if the sod has not been over-pastured and if the land has not become too heavily infested with meadow nematodes, small round worms that cause brown root-rot. There are many partial failures when tobacco follows old bluegrass sod, caused either by meadow nematodes or reduced fertility, particularly low available potash, resulting from overgrazing. Tobacco may grow slowly after corn, soybeans, timothy, orchardgrass, and some of the meadow and pasture legumes, particularly in a season that is wet during or immediately following setting. Alfalfa or other legumes cut for hay cause depletion of nutrients, particularly potash, and result in poor quality tobacco if it follows the legumes, unless the soil is well fertilized. Weeds make an excellent preparation for tobacco, presumably because those weeds develop best that are highly resistant to pathogenic organisms such as meadow nematodes, and consequently leave the soil relatively free from injurious organisms. A rotation that is all too commonly used in Kentucky is continuous tobacco with a cover crop of a small grain and hairy vetch. In fields that have been in this rotation or in a tobacco-small grain rotation for years, meadow nematodes are found in extremely small numbers, if at all, but the soil gradually becomes compacted, poorly aerated, and highly acid, increasing root troubles and manganese toxicity. With the rapid spread of black shank a rotation is to be preferred over continuous tobacco. If a few black shank plants in a field one year are disregarded they may result in heavy loss the next year. Rotation will greatly reduce the chance of appreciable loss.

Physical Condition of Soil

Good physical condition of the soil is desirable, especially good surface and under drainage. Tobacco often frenches on soil too wet, or if water stands long about the plants it may cause them to wilt, turn yellow, and finally die. On hard, poorly aerated soil, tobacco grows slowly and produces inferior leaf. Loose, open soil such as results from plowing under a good sod is most likely to make rapid-growing, high-quality tobacco, if the necessary nutrients are available.

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