PASTURE IN KENTUCKY

CIRCULAR 510
Revised
April, 1954

Cooperative Extension Work in Agriculture and Home Economics
College of Agriculture and Home Economics, University of Kentucky
and the U.S. Department of Agriculture, cooperating
FRANK J. WELCH, Director
Issued in furtherance of the Acts of May 8 and June 30, 1914.

4M—6-53

CONTENTS

This circular was prepared by committees of the staff of the Kentucky Agricultural Experiment Station and Extension Division of the College of Agriculture and Home Economics, under the chairmanship of W. P. Garrigus, Associate Director of the Agricultural Experiment Station.

CHAPTER 1

ESTABLISHING PASTURES

Engineering Practices

Where pastures are to be established or re-established, engineering or water management practices need to be used. Old gullies on hill land, if not filled, will restrict the area of grazing land and prevent the mowing of pastures to control bushes and weeds. Good stream or surface drainage may greatly limit the productiveness of bottomland pasture during many months of the year. The engineering practices adopted should be those required to correct conditions which, even though land is properly fertilized and seeded, may limit production, increase the cost of maintenance, and decrease the life of the pasture.

Rotation and permanent pastures

Where pasture crops are included in a rotation with other crops on cropland, usually of 10 percent slope or less, the engineering conservation practices should be adopted which are required to control erosion when the land is plowed. Grass waterways, contour cultivation, and terraces are the engineering methods recommended for controlling erosion on rotation cropland. Many Kentucky farmers who want to reduce erosion losses to a minimum object to cultivating terraced rotation cropland. These may prefer to establish permanent pasture on such land as an erosion control measure. There can be no objection to this practice.

Permanent pastures are established in all parts of Kentucky on many different classes of land, both upland and bottomland, with the thought that except for a period of renovation, the sod will not be broken and seeded or planted to another crop. A slope of more than 30 percent, that is 30 feet drop to 100 feet of horizontal distance, is not likely to be profitable in pasture. Pastures are maintained on steeper slopes, but the carrying capacity is limited, they cannot be mowed with safety, and hand clearing is expensive.

Engineering practices for pastures on upland

Engineering practices most frequently required before fertilization and seeding of upland pasture are as follows:

1. Gullied and rough areas should be leveled to permit mowing to

Bushes and trees may be cleared off the land with a bulldozer.

Or the bushes and smaller trees may be chopped up and worked into the soil by a bog harrow.

control the growth of bushes and sprouts. Much land has been cleared of brush and trees, fertilized, and seeded only to go back to brush land because hand labor for removing sprouts and bushes was considered too costly.

2. Diversion ditches may be required to protect gullied areas or galled spots from erosion while grass is becoming established.
3. Land clearing may be required for all or part of the area. Land clearing and the filling of gullies may be done in one operation if a bulldozer is used. The method used to remove brush and trees will depend on the density and size of the growth to be removed.
4. An ample year-round supply of water for livestock should be provided in each pasture area.

Engineering practices for pastures on bottomland

Water management practices frequently required for permanent bottom land pasture are:

1. Stream channel clearance and straightening to eliminate or reduce the hazard of overflow.
2. Surface drainage by open ditches to remove surface water at times of overflow and during rainy periods.
3. Diversion ditches at the foot of adjoining upland for protection from hill water.
4. Tile drainage of wet bottomland may be considered, but unless a satisfactory outlet is available and surface drainage is good, it is better to provide adequate stream and surface drainage and to seed water-tolerant grasses and legumes. Well-drained bottomland may be needed more for the production of grain and rotation crops than for pasture.

Diversion ditches on sloping pastureland help to control erosion if sod cover becomes thin.

Bottomland pastures often require open ditches for surface drainage during rainy periods.

Treating Soils to Establish Pastures

Many failures of new pasture seedings in Kentucky occur because of low soil productivity. It is very important, therefore, that the lime and fertilizer needs of the soil be met adequately during the preparation of the seedbed. If one is not certain as to these needs, chemical tests on properly taken soil samples will furnish useful information as to lime, phosphorus, and potassium needs. Nitrogen needs cannot be determined satisfactorily by chemical tests, but can be estimated fairly well from a knowledge of previous cropping, manuring, and fertilizing practices used on the land.

For a small charge farmers can have lime, phosphorus, and potassium tests made in a county laboratory or, if no county laboratory is available, at the Agricultural Experiment Station at Lexington. Consult your county agent about these chemical tests.

In general the soils of Kentucky should be limed at the rate of 2 to 3 tons of ground limestone per acre unless the land has been adequately limed in the past 5 years. In general also, on low phosphate soils, the fertilizing at the time of starting the pasture as given in Table 1 is recommended:

Table 1.— Fertilizing at Time of Starting Pasture
(N=Nitrogen; P_2O_5=Phosphoric acid; K_2O=Potash)

	Pounds plant food to apply per acre			*Plant food supplied in mixed fertilizer*		
	N	P_2O_5	K_2O	*Ratio*	*Minimum grade*	*Pounds to apply of minimum grade*
No N needed	0	140	70	0-2-1	0-14-7	1000
N needed to establish the seedlings	40	140	70	1-4-2	4-16-8	850
				or	or	
				1-3-2	4-12-8	1000

The above treatments are for low-phosphate soil. Phosphorus is not needed on the high-phosphate soils of the Inner Bluegrass nor when manure is applied, on the medium phosphate soils of the Bluegrass region or the overflow soils of the Ohio, Mississippi, Tennessee, and Cumberland rivers. When manure is not applied half the amount of P_2O_5 recommended in the preceding table may pay on these medium-phosphate soils. Soils derived from Eden Shales on the hillsides in the Bluegrass region should not need K_2O, except perhaps after long cropping to alfalfa for hay or after long cropping to tobacco.

It may be desired to apply part or all of the plant food in straight fertilizers. In this case the proper amount can be figured.

The first step toward preparing for pasture seeding is to test the soil.

Apply the fertilizer that the soil tests call for.

In general, on the basis of equivalent plant food, the various straight fertilizers for each plant food are about equally effective. For statement on equivalent amounts, see Kentucky Agricultural Experiment Station Circular 70.

For any ratio, higher grades than those in the foregoing table also are recommended. Use a higher grade if one is on the market and plant food is cheaper in it. Reduce the rate of application to apply the same amount of plant food. For example, if 0-20-10 is used instead of 0-14-7, the rate of application would be 700 pounds per acre instead of 1000.

On soils low in organic matter, plowing under a green-manure crop of sweet clover or other legumes before seeding will add nitrogen and help greatly in preventing seeding failures.

Other plant foods are not needed for the establishment of pastures. However, some may be deficient for continued good pasture yields and applying them before seeding the pasture might be advisable. Boron is deficient in perhaps one-third to one-half of the soils of the state for alfalfa and may be too low for the best development of other legumes. There is also the possibility that magnesium may be too low in some soils. Boron may be supplied by applying borax at the rate of 20 pounds per acre. In general magnesium may be best supplied by using dolomitic limestone or by using a magnesium fertilizer.

Unfertilized strip at left; fertilized at right. This pasture was seeded in the fall; the picture was taken the following spring.

Fertilizer can be broadcast and disked into the soil in preparing the seedbed, or can be applied through the fertilizer attachment to the grain drill when sowing the small grain in which grass and legume seeds are to be sown. Limestone should be applied and worked into the soil two or three months before seeding the pasture legumes, usually while preparing the seedbed for the small-grain nurse crop.

Preparing the Seedbed

The seedbed may be prepared by plowing and working the soil down thoroughly, or by thorough disking and harrowing alone. In either case preparation of the land should be begun a month or more before seeding time, if possible, so that the land may be fallowed during its preparation. This practice reduces weed seedlings in the new pasture and firms the seedbed. Final preparation should leave the seedbed firm underneath and loose on the surface. If the soil is dry on the surface the cultipacker is an excellent tool for finishing seedbed preparation.

Choice of Pasture Crops

Many failures in seeding pasture grasses and legumes occur because of poor judgment in seeding or an unwise choice of seeding

A well-pulverized, granular, compact seedbed, prepared well in advance of seeding, helps in accumulating moisture for good germination and establishment of stand.

practices. In general, little difficulty is experienced in getting good stands if good seed of adapted varieties of the right crops is properly sown on productive or well-fertilized soil.

The choice of crops for pastures in Kentucky depends primarily upon (1) soil conditions, (2) length of time the pasture is to stand, (3) kind of livestock for which the pasture is to be used, (4) seasonal grazing needs and (5) cost of seed.

Most Kentucky soils are of the medium to heavier types and therefore well suited physically for grasses and legumes. They vary greatly, however, in aeration, drainage, and fertility. Those that are well drained, well aerated, and fertile are suitable for all of the pasture crops commonly grown in Kentucky. Other soils are suitable only for those adapted to the soil in question. Fortunately there are at least a few pasture crops for each soil condition found in Kentucky.

The length of time the pasture is to stand is an important consideration in choice of pasture plants because some live only a year or two whereas others are practically permanent. Some become established so slowly that they ought not be sown unless they are to stand several years; others become established quickly and are valuable even though they stand but a few years.

The kind of livestock to be grazed on the pasture deserves some consideration in selecting pasture plants because economic

returns from different kinds of livestock appear to be related somewhat to the pasture plants. Further consideration is given this relationship in the section on utilization of pastures.

Cost of seed should be given consideration in selecting pasture plants only when other factors are unimportant or when price of a particular kind of seed is unusually high because of scarcity. Ordinarily the variations in cost of seed for different pastures are insignificant when evaluated as an annual figure for the life of the pasture.

Choice of crops for any given pasture must of course involve both grasses and legumes. It is seldom advisable to seed a pasture with a single species. A grass-legume mixture is more productive, better in over-all nutritive value, and usually longer lived than the pasture consisting of one species. Important characteristics of most crops used in permanent pastures in Kentucky are described in the following paragraphs.

Grasses

Kentucky bluegrass is a perennial sod-forming grass of high grazing value. It is a highly desirable pasture crop in the limestone region of central and northern Kentucky, known as the "Bluegrass Region," where it grows well generally with little or no soil treatment. On the well-drained soils outside this area, especially those of limestone origin, good bluegrass can be grown by liberal use of limestone and fertilizers. Kentucky bluegrass grows best in spring and fall. It is largely dormant during midsummer. Well-managed pastures of bluegrass and suitable legumes, especially white clover, are practically permanent.

Orchard grass is a bunch grass. Though a perennial, it is not long lived. Stands begin to thin after a few years and frequently become unsatisfactory after 8 to 12 years, particularly on hilly land. It is adapted to well-drained soils of medium to high productivity but does well on soils of limestone origin that are low in organic matter. Orchard grass is most useful for pasture during spring and fall. It is semidormant during midsummer. Properly managed orchard grass pastures are highly productive.

Redtop is a perennial sod-forming grass but redtop pastures live usually only 8 to 10 years in Kentucky. It is especially useful on wet bottom soil. However, it is high yielding on productive upland soils, particularly in late spring and early summer.

Timothy is a good grass for short-time pasture on good soil. The cost of seeding timothy is small, and getting a stand is easy. Though timothy is a perennial grass, stands seldom remain good

more than 3 years in Kentucky. It is valuable to furnish cover and pasturage while slower growing pasture grasses are becoming established. Timothy is usually one of the least costly grasses to seed. Early varities such as Marietta and Shelby are more productive in Kentucky than ordinary kinds.

Tall fescue is a vigorous, long-lived bunch grass. Its root system is dense and large and grows deep into the soil. It is adapted to practically all soils of Kentucky. It is exceptionally well adapted to wet and flooded land, yet it is one of the most drouth-resistant grasses suitable for use in Kentucky. Tall fescue is valuable for pasture primarily during the cool seasons of the year. If late summer and early fall growth is allowed to accumulate, this grass furnishes much winter grazing in Kentucky. At other times it should be closely grazed or kept short by mowing. Ky 31 fescue is one of the most widely grown varieties of tall fascue.

Smooth bromegrass is a perennial sod-forming grass. It is adapted to well drained, good land. In all stages of growth it is highly palatable. Broadly speaking, there are two types of smooth bromegrass—Southern and Northern. The southern type is almost twice as productive in Kentucky as the northern type. Achenbach, Lincoln, Fischer and Elsberry are varieties of the southern type. Southern smooth bromegrass can be used advantageously as a pasture grass on many farms in Kentucky. Perhaps it is most useful when its accumulated spring and early summer growth is used for grazing in midsummer. Continuous close grazing of smooth bromegrass is likely to destroy it. Leaf diseases are frequently severe on smooth bromegrass in midsummer.

Reed Canary grass is a perennial sod-forming grass. It is especially adapted to wet land and is seldom injured even when flooded for quite long periods. It is useful for pasture from late spring until fall.

Bermuda grass, despite its reputation as a pest, has qualities that recommend it as a pasture grass in Kentucky under certain conditions, particularly in mixtures for land that should seldom, if ever, be plowed. It grows from early summer until fall and is better adapted to hot weather than other pasture grasses adapted to Kentucky.

Legumes

Alfalfa is a perennial legume, well adapted throughout Kentucky to soil that is well drained, highly productive, and not more than very slightly acid. Continuous close grazing of alfalfa is injurious to the stand. Atlantic, Buffalo, and Ranger varieties of alfalfa are well adapted to Kentucky. Spreading alfalfas may have

a place in pasture mixtures in Kentucky. They produce less herbage than erect growing adapted varieties but may live longer under grazing.

Lespedeza is the name of a group of legumes. They are especially useful on the less productive soil of Kentucky but applications of limestone and fertilizer usually improve lespedeza pastures enough to pay the cost of treatment in a year or two.

Korean is by far the most extensively grown legume in Kentucky. It is a summer annual that matures in late September and furnishes grazing from early June until frost. It usually produces an abundance of seed even when closely grazed and consequently seldom fails to reseed in pastures. Climax, Rowan, and other varieties of Korean lespedeza have little if any superiority over ordinary Korean for Kentucky, except perhaps in the southwestern part of the state.

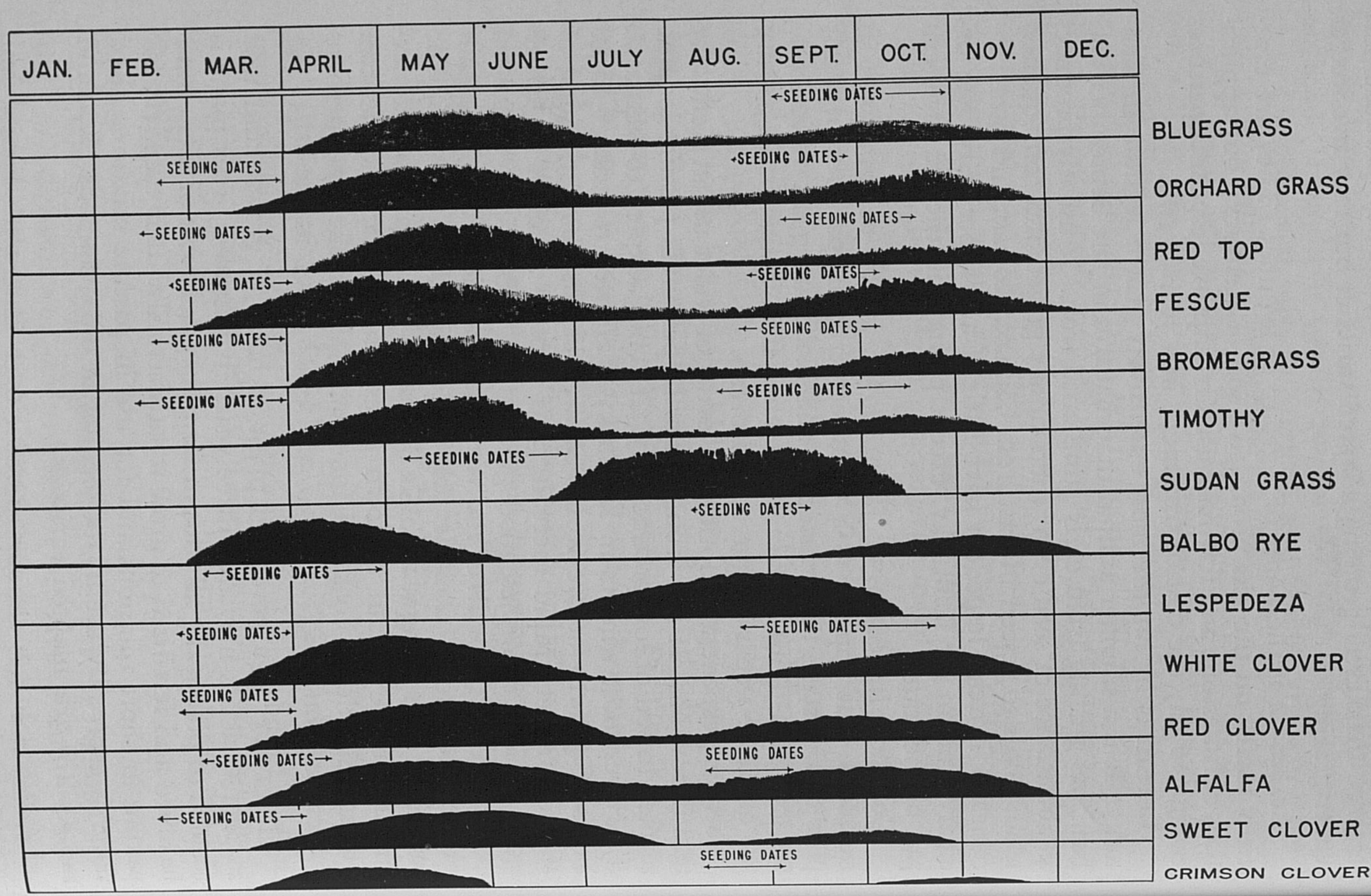
Common lespedeza, or Japan clover, is now seldom sown in Kentucky, but appears as a volunteer crop in pastures in many parts of the state. Tennessee 76 and Kobe are giant varieties of the common. Both remain green until frost and furnish pasture two or three weeks longer than Korean.

Sericea lespedeza doubtless is worthy of wider use in Kentucky than it now has. It is a drouth-resistant perennial pasture legume adapted to soil of low productivity. It is not adapted to wet land. It survives most winters in Kentucky if allowed to make 8 to 10 inches of growth before frost. Growth begins about the first of May and is very rapid thereafter. If kept to a height of 4 to 8 inches sericea furnishes good grazing. It is especially useful on the less productive soils of the Western Coal Fields and Mountain areas of Kentucky. Considerable interest has been shown in the possibility of growing it with Ky 31 fescue. To obtain such a mixture the fescue should be sown in established stands of sericea. The soil should be loosened for sowing the fescue, and perhaps the fescue should be sown in 7 or 14-inch rows, in the fall.

Red clover is a perennial plant in habit of growth and well adapted varieties may live three years in pastures. This plant is adapted to practically all soils in Kentucky but most of them must be limed and fertilized to grow it satisfactorily. It is excellent for pasture in short rotations and for use in pasture mixtures. Red clover is especially useful for seeding in old grass sods. Kenland and Ky 215 are adapted varieties.

Alsike clover is similar to red clover in growth habits, but somewhat better adapted than red clover to wet soils. In general it produces less pasture than red clover in Kentucky.

GRAZING PERIODS FOR PASTURE PLANTS



White clover is a perennial legume and lives indefinitely unless killed by drouth. It is adapted to all soils in Kentucky but many must be limed and fertilized to grow the crop satisfactorily. It is only moderately resistant to drouth. Perhaps it is better adapted than other pasture legumes to wet soil. White clover stems grow on top of the soil and root at the nodes. Thus only the leaves and flowers are grazed.

Two kinds of white clover are important in Kentucky—common or ordinary white and Ladino. Common white clover is a pasture legume of great value, particularly for growing with bluegrass. The continued productivity of old bluegrass pastures is undoubtedly due to the growth which white clover makes in the pastures, thus renewing the supply of available nitrogen. Kentucky-grown seed is adapted to Kentucky and is recommended in preference to seed from other regions. Southern-grown seed is recommended for use in Kentucky if Kentucky-grown seed cannot be obtained. Dutch white clover is not well adapted to Kentucky.

Ladino white clover is a large-growing white clover. It cannot be distinguished from the ordinary white clover except when the two are growing side by side. While ladino clover may be grown with Kentucky bluegrass and redtop, it is likely that it will be more usful with orchard grass or Ky 31 fescue.

Ladino clover does well in all parts of Kentucky. It is less resistant to certain diseases than adapted varieties of common white.

Crimson clover is a winter annual legume used considerably for spring pasture. It is sown often with one of the winter grains and the mixture produces excellent pasture in late winter and spring. This clover is adapted to practically all soils in Kentucky. Reseeding-hard-seeded varieties may be worthy of sowing in permanent pastures, as such varieties may volunteer if allowed to reseed.

Sweet clover is either annual or biennial, and there are two kinds of each of these—the white and the yellow. Practically all of the sweet clover grown in Kentucky is biennial. The yellow and the white kinds differ principally in the color of their flowers, as the names suggest. The yellow-flowered kind blooms about ten days earlier than the white-flowered kind, and has somewhat finer and shorter stems when mature. A few varieties of each of these biennial sweet clovers have been developed. Perhaps Evergreen, a white-flowered variety, is the most useful for pasture in Kentucky because it matures about two weeks later than ordinary biennial whites. Sweet clover should not be grazed close during the first year, because of danger of winterkilling, but during the sec-

ond year should be kept grazed short so as to be most palatable. Sweet clover will grow on practically any soil of Kentucky if it is not acid, and on acid soil if it is limed. It does not remain long in permanent pastures if grazed to capacity during the first year. It is therefore most useful in supplementary pastures.

Hop clover, a small-growing annual clover, has become very abundant in pastures in Kentucky in recent years. It has small, yellow blossoms which appear in June. The mature heads resemble a small hop—whence the name. The extremely small seeds ripen in June and July. The plant is a winter annual, that is, the seeds germinate in the fall. This clover provides pasture in the spring and early summer.

Yellow trefoil, or black medic, another annual or sometimes biennial legume, is abundant on limestone soils in Kentucky. The small yellow blooms appear at the same time as those of hop clover. It does not grow so upright as the latter. The seeds are much like alfalfa seed in size and shape. Though yellow trefoil has been recognized as valuable in pastures for many years, it has proved difficult to get stands of this crop, and it has never been extensively used in pastures.

Birdsfoot trefoil is a deep-rooted perennial legume rather well adapted to Kentucky and appears suitable for soil somewhat low in productivity as well as for better soil. It is drouth resistant, yet does fairly well on poorly drained land. It has fine stems and yellow flowers and is moderately leafy. Other than in color of flower, the plant resembles alfalfa in appearance though the leaves are lighter green. It is palatable and nutritious. Livestock seldom, if ever, bloat when grazing this legume. Broadleaved varieties of this legume are best for Kentucky. Imported seed is at least as productive of grazing as that produced in the United States. Seedings of birdsfoot trefoil are rather difficult to establish and at best become established slowly. Stands that appear poor the first year often become satisfactory in two or three years. It is perhaps better adapted to growing with bluegrass than with the taller growing grasses.

Kudzu is a large-leaved, viny, perennial legume that spreads rapidly by rooting at the joints of the prostrate, thick, vigorous growing stems to produce new plants or "crowns." Usually the stems are killed back to the crowns each winter and new stems develop the following spring. Except for winterkilling of the stems, kudzu appears to be generally winter-hardy in all parts of Kentucky. Kudzu is widely adapted to soils except those that are wet for considerable periods of time. Fertile soil needs no treat-

ment to grow kudzu, but soil of medium productivity should be limed moderately and fertilized liberally for best results.

Stands of kudzu are usually established by transplanting well-rooted crowns or cuttings during early spring before they begin growth. The plants are set from 3 to 7 feet apart each way. A crop of corn can be grown between the wider spacings. Kudzu plantings are also established from seed sown ¼ to ½ inch deep in rows on a good, well-drained seedbed at a rate of 15 to 20 seeds per foot of row. Four pounds will plant 1 acre where rows are 6 feet apart.

Kudzu furnishes palatable and nutritious pasture, and its carrying capacity is high if not overgrazed. However, it appears to have little, if any, place in Kentucky on land that is reasonably level and sufficiently productive for other good forage crops.

Buying Seed

Seeds of pasture plants offered for sale in Kentucky must be accompanied by a tag that shows the kind of seed, its germination and purity, including the amounts of noxious weed seeds present, if any. This information should be considered carefully when purchasing seed. Almost invariably the least expensive germinable crop seed will be secured by buying seed of high germination and purity.

Certified seed of an increasing number of improved varieties of forage crops is becoming available for farm seeding. This class of seed of the varieties adapted to Kentucky is recommended for sowing in Kentucky.

Inoculation of Seed

Despite the fact that inoculation of legume seeds is often not needed, it is best to inoculate legume seed with commercial cultures of the proper bacteria before seeding. If properly done, this assures good inoculation with vigorous strains of nitrogen-fixing bacteria. Well-inoculated legumes provide more and better grazing than those poorly inoculated.

Sowing the Seed

Seeds of pasture crops must be covered very shallow or the delicate seedlings will be unable to force their way to the surface. If the surface soil dries even slightly the germinating seeds may be destroyed. Chances of getting good stands depend greatly, therefore, upon seeding in a manner that assures uniform shallow covering of seed and favorable soil moisture conditions during

Seeding and cultipacking. Especially where the soil is dry on the surface, the cultipacker is excellent for finishing the seedbed.

the period of germination and seedling establishment. The latter conditions exist most commonly in spring, late summer, and fall; therefore pasture plants are seeded during those seasons of the year.

Late summer and fall seeding

Late summer and fall seedings are made approximately between August 10 and October 20. For these seedings the land should be prepared as long as possible before seeding, and harrowed at intervals to kill weed seedlings. Crimson clover always should be sown in late summer in Kentucky, and alfalfa is sown advantageously at that season. Fall-sown alfalfa is subject to attack by the crown rot fungus during early spring, and this fungus may reduce stands considerably. Crimson clover also it attacked by this disease. Apparently birdsfoot trefoil may be sown successfully in late summer. Red clover may be sown in late summer, but spring seedings generally are preferable. Pasture grasses may be sown in August without a nurse crop, but fall seeding in a nurse crop is more common and is so generally successful that the practice ought to be followed whenever possible. Furthermore, grass seedings that are well established in the fall are more likely than spring seedings to withstand drouths the following spring and summer.

Fall seeding of Kentucky bluegrass is particularly advisable.

September 10 to 20 may be regarded as the most favorable time. Good stands may be obtained, as a rule, by sowing as late as November 1 but the plants make such a small growth before freezing weather that they may be lifted out of the ground during the winter. Young orchard grass is not so winter-hardy as the other grasses, and unless the seed is sown by the first of October it is better to wait until late winter. Ky 31 fescue seeded after the first of October, especially if sown alone, may make little growth before winter, and consequently many of the seedlings may be lifted during winter and spring freezes. Late summer seedings of orchard grass and Ky 31 fescue without a nurse crop provide good ground cover during the winter and much grazing in the spring if soil moisture conditions are good at seeding and during the fall.

Few of the legumes are sufficiently winter-hardy in the early stages of growth to be sown safely in the fall. Alfalfa is a very rapid growing legume and, if sown early in September, usually becomes large enough to survive a moderate winter, especially in the southern part of the state. Seedings made later in September and early in October frequently survive the winter if sown with a moderate seeding of small grain. Seedlings of hop clover and yellow trefoil, or black medic, are seldom winterkilled.

Spring seeding

Good stands of grasses except bluegrass are usually obtained by sowing in late winter or very early spring. Most of the legumes, except winter annuals, are sown satisfactorily in the spring. Red clover, alsike clover, sweet clover, and sericea lespedeza are best sown in the spring in Kentucky. Korean, Kobe, and other annual lespedeza should always be sown in the spring.

There is considerable difference of opinion, even among experienced farmers, as to what time in the spring is best for seeding any particular legume. Experiment Station information on the subject is rather meager and indefinite, but it indicates that seedings may be made over a considerable period in the spring with more or less similar success in getting good stands. This is because the seedlings are subjected to a variety of hazards. In late winter and early spring they may be killed by severe freezes. In late spring and early summer dry weather may destroy them unless they are well rooted. In general, however, experimental information indicates that good established stands of each legume are more likely to be secured if each is seeded during a certain relatively short period.

The young plants of red and alsike clover are not easily injured by cold, but the sprouted seeds often are killed by freezing

weather if exposed on the surface of the ground. Clover seeded in late winter or early spring is usually successful if the seeds become well covered. This fails so often, however, that a larger percentage of good stands is obtained from later seeding. At Lexington, seeding between March 1 and 15, before or after light disking of the winter grain, has been most successful. Slightly earlier seeding would undoubtedly be better in western Kentucky.

Sweet clover and alsike clover should be seeded at about the same time as red clover.

Alfalfa probably should not be sown until danger of severe freezing weather is past. Late March or early April seedings may be regarded as safest. Alfalfa often is a failure when sown in a crop of wheat or other winter grain in the spring, because the roots are heavily attacked by meadow nematodes and the plants die. Similar but less severe damage probably occurs in red clover and other legumes sown in a winter grain.

Seedlings of Korean and other annual lespedezas are easily killed by heavy frost; consequently seeding these crops in late March or early April, before or after light disking of land in winter grain, produces the largest number of successful stands except, perhaps, seeding in spring-sown oats or on a specially prepared seedbed.

Nurse Crops

Sowing pasture crops with one of the small grains, usually called a nurse crop, is generally a wise practice in Kentucky. The chief advantages of the nurse crop are that it checks development of weeds and protects the soil against erosion. It competes, of course, with the grasses and legumes and may cause loss of stands, especially during dry weather. However, pasturing the small-grain crop largely avoids that danger. The protection against erosion afforded by the nurse crop is extremely important in Kentucky on even slightly rolling land where pasture crops are sown on a specially prepared seedbed. Seeding the nurse crop in 14-inch rows on the contour—accomplished by covering alternate outlets in the drill—affords soil protection without seriously affecting the establishment of new pasture seedings. Liberal fertilization when sowing the grasses and legumes increases the chances of survival of the new seedings.

A nurse crop for alfalfa, and possibly for sweet clover is seldom necessary. Both legumes grow very rapidly under favorable conditions, and a good stand usually survives weed competition successfully. However, when seeding alfalfa is the spring on a newly prepared seedbed it is usually best to sow it with an oat nurse crop.

Ky 31 fescue germinates so quickly and grows so rapidly in the seedling stage that usually it is unnecessary to sow a nurse crop with it. However, a seeding of Ky 31 fescue on a very dry seedbed in the fall may produce little or no growth before winter. During very dry weather, therefore, a small grain should be sown before sowing the fescue, to protect the fescue during the winter, provide winter and spring pasture, and prevent soil erosion.

For Kentucky, wheat is probably a better nurse crop than rye, unless the rye is pastured. Winter barley, if not too thick or if pastured, is very satisfactory. Unpastured barley on very fertile soil makes such a rank growth as to smother the crops sown with it. Spring oats usually make an excellent nurse crop for spring seedings of pasture crops. The varieties Columbia, Andrew, Mo. 0200, and Mo. 0205 are recommended because they mature early and stand up well. For nurse-crop purposes they should be sown at light rates, not over 4 pecks per acre.

Nurse crops should be grazed or clipped so that they offer as little competition as possible for pasture seedlings. If harvested for grain not more than one ton of straw, evenly distributed, should be left on the field.

Methods of Sowing Seed

Perhaps as many failures to get stands of pasture plants particularly of spring-seeded legumes, are due to imperfect covering of the seed as to any other cause. It is most important to get the seed covered thoroughly at the proper depth on a firm seedbed. Uncovered seed are likely to be injured by alternate wetting and drying or by freezing after they have absorbed water. If there is enough moisture to sprout the seeds, either freezing or drying may destroy them. The chief disadvantage of sowing legume seeds in late winter or early spring is the difficulty of getting an adequate covering. On heavy soil where the surface "honeycombs" in freezing, it is not so difficult provided it lasts long enough for the seeding to be done.

Usually a good covering can be obtained in the spring by sowing when the ground is dry enough for using a clover seed drill or some implement to stir the surface lightly before or after seeding. A spike-tooth harrow is good for this purpose on land free from trash. A disk harrow with the disks set almost straight, or a grain drill, prepares a good seedbed and is especially useful on trashy land. A rotary hoe is good. The ground should be worked only enough to loosen a small amount of soil. Very little seed will be covered directly, but even a light shower settles this loose soil, resulting in an excellent covering of the seed. On the average,

this method of seeding gives better stands than seeding on frozen ground. If the ground is dry enough to stir, there is little danger of the seed sprouting until a rain occurs. Harrowing fields that have been sown to grasses in the fall causes little or no injury to the stand. If the soil cannot be stirred, it is better to seed early, as alternate freezing and thawing and rains may accomplish some covering. Seeding should be done either on frozen or dry ground, rather than on a wet surface.

In spring or fall seeding of either grasses or legumes on a loose seedbed, rains cover the seed without harrowing; in fact, it is unsafe to use an implement as the seeds are likely to be covered too deeply, especially in the spring. Where the soil is quite loose, it is advisable to use a culti-packer before sowing the seed. Under average conditions it is a good practice to sow the seed with the grass-seeding attachment of the grain drill, when the nurse crop is sown. The seeds should fall behind the disks or among them, rather than in front. Some kinds of seeds cannot always be sown heavily enough with grass-seeding attachments.

Summer seeding on a dry seedbed is perhaps best done with a cultipacker equipped with a seeding attachment. If this is not available the land may be rolled with a cultipacker, seeded, and then cultipacked again. Or in lieu of the second rolling the land may be given a light drag harrowing or "brushing." Or the seed may be sown with a clover seed drill if the land is quite firm.

The horn seeder is extensively used in Kentucky for sowing pasture and meadow crops, probably because it costs so little. After considerable experience, it is possible to sow most of the heavier seeds quite evenly with this seeder. It is much easier to get uniform distribution with one of the rotary seeders, however, and the amount of seed sown can be regulated more accurately. The wheelbarrow seeder is decidedly the most satisfactory of all hand broadcast seeders on fairly level land. It sows evenly, and any desired amount of seed can be sown with accuracy. It can be used on windy days also, which is a great advantage. Since it sows a strip 14 feet wide, from 25 to 30 acres can be seeded per day. Double-hopper wheelbarrow seeders are adapted for sowing light, chaffy seeds, such as orchard grass and bluegrass, as well as clover, timothy, and other heavy seeds.

The clover-seed drill is an excellent implement for sowing heavy seeds. It is constructed on the same principle as a grain drill, and the feed is the same as on the grass-seeding attachment of the grain drill. On a good seedbed the seeds are covered, but on hard ground the disks merely cut a shallow channel in which the seeds are deposited. However, even a light shower covers the

It is risky to prepare a smooth seedbed on a fairly steep slope. Before a sod can be established, rains may gully the land.

seed very effectively. A rotary hoe with a grass-seeding attachment is a good seeding implement and valuable for other uses.

A grass-seeding attachment on the grain drill is an excellent tool for sowing timothy and redtop with grain in the fall, or any of the heavy seeds with oats in the spring. Orchard grass, Ky 31 fescue, and bluegrass cannot be sown through the attachment, however. Where rather heavy seedings of the latter kinds are to be made, the seeds can be put into the grain box and sown the same as grain. To prevent bridging, the agitator provided for sowing oats should be used in sowing orchard grass and bluegrass, or cracked corn may be mixed with the grass seed to give more weight. This is not necessary, usually, if clover or other heavy seeds are sown with the grass seed. To get a uniform distribution of the seeds, the drill tubes are removed. A drill setting of 3 pecks on the wheat scale usually sows about 15 pounds of orchard grass seed per acre, a setting of 2 pecks sows a bushel of bluegrass seed, and a setting of 1 peck sows about 10 pounds of Ky 31 fescue seed. This applies to well-cleaned, full-weight seed. If the seeds are trashy, the drill must be set to sow at a higher rate.

Smooth bromegrass seed is difficult to sow because the individual seeds are large and chaffy. If no mechanical seeder that sows this seed satisfactorily is available, the seed must be sown by hand or mixed with oats, cracked corn, or other material to provide bulk, and sown through the oat runs of a grain drill. It may be sown with an end-gate seeder also, but a cultipacker or other

tool should be used afterwards to cover the seed. It is very important that smooth bromegrass seed be covered one-half to three-fourths inch.

In order to do a good job of seeding it is sometimes desirable to mix the seed with some inert material. Commercial fertilizer is one of the best materials for this purpose. The seed may be sown at the proper rate by mixing the amount of seed desired to sow to an acre with a definite amount of fertilizer—from 100 to 300 pounds of fertilizer per acre—and then sowing the mixture through the fertilizer attachment of a grain drill, or a fertilizer spreader, set to sow that amount of fertilizer. Superphosphate or a complete fertilizer may be used. This method distributes the seed properly and furnishes plant food for the seedlings. It is especially useful in sowing smooth bromegrass. Seeding machines that place the fertilizer below the seed or in bands near the seed appear to be highly effective in establishing vigorous seedings with minimum effect on the growth of the nurse crop or of weed seedlings.

Rate of Seeding

Seeding experiments show that pasture crops may be seeded at much lower rates per acre than commonly practiced if the seeds are sown evenly in a good seedbed and covered properly. However, seeding is seldom done perfectly; consequently it is advisable to sow at somewhat higher rates that will allow for some degree of imperfect seeding. The rates given below are for such seedings when the respective crops are sown alone. Sowing at somewhat heavier rates will do no harm and for special situations may be advisable. Except for Korean lespedeza, seedings on soils of low and medium productivity should be at the higher rates. In sowing mixtures of legumes and vigorous growing grasses, especially at heavy rates, it is usually advisable to sow the grasses in rows so that the legumes will have relatively little competition from the grass. Orchard grass may be sown in 7-inch rows and Ky 31 fescue in 7-or 14-inch rows.

	Pounds per acre
Alfalfa	12 to 20
Alsike clover	6 to 8
Crimson clover	12 to 20
Kentucky bluegrass	12 to 15
Ky 31 fescue	10 to 15
Lespedeza—Korean and Kobe	20 to 25
Orchard grass	10 to 15
Red clover	8 to 12
Redtop	5 to 6
Sericea lespedeza	30 to 35
Smooth bromegrass	15 to 20
Sweet clover	8 to 10
Timothy	8 to 10
White clover, including Ladino clover	3 to 5

Some Seeding Mixtures for Permanent and Semipermanent Pastures

(Rates in pounds of threshed, clean seed per acre. Mixtures listed are intended to be suggestive of possibilities.)

For highly productive soil

No. 1

Kentucky bluegrass	15 lb
Kenland red clover	8 lb
Lespedeza	5 lb

No. 2

Kentucky bluegrass	15 lb
Alfalfa	8 lb
Lespedeza	5 lb

No. 3

Kentucky bluegrass	15 lb
Ladino or white clover	½ lb
Lespedeza	5 lb

No. 4

Orchard grass	8 lb
Kenland red clover	6 lb
Lespedeza	7 lb

No. 5

Orchard grass	8 lb
Alfalfa	8 lb
Lespedeza	7 lb

No. 6

Orchard grass	7 lb
Kenland red clover	4 lb
Alfalfa	4 lb
Lespedeza	5 lb

No. 7

Orchard grass	10 lb
Lespedeza	10 lb

No. 8

Orchard grass	10 lb
Ladino or white clover	½ lb

No. 9

Orchard grass	8 lb
Alfalfa	8 lb
Ladino or white clover	½ lb

No. 10

Ky 31 fescue	10 lb
Ladino or white clover	½ lb
Lespedeza	7 lb

No. 11

Ky 31 fescue	8 lb
Kentucky bluegrass	10 lb
Kenland red clover	7 lb
Lespedeza	5 lb

No. 12

Smooth bromegrass	8 lb
Ladino or white clover	½ lb

No. 13

Smooth bromegrass	8 lb
Alfalfa	8 lb
Ladino clover	½ lb

No. 14

Timothy	5 lb
Kentucky bluegrass	10 lb
Kenland red clover	7 lb

No. 15

Orchard grass	8 lb
Sweet clover	7 lb
Lespedeza	8 lb
Ladino or white clover	½ lb

No. 16

Ky 31 fescue	8 lb
Sweet clover	7 lb
Lespedeza	8 lb
Ladino or white clover	½ lb

NOTE: White clover seed should be Kentucky or southern grown. For hogs, mixtures of alfalfa, Ladino, and red clover may be superior to grass-legume mixtures.

For soil of medium fertility

No. 1

Orchard grass	10 lb
Redtop	3 lb
Lespedeza	5 lb

No. 2

Redtop	5 lb
Lespedeza	5 lb
Hop clover	1 lb

No. 3

Ky 31 fescue	10 lb
Lespedeza	10 lb

No. 4

Ky 31 fescue	10 lb
Sericea lespedeza (scarified)	30 lb

(Establish sericea before seeding fescue.)

Five pounds Canada bluegrass may be added to any of the above mixtures to good advantage.

For wet land, state as a whole

For pastures on "wet" land on which water does not stand:

No. 1

Redtop	6 lb
Alsike clover	5 lb
Lespedeza	5 lb

No. 2

Ky 31 fescue	10 lb
Ladino clover	½ lb
Lespedeza	8 lb

For pastures on land on which water stands more than 10 days in winter or more than 3 days in summer:

No. 1

Reed canary grass	15 lb
Lespedeza	8 lb

No. 2

Ky 31 fescue	10 lb
Lespedeza	8 lb

CHAPTER 2

MANAGING AND MAINTAINING PASTURES

Fertilizing Established Pastures

Does your pasture need fertilizing?

The yield and quality of pasture plants, like that of other crops, is in proportion to the productive capacity of the soil on which they grow. Soil fertility is one of the major factors influencing the productive capacity of soils. Although the supply of available plant-food materials is not depleted as rapidly by pasture crops as by cultivated and harvested crops, additional fertilizers are needed to restore what is removed by the grazing animals and by unavoidable losses. While not all pastures need fertilizing every year, most or all of them respond profitably to top-dressing at certain intervals. The decision as to whether a pasture field needs fertilizing should be based upon the supply of available plant-food materials in the soil, the kind of plants making up the pasture mixture, seasonal conditions, and the economic conditions that prevail at the time.

How recognize the need for fertilizer in a pasture?

The plants themselves, where they are observed closely, are the best indicators of deficiencies of plant-food materials. Actual applications of materials on marked areas, followed by careful observations of growth and grazing by livestock, will reveal response to various fertilizer treatments. Field trials and observations may be supplemented by soil tests made in the soil-testing laboratories. These tests, if carefully made and accurately interpreted, provide useful information as to the soil reaction and the available supply of the principal plant-food materials.

Controlling soil acidity

Since it is highly desirable to maintain legumes in a pasture mixture, it is necessary to lime most Kentucky soils at intervals to control acidity. Even when soils are adequately limed at the time the pastures are established, they gradually become acid in reaction. Difficulty in maintaining satisfactory stands of the more desirable pasture legumes is often due to the lack of lime and may indicate the need for an additional application of lime. When plant growth or soil tests indicate a soil reaction approaching pH 6.0, an application of 1 to 2 tons of agricultural ground lime-

Pasture soils, even when limed adequately when the pasture is established, gradually become acid, and usually such soils need reliming at about 8-year intervals.

stone per acre is recommended. For sandy soils the lighter application would probably be adequate, while for those high in clay content the heavier application is recommended. The field should be checked for need of lime at intervals of about 8 years. Any application of lime may be applied as a top-dressing on the pasture field or worked in when renovating the pasture. Don't put on more lime than the tests call for.

Keeping up the nitrogen supply

On most Kentucky soils the greatest need for plant nutrient elements is for nitrogen. Nitrogen should generally be supplied by properly inoculated legumes. When the vegetation is mainly grass, or where legumes make up less than half the herbage, annual applications of 30 to 90 pounds of actual nitrogen is recommended. This amount of nitrogen may be applied in March in liquid form, anhydrous ammonia or the more common granular forms of nitrogen fertilizers, whichever can be applied most economically at the particular location. A June application of 30 to 60 pounds of actual nitrogen is recommended to increase summer pasture if there is enough rainfall, or if the pasture can be irrigated.

Keeping up the potassium supply

Another of the plant nutrients frequently becoming inadequate for highly productive pastures is potassium. Legumes use large quantities of this element, and the supply of available po-

tassium is deficient in many areas. Top-dressing with potassium fertilizers at least in alternate years is suggested for permanent pastures. Fifty to 80 pounds of K_2O (about 80 to 130 lb muriate of potash or the equivalent) should be adequate as a single application for most situations. Where the supply of potassium has been severely depleted, annual applications at the above rate would probably be profitable.

Keeping up the phosphorus supply

Most Kentucky soils, except for a few soils in the Bluegrass section, have too little phosphorus. On such soils heavy applications of phosphorus should be made when preparing the seedbed for establishing the pasture or when renovating old pastures. Top-dressing established pastures with about 80 pounds of P_2O_5 at 3-year to 4-year intervals should maintain the phosphorus content of soils used for pasture. This amount of phosphorus may be supplied with about 400 pounds of ordinary superphosphate or the equivalent. If rock phosphate is used apply 700 to 800 pounds per acre at 3- or 4-year intervals.

Using mixed fertilizers on pastures

Where two or all three of the elements mentioned above are needed on a pasture, it is usually more satisfactory to apply them as a mixed fertilizer. Top-dressing with 400 to 500 pounds of

For best results, permanent pastures usually need top-dressing of potassium about every other year, and of phosphorus at 3-year to 4-year intervals.

0-10-10 or 0-12-12 per acre on alternate years should maintain the supply of phosphorus and potassium on permanent pastures, except that where the supply of available potassium has been severely depleted, 300 to 400 pounds per acre of 0-10-20 should be applied annually. Other mixed fertilizers, applied at a rate to supply equivalent plant food, also may be used. If the legume population is maintained to equal that of the grasses in the mixture, no additional nitrogen would be needed except during unfavorable weather.

When the need for extra production is great and when economic conditions justify highly intensive production, annual applications of 500 to 1,000 pounds of 8-8-8 or 10-10-10 grade fertilizer per acre is suggested. If manure is available for top-dressing pastures, 5 tons per acre supplemented with one bag of superphosphate per ton of manure is recommended.

Renovating Pastures

Most permanent pastures eventually become more or less unproductive. Some of the desirable kinds of plants thin out or disappear from the stand, especially legumes. Where this occurs the pasture may be plowed and put into another crop, or the pasture may be renovated.

Renovation is a direct method of converting a low-producing pasture into a high-producing pasture without growing a culti-

Spreading manure where turf is thin gives temporary protection from grazing, fertilizes the grass, and mulches the land to protect against erosion.

vated crop between. It may consist of completely destroying the old vegetation, fertilizing, and reseeding; or it may consist of a light disking, fertilizing, and reseeding certain plants, usually legumes.

When a pasture needs renovating

Properly fertilized pastures, even when carefully grazed and mowed, have a tendency to become less productive. This deterioration is due to several things. Trampling by grazing livestock tends to compact the soil and reduces aeration and water penetration. Many of the better pasture grasses and legumes tend to go out and less desirable weed grasses and other weeds come in. There is often an accumulation of undecomposed organic matter at the surface of the soil which, although it permits the entrance of more water into the soil, tends to tie up some of the available nitrogen and may result in a condition known as "sod-binding." Such pastures should be renovated.

Will it pay to renovate pasture?

Does it always pay to renovate poor-producing permanent pasture? Here are three points to consider in figuring whether it will be profitable:

1. Will the value of the added pasture production *plus* the value of erosion control *minus* the cost of renovation be greater than the net return which could be gained from some other use of the land? Returns credited to pasture renovation should include a reasonable value for greater production and better quality of pasture, and for a more uniform distribution of pasture through the season. Costs and returns should be figured for the full expected life of the renovated pasture—for example, for 3, 4, 5 or more years.
2. If resources are limited and could be used for other farm enterprises, will the returns from putting the resources into pasture improvement be greater than the returns which could be expected if the resources were used for another enterprise? If a given farmer has plenty of resources of capital, labor, and such for all his farm enterprises, this is not an important consideration.
3. Will increased pasture production have an effect on total net farm income (not directly chargeable to value of increased forage) greater than the cost of pasture renovation? For example, on a given farm an increase in size of total farm business might be much needed and the increase might depend upon improving the quantity and quality of production on the permanent pasture.

For further discussion of this subject, see Kentucky Agricultural Extension Circular 498, "Planning for Economic Production of Pasture."

New seed drilled into this thin turf, along with needed fertilization, will restore the stand in this damaged pasture.

Choice of renovating procedure

Top-dressing old pastures for increased production is often an inadequate remedy. The response to lime and fertilizer is often slow and the problem of a uniform supply of pasture throughout the grazing season is difficult to obtain by such means. Therefore, reseeding to grasses and legumes such as alfalfa, Ladino, orchard grass, and tall fescue is likely to produce more desirable results.

Preparing a seedbed

Recently machines have been developed which will place seed and fertilizer in an established sod. The placement of the fertilizer in the soil near the seed may overcome the need for a rather complete kill of the existing vegetation in order to reduce competition with the new seeding. Until these machines have proven their worth, however, it probably should be assumed that the first step toward a good seedbed is the killing of the existing vegetation.

Where erosion is no hazard, the plow is probably the best implement. Because so many Kentucky pastures are on rolling or steep land the heavy cutaway disk (bush-and-bog harrow) will likely be the most popular implement. However any implement which will work up the top three or four inches of soil will be satisfactory. In very stony ground it may be necessary to use herbi-

The bush or bog harrow is popular in Kentucky for preparing a seedbed on old pastures on sloping land because it works the vegetation into the soil and offers less exposure to erosion than on land that is plowed.

cides to kill existing vegetation so that the seeded grasses and legumes can be established.

Some special precautions should be taken when renovating pastures on steep slopes or highly erodible soils to prevent gullying or serious loss of surface soil. A system of diversion terraces is recommended for protecting such areas while the pasture is being renovated and afterward. The planning and construction of these erosion control devices should be done with the assistance of technically trained and experienced help.

Time of renovation

There is no best time for renovation. Early spring, late March, or early April would likely be most favorable from a moisture standpoint. However, late summer or early fall might be the best time to kill the old vegetation. Favorable moisture during this time would insure a good stand and the loss of use of the pasture would be the least if renovated at this time.

Fertility considerations

Renovation is not complete without proper fertilization. Soil tests will give an indication of the need for lime and fertilizer. The lime should be applied and worked into the soil during seedbed preparation. The fertilizer should be a complete fertilizer

and should contain enough nitrogen so that at least 30 pounds of actual nitrogen is applied per acre.

Seeding and management

Seed-mixtures for reseeding old pastures should include grasses and legumes that are adapted to the purpose for which the pasture is to be used and to the soil conditions. (See the section on seed mixtures for suggestions relative to grasses and legumes suitable for various land conditions and uses.)

Seed should not be covered too deeply. When drilled it should be put in no deeper than one-half inch. If the seed is not drilled it may be seeded on the surface of the prepared seedbed and a cultipacker used to firm the soil around the seed and to cover it to the extent needed.

Potentially productive pastures may easily be ruined by mismanagement soon after renovation. Control of weeds without damage to the young legumes or grass is the objective of the management program the first year. Light grazing will help to control weeds but damage may result if the area is too wet or too dry. If areas in the field become weedy, clip low before September 1. Neither pasturing nor mowing of the newly renovated pasture should be done after September 1.

Clipping pastures, both for controlling weeds and removing excess forage, is an essential practice in good pasture management.

Irrigation of Pasture Lands in Kentucky

The irrigation of pasture and meadows in Kentucky materially reduces the risk of feed shortages caused by drouths and seasonal variation in rainfall. The average rainfall in western Kentucky for the early months of the grazing season, March, April, May, and June, is 4.40 inches per month. For July, August, September, and October it is about 25 percent less, or 3.23 inches. For the eastern part of the state the average rainfall during March, April, May, and June is 4.06 inches per month and for July, August, September, and October, 3.28 inches.

On most livestock farms the demand for pasture is greater late in the grazing season as young stock approach the marketing season. Since, as a rule, least pasture is available when it should be greatest, supplemental feeding is necessary to prevent loss of early gains or the number of livestock must be reduced to that which can be pastured during the low period of pasture production.

During dry years there is a shortage of forage for supplemental feeding as well as of pasture. To overcome the hazard of losses due to lack of pasture, many farmers stock their farms with 1/2 to 2/3 of the livestock that could be carried during a season of evenly distributed rainfall.

Although irrigation of pasture is a comparatively new practice in Kentucky, farmers have had enough experience to indicate that

Availability of irrigation facilities for at least part of the pasture acreage on a farm is good insurance against pasture failures.

it is an effective means of reducing the hazards of livestock production. The chief benefits reported by farmers are as follows:

1. Increases the number of livestock that can be produced on a farm without risk of overstocking in drouth years and at periods of the year when pasture growth is below normal because of unfavorable weather.
2. Eliminates the hazard of failure of grass and legume seedings from lack of moisture, with the loss of seed and labor, as well as of the expected pasturage.
3. Guarantees early germination and continued rapid growth of fall seedings of winter cover crops on rotation crop land.
4. Makes possible good production of forage crops for silage or hay during periods of dry weather.

The benefits to be gained from irrigation are indicated by the results of pasture irrigation research work conducted by the Kentucky Agricultural Experiment Station at Steelway Farm in Bourbon County in cooperation with the Republic Steel Corporation, and on the Experiment Station Farm in Fayette County.

Steelway Farm in Bourbon county, 1951-52

Ten pastures ranging in sizes from 1.60 to 2.05 acres each were fenced and given fertilizer treatments during the summer of 1950. The original vegetation was mostly Kentucky bluegrass with some white clover. Treatments consisted of (1) 30 pounds of nitrogen per acre in spring, midsummer and early fall, (2) 600 pounds 6-8-6 fertilizer per acre, (3) check, no treatment, (4) Korean lespedeza seeded on surface, (5) Ladino clover seeded on surface. Each of these treatments was made on two pastures, one of which was irrigated. Thus, there was no replication of plots and the results should be considered in that light. The soil is very high in available phosphorus and low to medium in available potash. Topography varies from nearly level to sharply rolling. Production of these pastures was measured by grazing steers and clipping caged areas.

During the 1951 growing season rainfall was between 4 and 5 inches less than normal at Lexington in adjoining Fayette county. In 1952 there was a deficit of nearly 4 inches. During the 1951 growing season 21 acre inches of water was applied at an estimated cost of $2.30 per inch, while in 1952, 15 acre inches costing $2.68 per inch was applied.

One of the most striking results of this work has been the great increase in the proportion of white clover in the irrigated pastures. Results obtained from the five non-irrigated pastures and the irrigated ones are given for both 1951 and 1952 in Table 2.

Table 2.— Results of Irrigation, Steelway Farm

Measure of production	Non-Irrigated		Irrigated	
	1951	1952	1951	1952
Total gain, lb/A	351	274	429	429
TDN, lb/A	2816	2236	3658	3694
Steer grazing days/A	272	232	368	379

Experiment Station Farm, 1951-52

In the fall of 1950 four 1-acre pastures were seeded to bromegrass, orchard grass, Ky 31 fescue, birdsfoot trefoil, and Ladino clover. Soil tests indicated a need for lime and potash and these were applied prior to seeding. The area is high to very high in available phosphorus. During 1951 the following treatments were compared: (1) no treatment, (2) nitrate, (3) irrigation, and (4) nitrate plus irrigation. On the nitrogen plots 100 pounds ammonium nitrate per acre was applied three times during the growing season. Seven 1-inch applications of water were made to irrigated plots during 1951.

In 1952 all plots were nitrated with 100 pounds ammonium nitrate three times and two of the four plots received nine 1-inch applications of water. Both 1951 and 1952 were dry years, the rainfall during the growing seasons being approximately 3.6 and 5.5 inches, respectively, below normal.

Ky 31 fescue and Ladino clover have been predominant from the beginning. By the end of the 1952 grazing season the vegetation consisted almost entirely of fescue on the non-irrigated plots while on the irrigated pastures a near-ideal mixture of fescue and clover was present. A summary of the two years results is given in Table 3.

Table 3.— Pasture Irrigation, Experiment Station Farm

Measure of production	No treatment	Nitrate only		Irrigation only	Nitrate plus irrigation	
	1951	1951	1952	1951	1951	1952
Fat-corrected 4% milk, lbs/A	7,594	6,575	4,581	10,045	10,033	6,493
TDN, lb/A	2 481	2,564	2,497	3,177	3.269	3,653
Dry matter, lb/A	5,981	7,043	3,756	6,757	8,551	5,325
Cow grazing days/A	199	224	184	254	272	273

Suggestions for pasture irrigation

1. Irrigation is most profitable on fertile soils.
2. Irrigation is most profitable where crops of a high cash value per acre are grown on fertile soil. Therefore, the irrigation of pasture for dairy cattle will be more profitable than for beef cattle.
3. With irrigation, rotation grazing is often practiced to advantage.
4. The irrigation of alfalfa after each cutting, if rainfall is not plentiful, appears to be a profitable practice in Kentucky.

5. If water is to be provided in irrigation reservoirs, at least 1½ acre-feet should be stored per acre to be irrigated.
6. On most farms it will be necessary, because of a lack of water, to concentrate pasture irrigation on only a portion of the permanent pasture or on supplemental or emergency pastures.
7. The total cost, including interest and depreciation, of irrigation at the experimental project at Steelway Farm in Bourbon county in 1952 where 150 acre-inches were delivered to 10 acres was $2.68 per acre-inch. On other farms total costs have been reported as low as $1.67 per acre-inch where 254 acre-inches were delivered to 39.5 acres.
8. The rate of application for pasture should not be high enough to cause run-off. Only on sandy bottomland soils and deep, loamy well drained, ridge soils should the rate of application exceed .40 or .50 inches per hour.
9. Enough water should be applied at one irrigation to reach the feeding roots of the grass or legume being irrigated. An examination of the soil at that depth should determine the need for irrigation and when enough water has been applied. Irrigation should begin when soil is crumbly but will hold together in a ball, and should be discontinued when water will come to the surface of a ball when it is squeezed.
10. Drouth-resistant grasses and legumes respond to irrigation about as much as those that are not considered drouth resistant.
11. New seedings can be more profitably irrigated in late summer and fall than can old established stands containing plants which have reached maturity or the dormant stage.
12. Nitrogen and other fertilizers which can be easily dissolved in water can be applied to the soil in irrigation water.

Control of Weeds in Pastures

Maintaining high soil productivity is in general the most important practice for controlling weeds in pastures. Mowing and controlled grazing are also effective.

In very weedy pastures where good perennial grasses are thin, renovation and reseeding is probably the most important improvement practice. Reseedings to be successful should be made on a good firm seedbed. New seedlings should be protected from grazing until established and should be grazed moderately during the remainder of the first year. Plowing and seeding to adapted grass or pasture mixtures where practicable will almost eliminate many of the perennial pasture weeds. This practice supplemented with 2, 4-D treatment is likely to give far better control of all weeds than either 2, 4-D treatments or mowing if the pasture were not renovated.

Mowing has been the recommended practice for controlling many kinds of weeds if done at the right time for 2, 3, or 4 years. In general, mow such herbaceous weeds as ironweed when in bud to blossom stage. Ragweeds are best controlled by mowing after plants have made considerable growth so that new shoots will not start up so readily.

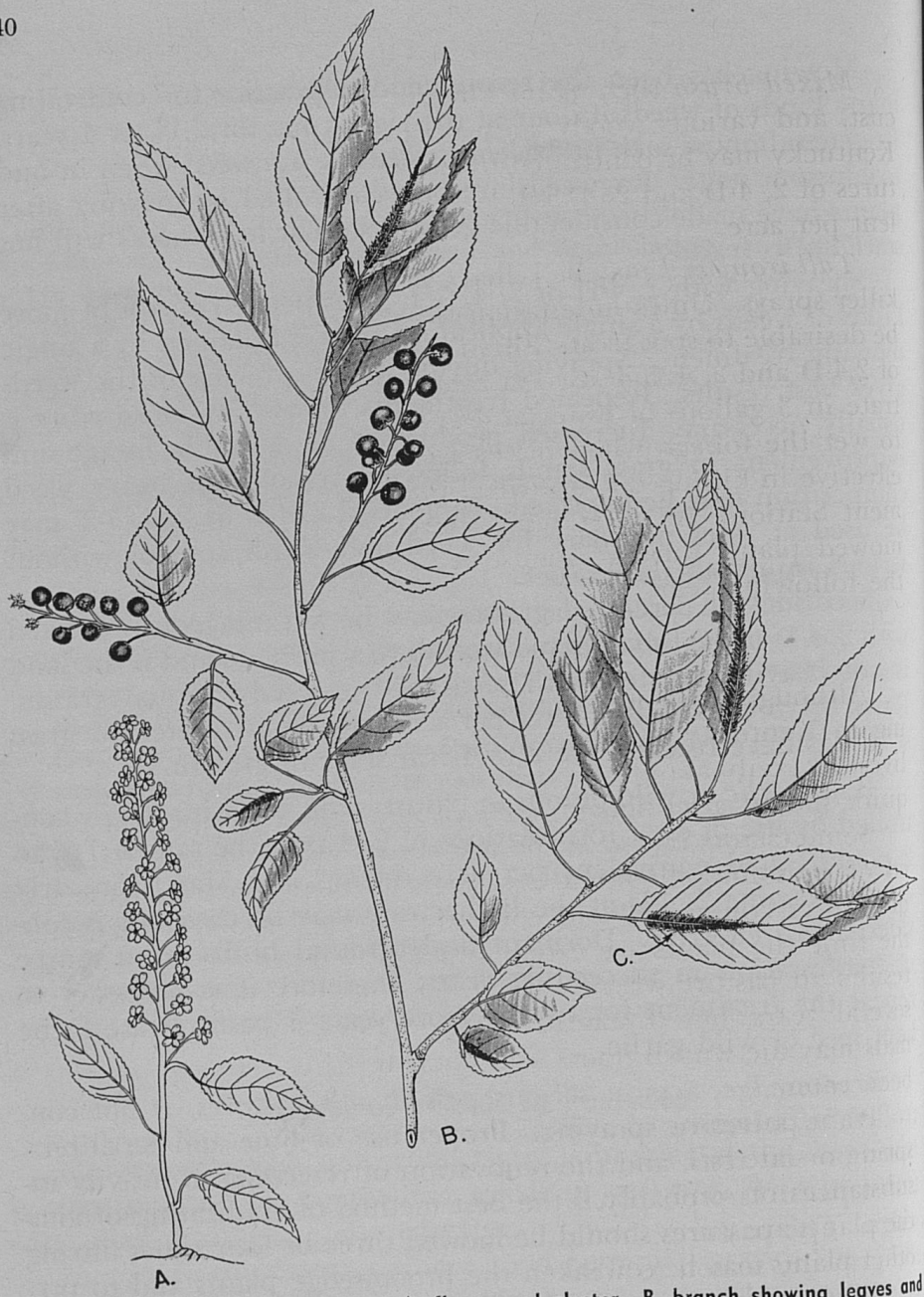
Spraying with 2, 4-D or 2, 4, 5-T gives better control of more kinds of weeds by a single application than is obtained by a single mowing treatment. Spraying during active growing of the weeds gives best results. Repeated treatments for two or more years is usually necessary. Increased production of desirable forage and improvement in grass stands following removal of heavy weed competition may be expected. In general 2, 4-D or 2, 4, 5-T may be used at rates necessary for weed and brush control without serious injury to the grasses.

Seedlings of perennial grasses may be advantageously treated with 2, 4-D if the broadleaved weeds are a problem and if the land is not heavily infested with seeds of the weedy annual grasses. Rates up to ¾ pound of ester per acre may be used after the grass seedlings have reached the 2 to 4 leaf stage of growth.

Wild garlic or wild onions in pastures can be satisfactorily controlled by use of ester formulations of 2, 4-D at the rate of 1½ to 2 pounds acid equivalent per acre during late March or early April. Armine 2, 4-D at the higher rate may be used but is considered less effective. Dormant underground bulbs are a source of reinfestation in succeeding years; therefore it is necessary to repeat the treatment for two or more years if pastures are to be kept free of wild garlic.

Broomsedge, a most serious pest in old pastures, is not controlled by selective spraying. Proper use of lime and fertilizers, based on soil tests, and the renovation of reseeding of heavily infested pastures probably is the best method of eradicating broomsedge. The pastures should be mowed three or four times during the growing season to weaken the broomsedge plants and to prevent seed production. Grubbing out of scattered plants of broomsedge or spot treating them with Sodium TCA in late summer has been effective in tests at the Experiment Station.

Sour dock (sheep sorrel) is not readily killed by 2, 4-D and similar herbicides. Where the weed occurs in isolated patches it can be removed by spading or by spot sterilization with sodium chlorate or Atlacide. Eradication of sour dock in heavily infested pastures will require complete renovation with special attention to the liming requirements of the soil.



Wild black cherry *Prunus serotina*. A. flower and cluster. B. branch showing leaves and fruit. C. leaf showing hairs among midrib of lower surface.

SYMPTOMS—Poison symptoms may develop very rapidly after an animal has easten wilted wild cherry leaves. The poisoned animal becomes uneasy, staggers and has convulsions. Breathing will be very difficult and the mucous membranes become blue. Death may come so quickly that the animal will be found near the wilted leaves or tree.

TREATMENT—If the condition is diagnosed in time intravenous injection of sodium thiosulfate and sodium nitrite will save the animal. Molasses and calcium dextrose are very helpful. In most cases the animal will be dead before a veterinarian can be called.

Mixed brush such as buckbrush, blackberry, green briers, locust, and various woody species which often invade pastures in Kentucky may be controlled by use of foliage sprays of 50-50 mixtures of 2, 4-D and 2, 4, 5-T at rate of 2 to 3 pounds acid equivalent per acre.

Tall ironweed may be killed by repeated applications of brush killer sprays. Unless infestation is very thick and extensive it may be desirable to spot treat. Fifty-fifty mixtures of low volatile esters of 2,4-D and 2, 4, 5-T used at rate of 5 tablespoons of the concentrate in 3 gallons of water and applied with a knap sack sprayer to wet the foliage when plants were in the bud stage was quite effective in killing tall ironweed plants in pastures at the Experiment Station. In other tests, spraying the regrowth from June mowed plants during August reduced stands about 90 percent the following year.

Poisonous Plants

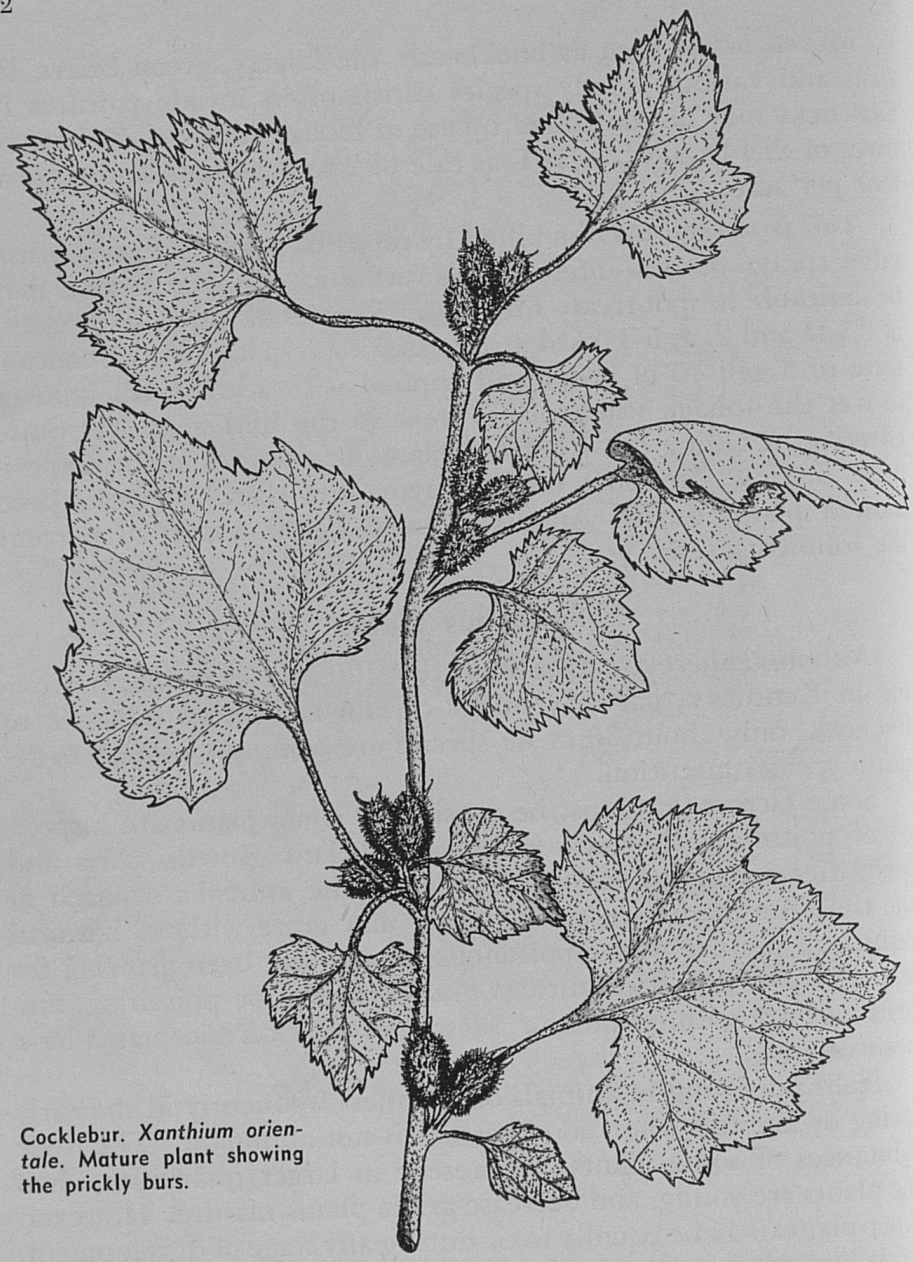
Although there are approximately 100 species of plants growing in Kentucky that may under certain conditions be toxic to livestock, only about 30 or 35 species are common enough to require special attention.

Some factors that must be considered when plants are suspected of poisoning livestock are stage of plant growth, parts and quantities consumed, and condition of the animal's stomach at the time the plants are eaten. Stock may graze without harmful results on pasture where poisonous plants have been growing for several years, but if conditions are favorable for poisoning, animals may die within hours or a few days after certain plants have been eaten.

Plant poisoning in animals occurs most frequently in the early spring or late fall when good pasture is not abundant. The toxic substances of some plants are present in larger quantities when the plants are young, and decrease as the plants mature. However, other plants may be equally toxic during any stage of development.

When plant poisoning of livestock is suspected, one should examine the fields where the animals had been pasturing to see if they were chewing the bark of any trees or grazing extensively on one or two kinds of plants. Areas that should be carefully investigated for poisonous plants are fence rows, woodlands, and wet, swampy places in pastures.

Plants suspected of being poisonous may be sent for identification to the Department of Entomology and Botany, Agricultural Experiment Station, Lexington, Kentucky. When possible, send the entire plant, including leaves, flowers, roots, fruits, and



Cocklebur. *Xanthium orientale*. Mature plant showing the prickly burs.

SYMPTOMS—Depression, often accompanied by nausea and occasionally vomiting occurs after cocklebur is eaten. The affected animal becomes gaunt, weak and unable to stand, has labored respiration and a rapid weak pulse. It may lie on its side and move the legs in a running fashion until completely exhausted. Within 24 hours after eating 0.75 percent of an animals weight of young seedling plants, it may die or show signs of poisoning. If death does not occur, several weeks will pass before the animal is back to normal.

TREATMENT—Give emergency treatment of fatty substances, such as mineral oil, cream or even whole milk by mouth or through a stomach tube. Keep the animal quiet and warm. The veterinarian will give antidotes for glucoside poisoning and other symptomatic treatment.

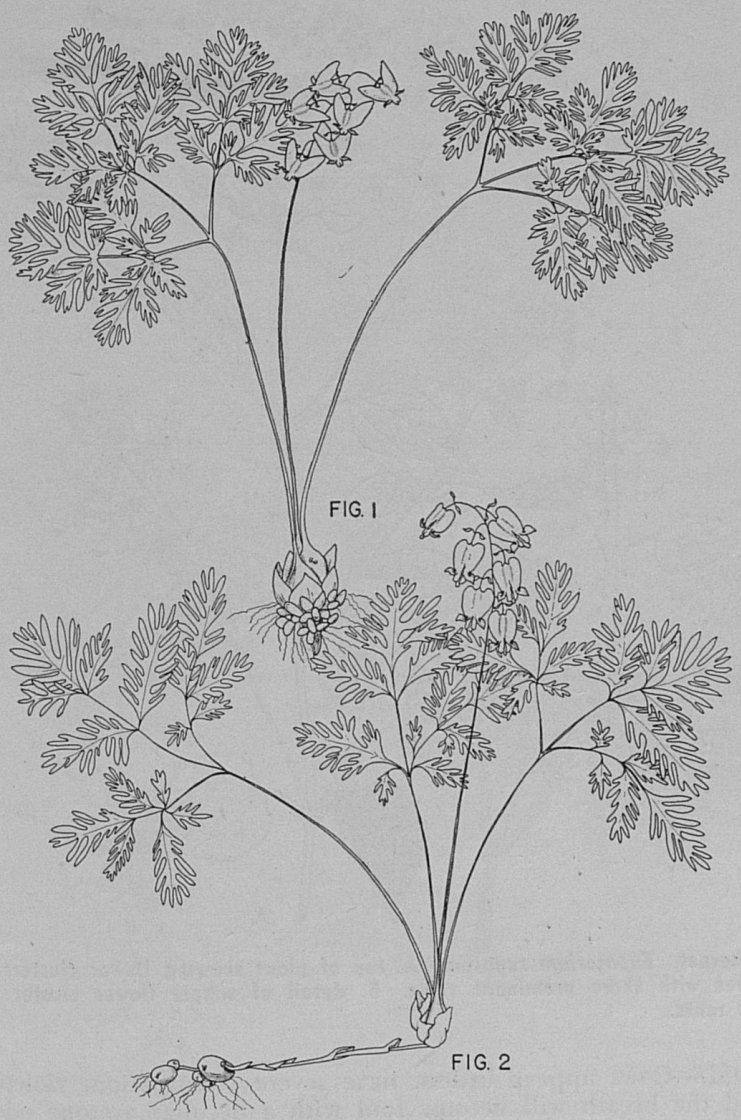
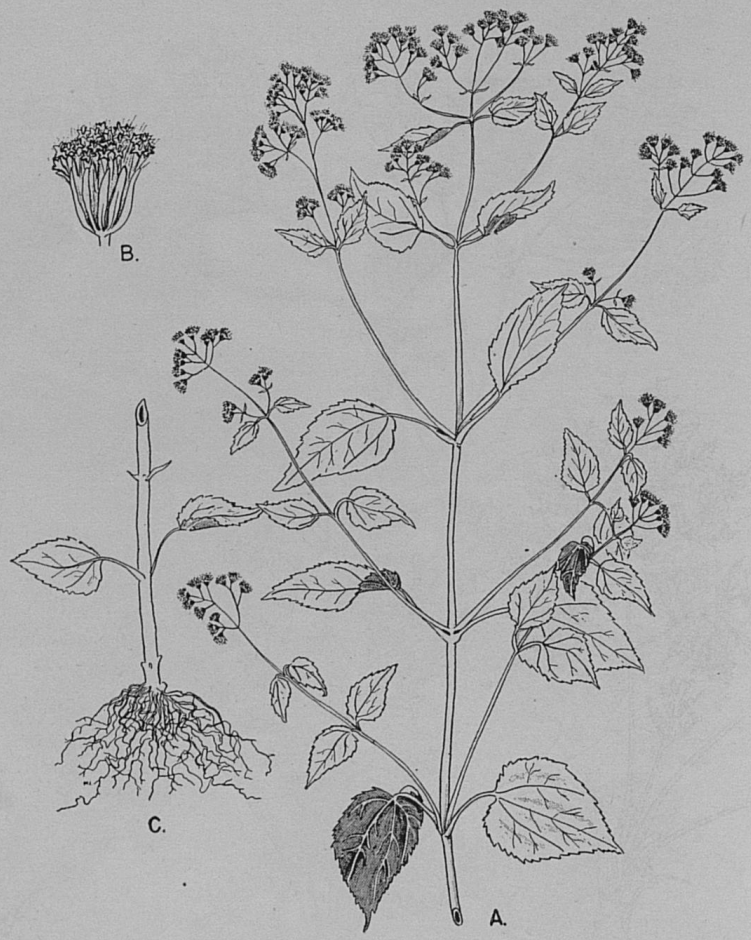


Fig. 1.— Dutchmans-breeches. *Dicentra Cucullaria*. Entire plant showing leaves, flowers, and tuberous roots at base of stem.

Fig. 2.— Squirrel corn. *Dicentra canadensis*. Entire plant showing leaves, flowers, and pealike tubers scattered along underground stem.

SYMPTOMS—Dutchman's breeches is more poisonous than squirrel corn. Symptoms are a staggering gait and a loss of milk production. Later symptoms are sudden trembling which increases in severity, frothing of the mouth, labored breathing, diarrhea and convulsions. Most animals will recover, if the dosage is not too heavy, and if they are kept away from the plants after the first symptoms appear.

TREATMENT—Animals showing "staggers" in the spring should be moved to clean pastures at once. If poisoning symptoms are severe, purgatives, mineral oil and stimulants may be given.



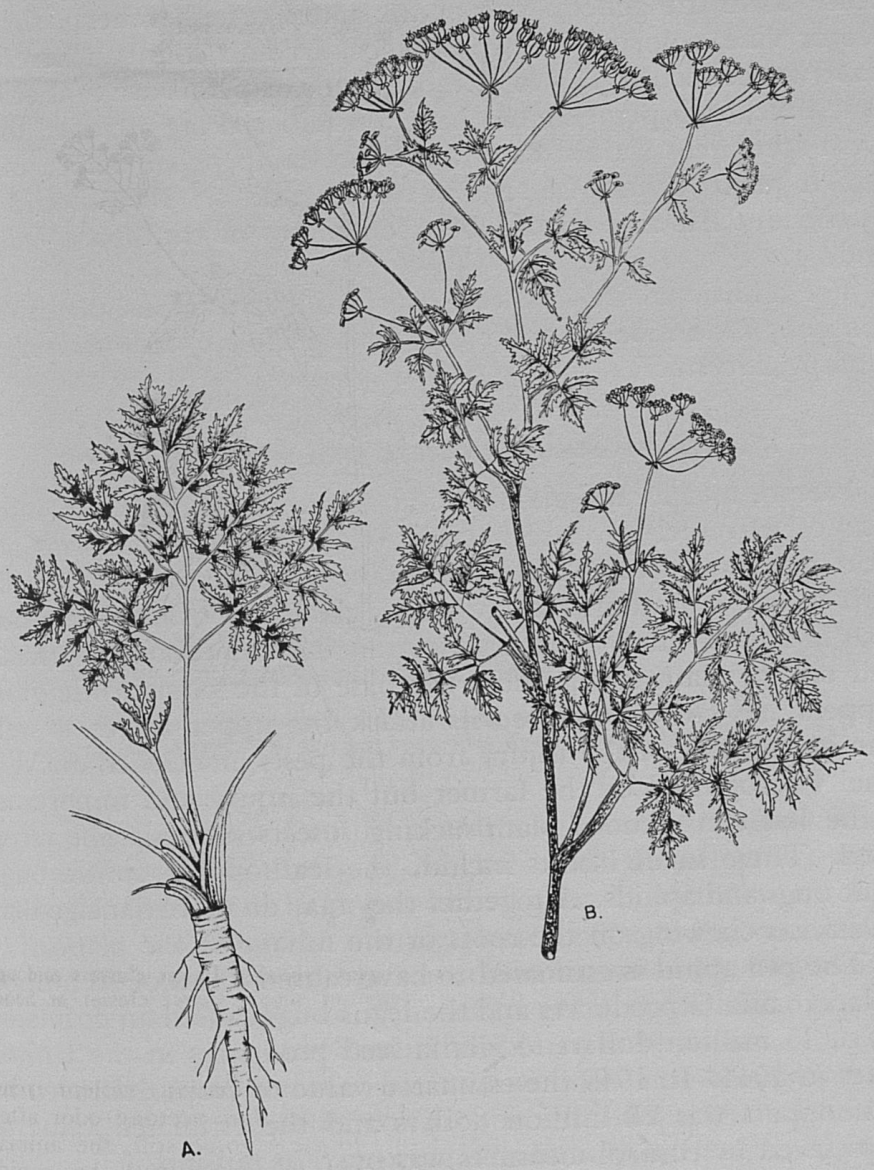
White snakeroot. *Eupatorium rugosum*. A. top of plant showing flower clusters and opposite leaves with three prominent veins. B. detail of simple flower cluster or head. C. fiberous roots.

SYMPTOMS—Cows appear listless, have severe constipation, violent trembling, and the breath will become foul with a peculiar acetone odor after being poisoned by eating white snakeroot. Joints become stiff, the animal falls and refuses to rise or otherwise exert itself, grinds its teeth, has rapid, labored breathing, and may die.

In horses the first stage is general sluggishness, marked depression and slight incoordination of the muscles, especially of the hind parts. The trembling stage, so characteristic of poisoned cattle is sometimes absent. Inability to swallow, due to paralysis of the throat muscles, accompanied by nasal discharge, will be shown as the disease progresses.

Human symptoms include severe constipation, vomiting, foul breath, subnormal temperature, weakness, delirium and collapse.

TREATMENT—Since poisoning usually occurs in late summer, cattle should be removed about the first of July from areas infested with this weed. When the animal reaches the trembling stage there is little you can do. Strong purgatives will help eliminate the drug from the digestive tract. Stimulants and calcium gluconate are helpful. Keep the cow milked out to eliminate the poison, but do not use the milk for human consumption.



Poison hemlock. *Conium maculatum*. A. taproot and young leaves. B. upper portion of plant with finely divided leaves and umbels of flowers and fruits.

SYMPTOMS—Poisoning from poison hemlock generally appears suddenly and the owner finds the animal "down." Some of the symptoms that may be noticed are: excessive salivation (slobbering), loss of appetite, muscular weakness or twitching of the muscles, incoordination, rapid pulse and great pain. There are no convulsions such as you will find with water hemlock.

TREATMENT—If animals are found and diagnosed early enough, purgatives may be given to empty the digestive tract as soon as possible. Intestinal astringents such as tannic acid are useful. Nerve and heart stimulants may be given.

seeds. State the general size of the plant, whether herb, shrub, tree or vine, color of flowers, and locality and county where the plant was collected. If two or more kinds of plants are sent at the same time, each plant should have a numbered tag attached to it. Fresh specimens should be wrapped in damp paper before mailing. If plants cannot be sent in fresh condition, they should be pressed out flat and packed between pieces of cardboard before sending.

For additional information concerning poisonous plants, see Kentucky Extension Circular 502, *Some Plants of Kentucky Poisonous to Livestock.*

Insects Attacking Pasture and Forage Crops

Pasture and forage plants are attacked by a number of insect pests of extremely diverse habits. White grubs, wireworms and the clover root curculio are found in the soil where they attack the roots of our important pasture plants causing considerable reductions in stands. Cutworms, armyworms, and sod webworms usually feed on the plant foliage near the base of the plant while grasshoppers and clover leaf weevils attack the upper leaves as well. The importance of the injury from the pests mentioned above is usually recognized by the farmer but the injury and importance of the less conspicuous plant-sucking insects often is not recognized. These small insects include the leafhoppers, spittle bugs, plant bugs and aphids. Altogether they may do more damage than the insects chewing on the roots or the foliage of the plants.

The pea aphid is estimated to have caused a loss of 30 million dollars to alfalfa producers and the lygus bugs caused an estimated loss of 15 million dollars to alfalfa seed producers in the United States in 1944. In 1949 the estimated value of crops destroyed by grasshoppers was 27 million dollars and the estimated value of crops saved by control measures was over 70 million.

The loss caused by pasture and forage crop insects is not confined to the decreased production of foliage. The nutritive value of injured plants may be decreased also. Plants attacked by sap-sucking insects may contain a smaller proportion of protein, which is so important in the production of animal flesh, than the uninjured plants. Fields in grass for many years may be found to be heavily infested with less desirable plants or weeds. Much of this may be due to the attacks of diseases and insects.

White grubs

White grubs, the larvae of several species of June beetles, feed on the roots of grasses, tobacco, corn, soybeans, and other impor-

May beetle grubs may kill pasture sod by feeding on and cutting the roots. The sod then can be lifted and rolled up as this has been. (See Kentucky Agr. Expt. Sta. Bul. 542, 1949.)

tant crop plants in Kentucky. Although not so abundant as in the more northern states, white grubs may be numerous enough in Kentucky to kill large patches of grass in pastures and lawns. The grass roots may be completely cut off a few inches beneath the surface and the sod can sometimes be rolled up like a carpet. A significant amount of damage to grass production, however, may occur without any readily visible signs of injury.

Pastures badly infested with white grubs can be renovated by thoroughly disking or harrowing the sod during late fall or early spring and sowing, in the spring, a seed mixture containing mainly deep-rooted legumes such as alfalfa, which are less favorable for the development of these insects. The grubs can be controlled by an application, as a spray or dust, of chlordane at 10 pounds per acre or aldrin at 5 pounds per acre to the sod in the early spring. Chemical control with these insecticides is expensive, however, and probably is not justified for pastures in Kentucky. Rotating alfalfa or other deep-rooted legumes with susceptible crops like small grains will help reduce grub populations in grain fields.

Wireworms

These small, slender, yellowish or brownish worms, the immature stages of click beetles, are commonly found in the soil of

pastures that have been in sod for two or more years and in sodland recently plowed for cultivated crops. By feeding on the roots of grasses, wireworms reduce production of forage, but their work in pastures is usually inconspicuous and slight.

Although wireworms can be controlled by applications of 5 pounds of chlordane or 3 pounds of aldrin per acre to the sod, control at present is not warranted in pastures. However, corn or tobacco, grown on land in sod the year before, may be severely injured by the feeding of wireworms on their roots, and chemical control in these crops may be desirable, at the rate of 3 pounds of actual toxicant per acre applied at time of preparing or planting the land.

Sod webworms

These thick-bodied, striped or spotted caterpillars construct loosely woven webs and short, silk-lined tunnels at the surface and just beneath the surface of the ground. They feed on the grass foliage close to the ground and each worm may consume several blades of grass daily. There are often thousands of these worms per acre of pasture and in dry weather, especially in July and August, they may kill or severely injure grass. When they are abundant their damage can be recognized by the irregularly-shaped dead spots, the unevenness of the grass, and the dying back of the new grass shoots. In years of abundant rainfall, when conditions are favorable for vigorous and abundant growth of grass, damage is confined to the loss of the grass eaten, which may be considerable but inconspicuous.

Chlordane at the rate of 2 pounds of the actual toxicant per acre applied as a dust or a spray will control the sod webworm. Chemical control of webworms in pastures under any but unusual circumstances probably will not be justified.

Cutworms

There are a number of different cutworms, most of which feed mainly on pasture plants and which are also serious pests of cultivated crops. When sodland is put into tobacco, corn, or other cultivated crops, there may be a considerable loss of seedling plants from the attacks of these insects.

These smooth-bodied, fat, rather large caterpillars feed in general on the foliage, or cut off the plant stems near the surface of the ground during the night and hide during the day in the soil or under clods of earth or trash on the ground. They are most important during the spring and early summer.

Control of these insects in pastures will usually not be economical, but where it is necessary the same procedures as for the control of armyworms will be effective.

Armyworms

The armyworm is closely related to the cutworms but because of its great importance and different habits will be discussed separately. When young, these light-striped caterpillars are pale green, turning to greenish brown when full grown. Most abundant following cold wet springs, the true armyworm often can be found in pastures in great numbers completely stripping off the grass foliage. When this food supply is exhausted, they may march in armies into fields of small grains and corn, causing enormous damage.

The fall armyworm, unlike the true armyworm, does not overwinter in Kentucky and is not an important pest of grasses here but causes extensive damage to corn, alfalfa, and small grains.

Toxaphene or chlordane at 1½ to 2 pounds per acre sprayed or dusted on the portion of the field where the worms are feeding will give excellent control of these pests, as well as of cutworms. A poison bait made up of 25 pounds of bran and 1 pound of toxaphene or ½ pound of chlordane, which is slightly moistened and broadcast at the rate of 12 pounds per acre during late afternoon where the worms are feeding or in front of their line of march, will also give good control. There is not so much danger of insecticidal residues from poison baits as from the dusts or sprays.

Grasshoppers

Grasshoppers are voracious feeders on a great number of agricultural crops, but they are essentially grass-feeding insects, migrating to adjacent fields when the supply of grass is poor or unpalatable. It has been estimated that 15 grasshoppers per square yard may consume up to half of the grass foliage. During dry years, such as the summer of 1952, they may be unusually abundant and their damage to grasses, alfalfa, and clovers is increased by the drouth.

In the spring, when they are small, the grasshopper nymphs are almost always found in pasture or grassland and this is the time to control them. Two ounces of aldrin, 1½ pounds of toxaphene, or 1 pound of actual chlordane per acre applied as dust or spray to grass or forage crops will kill nearly all of these small nymphs. If the grasshoppers are controlled in the pastures, the damage to corn and tobacco will be slight.

Spittlebugs

Spittlebugs have not been a problem in most of Kentucky, although they are abundant in Ohio and Illinois. Some species of spittlebugs attack grasses but those that are a problem in Kentucky attack alfalfa and other legumes. The yellowish-colored

nymphs hatch from over-wintering eggs in April or early in May, produce a small mass of froth (spittle) around themselves and the stems of alfalfa or clover, and suck the sap from the host plant. Heavy infestations of spittlebugs, one to every two or three plants, may lower forage yields as much as 30 percent, and the spittle may cause the hay to mold unless it is dried longer than usual.

One pound of methoxychlor, 0.2 pound of gamma isomer of BHC or lindane, or 1½ pounds of toxaphene per acre is most effective when applied before the new growth of the legume is 8 inches high and before many of the nymphs have become enveloped in spittle.

Leaf hoppers

Several species of leaf hoppers attack bluegrass, alfalfa, and other pasture grasses and legumes. These small, slender, usually pale-colored, sap-sucking insects start to appear in early May. Their feeding may wilt and wither bluegrass while the damage may be attributed by the casual observer to lack of moisture. Heavy infestations will retard growth and their feeding may cause alfalfa and clover leaves to turn reddish brown or yellow.

Methoxychlor as a spray or dust at the rate of ½ to 1 pound per acre will give excellent control of these pests.

Aphids

The pea aphid is the most important aphid pest of legumes in Kentucky. In early spring this small, pale-green, plump, usually wingless plant louse is found, sometimes in large numbers, sucking the plant juices from legumes. It may entirely destroy the first crop of legume hay.

Where aphids are a serious problem, cutting the legume crop as early as possible will help reduce the injury. A 1-percent parathion dust applied at the rate of 35 to 40 pounds per acre, or a spray containing 1 pint of 25-percent parathion emulsion concentrate per acre, will give excellent control, but the legume should not be cut or pastured for at least two weeks after the parathion is applied. It should not be applied when the legume is in blossom as it is very toxic to bees. It is also very toxic to man and animals and should be handled with extreme caution according to the directions on the label of the container. Malathion, 1½ pints of 50-percent emulsion concentrate per acre, shows promise for aphid control.

Clover root curculio

The adult, a small darkish snout beetle, eats out rounded, irregular patches from the margins of clover and alfalfa leaves. It

is not of great importance except to young seedlings. However, the small, whitish, legless grubs, which feed on the crown and fine rootlets and gnaw out burrows in the main root of legumes, may substantially reduce the stands of these legumes. The adults become active during March and the grubs start feeding on the plant roots early in April.

No practical method of preventing damage by these grubs has been found although dusting or spraying with lindane, chlordane, aldrin, or parathion to kill the adults during their spring flight will reduce infestations.

Clover leaf weevil

The greenish, legless, fat-bodied larvae of this weevil are often destructive to clover and alfalfa fields in early spring. At night the larvae eat out holes in the leaves and irregular areas from the leaf margins. During the day they hide around the crown or base of the host plant.

In wet or normal springs this weevil is usually not of great importance because it is controlled by a fungus disease which kills the larvae. If chemical control is necessary the same treatment as that for aphids should prove effective.

Plant bugs

All the plant bugs important to pastures in Kentucky are small, soft-bodied, rather active, sap-sucking plant pests. Lygus bugs are often abundant on alfalfa and they may retard plant growth, but they are most important in their destruction of the alfalfa seed crop by the "blasting" of the seed heads. The bluegrass bugs are mainly grass feeders and are especially damaging to the yields of bluegrass seed in Kentucky.

Aldrin at the rate of 6 to 8 ounces per acre or lindane at 4 to 6 ounces per acre applied before the bugs have acquired wings will control these plant bugs. The treated plants should not be cut for hay or used for grazing for four weeks after application of either insecticide. The insecticide will not harm the seed of either alfalfa or bluegrass.

Leatherjackets

Leatherjackets are the legless, grayish-brown, leathery appearing larvae of crane flies. They usually feed on decaying organic matter and are not considered harmful. However, in the spring of 1953 severe damage to the roots of seedling lespedeza and clover in western Kentucky was reported.

If control measures are necessary a spray containing 2 pounds of 15-percent parathion wettable powder in 50 or more gallons of water per acre should be used.

General insect control procedures

The control of insects in pastures is very difficult because of the diversity of species and the differences in their habits. The pasture grasses and legumes are attacked by one or more of these pests throughout most of the year. Although one application of an insecticide might control several insect species, it would take many applications to control most of the harmful species. This sort of insect control program would not be justified economically. Where one or two of these pests are unusually abundant, the application of some insecticide should be considered.

Most of the new synthetic insecticides are not recommended where the pasture is going to be grazed or cut for hay to be fed to animals being fattened for slaughter within 21 days. Pasture for dairy cows should not be treated with any of the synthetic insecticides except methoxychlor, malathion, parathion and TEPP. Methoxychlor and TEPP treated fields are safe to use the day after treatment, but parathion treated fields are not safe to use for two weeks. Two weeks should elapse before fields treated with other synthetic organic insecticides should be used for beef cattle. TEPP and parathion should be handled with extreme care because of their toxicity to man.

Fields which can be taken out of grass and put into cultivated crops every three or four years will have less loss from insect attacks than fields in permanent sod or in grass for long periods.

Diseases of Pasture Plants

All of our cultivated plants are subject to diseases of various kinds, and to insect injuries other than direct eating of plant parts. For example, stands of red clover can be reduced the first summer by nematode injury to roots, by feeding of aphids or leaf hoppers, by a combination of these and drouth, and by such diseases as southern anthracnose. During the winter, stands may be further reduced by sclerotinia crown crown rot, by winter injury, and by heaving. During the next summer there may be further reduction by one or another or a combination of the troubles mentioned. While the diseases differ on different crops, yet the same kinds of troubles reduce stands of any of the pasture plants. Well-adapted varieties of any of the crops are those that are best able to withstand the constant bombardment by insects and diseases, while the unadapted varieties are those that succumb most rapidly.

Because of the nature of the plants used in pastures, it is not easy to control diseases that attack them, but some knowledge of the more common troubles of pasture plants may be helpful.

Crown rot

Alfalfa, red clove, white clover, crimson clover, and perhaps other legumes, are subject to crown rot during late winter and spring. The plants rot at the surface of the ground, and white or black seedlike bodies can be found buried in the decayed tissue. The stand of fall-sown alfalfa may be reduced, but alfalfa sown the previous spring is affected only slightly. Large areas of red and crimson clover may be destroyed by crown rot, but the adapted stains of red clover are but little affected.

Black stem

This occurs on alfalfa, red clover, and sweet clover. In the spring alfalfa is likely to suffer severely. New shoots die and are replaced by others, which in a cool, wet season are also destroyed. Sometimes old plantings are greatly reduced in stand. Early spring pasturing is beneficial to the development of healthy first crop shoots.

Leaf spot of alfalfa

There are several fungus leaf spots of alfalfa that yellow the leaves and cause them to fall. Well-nourished alfalfa will grow rapidly and be ready to cut before too much loss occurs from these diseases. Cutting greatly reduces the source of inoculum, so the next crop may be relatively clean.

Anthracnose

Timothy is subject to damage during open winters by the cereal and grass anthracnose fungus. Stands may be greatly reduced. Sometimes stands of orchard grass are also reduced by anthracnose following a heavy seed crop.

Ergot

Ergot is a common disease of rye and many grasses. In place of the seed a black seedlike body several times the normal size of the seed develops. These black ergot bodies, when eaten by animals, cause ergot poisoning which sometimes results in sloughing off the hoofs of animals, and in other symptoms. Care must be taken that animals are not allowed to feed on maturing grass seed affected by ergot or on straw of grasses from which seed has been threshed. Tall fescue seed heads are eaten readily by livestock and, if affected by ergot, may cause poisoning. The so-called "fescue foot" seems to be similar to ergot poisoning, but according to reports is caused by western wild species of fescue not used for pasture purposes. The development of ergot bodies can be prevented by mowing grasses, that are not being saved for seed, at blossoming time.

CHAPTER 3

UTILIZING PASTURES

Nutritive Value and Palatability of Pasture Forage

From the standpoint of nutrition, pasture forage grazed at the proper time is one of our best feeds. It is quite high in protein, calcium, many of the vitamins, and certain unknown factors, all of which are essential for the well being of farm animals. It is particularly high in vitamin A value because of its carotene content, and in most of the B-complex vitamins. Pasture forage grazed at the proper growth stage also contains fairly large amounts of energy or total digestible nutrients. As far as is known, Kentucky grown pasture contains adequate amounts of phosphorus and of the trace minerals such as iodine, iron, copper, cobalt, manganese, and zinc. However, the content of these minerals in forage will vary considerably depending on the soil upon which the forage is grown.

Although pasture forage is particularly good in preventing many nutritional deficiencies, it cannot be thought of as perfect from all standpoints. It is relatively high in fibrous materials which are usually poorly digested compared to other nutrients and tend to limit total intake of forage. Another limitation is the fact that pasture forage is generally quite high in water content which like fiber tends to limit total intake of forage to the degree that maximum production by farm animals cannot be realized. Consequently, in many instances where maximum production is desirable supplementary feeding of high energy feeds such as corn or other grains is necessary. On the other hand, pasture forage, if grazed properly, usually contains enough of all nutrients to meet the needs of growing cattle or sheep not yet fattening or in milk production.

Excellent pasture forage will also do a satisfactory job of fattening older beef cattle that have already attained most of their growth. It will supply most, if not all, of the nutrients required by dry cows and idle work stock throughout the growing season and on into early winter. It also greatly cheapens the cost of producing meat, milk, wool, eggs, and horsepower through sizeable savings in grain, hay, protein concentrate, and mineral and vitamin supplements.

Table 4.— Nutritive Value of Some Pasture Forages

Many All-Forage Rations are Low in Energy or Total Digestible Nutrients but Meet Other Requirements (assuming no differences in palatability between plant species).

	Air-Dry Feed	*Digestible Protein*	*Total Digestible Nutrients*	*Calcium*	*Phosphorus*	*Carotene*
	lb	lb	lb	gms	gms	gms
Daily requirements for an 800-pound fattening steer	22	1.5	14.0	20	19	48
Ration 1: 66 pounds of Kentucky bluegrass pastured before bloom	22	2.6	12.7	47	39	2376
Ration 2: 88 pounds of alfalfa-bromegrass pasture in vegetative stage	22	3.2	12.8	120	28	2200
Ration 3: 121 pounds of Ladino clover	22	4.5	13.8	110	38	3026
Daily requirements for a 1200-pound cow producing 30 pounds of 3.5 milk	30*	2.4	21.2	52	40	72
Ration 1: 105 pounds of Ky 31 fescue pasture in vegetative stage	30	2.9	17.2	66	49	2625
Ration 2: 108 pounds of orchard grass pasture in vegetative stage	30	3.2	17.3	68	59	2700
Ration 3: 135 pounds of clover and mixed grass pasture closely grazed	30	4.6	18.8	141	43	3375
Daily requirements for a 60-pound fattening lamb	2.3	0.18	1.4	2.6	2.2	3.6
Ration 1: 8.3 pounds of Korean lespedeza in pasture stage	2.3	0.28	1.4	13.0	3.2	258
Ration 2: 10.3 pounds of mixed Ladino clover and grass pasture	2.3	0.30	1.4	14.0	3.7	309
Ration 3: 12.7 pounds of rape pasture	2.3	0.30	1.6	14.0	4.0	229

* Air-dry-roughage equivalent. Additional grain may be consumed if needed to meet nutrient requirements.

Stage of growth of pasture plants is one of the most important factors affecting their nutritive value. As most plants advance in maturity, their content of indigestible material increases along with a corresponding decrease in content of protein, minerals, and most vitamins. These changes lower the nutritive value of the plant and further limit the intake of total forage as shown in Tables 5-8.

Palatability needs to be considered in assessing the nutritive value of forages. Maximum efficiency of production is obtained from the most palatable forages because greater production per animal unit reduces production costs. In the case of fattening animals an additional premium is realized from the more palatable forages because of increased quality of finish or fleshing. On this

Table 5.— Effect of Stage of Maturity on Nutrient Content of Pasture Forage (Dry Basis)

	Total Digestible Nutrients	*Crude Protein*	*Crude Fiber*	*Mineral Matter*
	%	%	%	%
Alfalfa				
Vegetative stage	69	26.7	17.9	12.3
Before bloom	61	20.7	23.2	10.6
In bloom	59	16.7	31.9	8.4
After bloom	47	9.7	42.9	7.4
Bluegrass				
Vegetative stage	68	22.0	23.2	6.6
Before bloom	64	18.2	25.2	8.3
In bloom	60	13.2	30.8	9.6
After bloom	46	9.7	34.8	7.3

Table 6.— Consumption and Nutritive Value of Mixed Timothy-Bluegrass Pasture Grazed by Cattle at Three Stages of Growth

	Total Digestible Nutrients	*Crude Protein*	*Crude Fiber*	*Mineral Matter*	*Intake of total Digestible Nutrients*
	%	%	%	%	lbs
Vegetative stage	72	16.1	26.5	7.5	8.5
Before bloom	65	12.0	29.6	6.9	6.8
Full bloom	57	10.4	33.2	5.4	5.9

Table 7.— Palatability and Nutritive Value of Each of Several Forages Grazed by Fattening Sheep

(Data from Ky. Agr. Experiment Station)

Forage and number of observations	*Digestible Protein, Dry Basis*	*Digestible Organic Matter, Dry Basis*	*Intake of Digestible Protein*	*Intake of Digestible Organic Matter*
	%	%	lbs/day	lbs/day
Ladino clover (24)	19.6	71	.65	2.35
Alfalfa (18)	18.4	68	.56	2.09
Timothy (21)	6.9	66	.18	1.68
Kenland red clover (6)	16.3	69	.41	1.67
Redtop (21)	6.0	60	.20	1.59
Birdsfoot trefoil (6)	13.1	62	.33	1.58
Lincoln bromegrass (21)	13.6	66	.34	1.58
Ky 215 red clover (2)	15.6	66	.37	1.56
Bluegrass (27)	16.3	64	.39	1.53
Orchard grass (32)	9.0	58	.20	1.24
Ky 31 fescue (34)	9.1	59	.18	1.10

Table 8.— Palatability and Nutritive Value of Each of Several Forages Grazed by Fattening Cattle

Forage and number of observations	*Digestible Protein, Dry Basis*	*Digestible Organic Matter, Dry Basis*	*Intake of Digestible Protein*	*Intake of Digestible Organic Matter*
	%	%	lbs/day	lbs/day
Lincoln bromegrass ..... (2)	11.3	74	2.86	18.8
Ladino clover ..... (11)	21.9	73	4.44	14.8
Alfalfa ..... (10)	15.5	65	2.84	11.9
Orchard grass ..... (20)	11.7	61	1.82	9.6
Bluegrass ..... (36)	10.8	66	1.50	9.0
Ky 31 fescue ..... (34)	10.8	62	1.24	7.1

basis all forages should be kept in a vegetative stage so far as possible. In addition, if conditions permit, the more palatable species shown in the accompanying tables should be used in making new seedings.

Only Ladino clover and alfalfa were consumed by the animals in the above experiment in sufficient quantity to meet the daily digestible-organic-matter requirements of approximately 1.8 pounds needed for fattening lambs of the size used. All forages, with the exception of Ky 31 fescue and timothy, provided at least 0.2 pound of digestible protein. This is considered to be an adequate intake of digestible protein.

As fattening steers of the size used in the foregoing experiment require approximately 1.4 pounds of digestible protein per day, all forages tried, except Ky 31 fescue, were satisfactory in meeting the protein requirement. However, under the conditions of the experiment, only alfalfa, Ladino clover, and Lincoln bromegrass met the daily requirement of 12 to 14 pounds of digestible organic matter needed for satisfactory gain.

Conserving and Utilizing Surplus Spring Forage

Almost all pasture forages produce more feed during spring and early summer than during the hotter, drier months of July and August. This results in one of several things: Either pastures are undergrazed during the spring and overgrazed during the summer, or farmers must make some provision for varying the number of livestock on their pastures, or some of the spring surplus may be preserved as hay or silage for future use. The spring rainfall, which is mainly responsible for this spring surplus of forage production, also interferes with haymaking. For this reason grass silage is becoming very popular as a means of preserving and storing this surplus feed for later use.

Also, small grain threatened by army worms or excessive lodging may be salvaged by ensiling. If the silage is to be stored

BEST CUTTING TIME FOR HAY OR SILAGE

Alfalfa, first cutting—when new shoots from crown are 2 to 3 inches long (usually in late May).

Alfalfa, 2nd and 3rd cutting—about 6-week interval from previous cutting.

Lespedeza, not later than full bloom and before bottom leaves begin to fall (usually about August 15).

Clover, red and most other clovers—from early bloom to ½ bloom. Many of these crops are cut too late.

Ladino Clover, when from 10 to 12 inches tall.

Sweet Clover, 2nd year, 1st cutitng—not later than beginning of bloom (a **high** stubble must be left if new growth is desired).

Sweet Clover, 2nd year, 2nd cutting—as soon as sufficient growth has been made.

Soybeans, when seeds are ½ to ¾ developed and all but the lowest leaves are still green.

Oats and most other cereals, when in the milk stage.

Timothy and most other grasses, soon after they are headed out, or in early bloom.

Corn (for silage)—when the kernels on the ears are denting and when all but the bottom leaf or two are still green.

Sorghums (for silage)—after the seeds have reached the dough stage.

in an upright silo, the small grain should be allowed to reach the early dough stage of maturity before cutting. If the silage is to be stored, unchopped, in a trench silo or stack silo, the small grain should be cut not later than the milk stage.

Any forage that is reasonably palatable and nutritious will make good grass silage. In order to save time and labor it is desirable to select a portion of pasture acreage that is reasonably smooth and as near as possible to the silo in which the forage is to be stored. This acreage should be protected from grazing during the spring in order to get maximum yield and therefore to reduce harvesting costs per ton of silage. Yields may also be increased by means of a fall top-dressing of manure or a spring top-dressing with ammonium nitrate or mixed fertilizer carrying a high percentage of nitrogen. Even Kentucky bluegrass with this sort of treatment will produce up to 4 tons of wilted silage per acre in the first cutting, which is normally made about the middle of May. The acreage used to produce grass silage during the spring is allowed to grow ungrazed from two to four weeks after cutting and then is available for grazing through the hot summer months. (See Kentucky Circular 361, "Grass Silage," for details on the making and storing of grass silage.)

Relative feed value of different silages

Quality is frequently given second place to quantity on the theory that if livestock are filled up they will get through the winter in good shape. This is poor reasoning, however, since it costs as much per ton to process and store poor silage as it does good silage. Then, too, during hard winters or severe drouths of 3 to 4 months duration, livestock can easily become depleted in vitamins, protein, and minerals, unless these are available in the roughage ration or in purchased supplements.

Research at the Kentucky Agricultural Experiment Station has shown the more common grass silages to have the contents of total digestible nutrients and digestible crude protein listed in Table 9.

Table 9.— Total Digestible Nutrients and Digestible Crude Protein in Grass Silages

Silage	*Quality*	*TDN*	*DCP*
		%	%
Ladino clover-molasses	good	69.5	18.5
Soybean-molasses	very good	49.9	9.7
Fescue-molasses	fair	58.2	5.5
Fescue-molasses	very good	65.3	10.3
Ky. bluegrass-molasses	poor	57.9	6.0
Ky. bluegrass-molasses	fair	67.8	11.7
Ky. bluegrass-molasses	very good	69.2	15.3
Alfalfa-molasses	very good	58.4	12.8
Corn	excellent	69.5	4.9

(See Kentucky Agr. Exp. Sta. Bul. 573 for more details)

Trench and upright silos

Trench silos have been used for many years in Kentucky as emergency silos for storage of corn, and in recent years they have been used successfully for chopped or unchopped grass-legume silage. They are the most efficient type of emergency silo, especially for use in storing a reserve supply of feed for use during drouth. Upright silos will continue to be preferred by many farmers for regular use because of less loss from spoilage, neater appearance, and more ready accessibility during bad weather. (For information on upright silos refer to U.S.D.A. Farmer's Bulletin 1820, "Silos and Their Construction.")

Size of Trench Silo to Build.— The figures in Table 10 are based on the feeding of 35 pounds of silage per animal per day for a 180-day feeding period. For young stock allow half as much as for mature cattle.

Construction of Trench Silo.— For ease of filling and feeding, the trench silo should be located, if possible, with one end open

Table 10.— Capacity of Trench Silos

Number of animals	Tons of silage needed	Depth in feet	Width in feet		Length in feet at top
			Top	Bottom	
5	16	6	8	6	23
10	32	8	10	7	28
15	48	8	12	8	36
20	63	8	12	8	47
25	79	8	12	8	58
30	95	8	12	8	70
35	111	8	12	8	81
40	126	8	12	8	92
50	158	8	15	11	97
75	236	10	16	12	99
100	315	10	17	12	126

and a ramp for entering the silo at the opposite end. Unless the silo is to be used only in drouth, it is often advisable that it be paved or covered with gravel or crushed rock. Provide a diversion ditch to keep surface water out of the silo, and also provide a drain in the bottom. Slope the floor toward the open end.

Construction with a bulldozer usually is easiest, quickest, and most economical.

Covering.— The top of a trench silo may be covered with building paper laid across the silo. The paper should be weighted down with earth, sawdust, waste forage material, or straw. Many farmers have successfully used ground limestone, dirt, sawdust, shavings, or weeds as a covering without first covering the silage with paper.

Silage harvesting machinery methods

Five basic silage harvesting methods are in use for making grass silage, as follows:

SILAGE PRESERVATIVE CHART

	Pounds to Use for Each Ton of:		
	Legumes	Legume and grass mixed	Grasses and cereals
Molasses (Approx. 50% sugar)	60	50	40
Ground shelled corn or small grain	150	125	100
Corn-and-cob meal	200	150	125
Dried whey	40	30	30
Phosphoric acid (75% concentration)	20	15	10
Sulfur dioxide	5	5	5
Sodium metabisulfite	8	8	8

1. *Mowing, raking, hand loading, hand feeding to stationary chopper at silo.* This method involves time and strenuous hand labor. It requires on an average of 2.3 man-hours to put up a ton of grass silage. It may be satisfactory for small operation where cash outlay for equipment and labor is not advisable.
2. *Mowing, raking, machine loading (loader), hand unloading into stationary chopper.* This method reduces the strenuous hand work of loading heavy hay of high moisture content, but does not reduce the labor of unloading into the chopper.
3. *Mowing, raking, using field chopper with pick-up attachment, loading directly into a truck, unloading by hand or by motor-driven unloader directly into silo filler.* This method requires a larger investment in machinery; but as it is the easiest and fastest way of harvesting grass silage, requiring about 1.05 man hours per ton, the machinery and labor cost will be less than for methods 1 and 2.
4. *Direct cutting, using field chopper with mower attachment, blowing silage into truck, unloading by hand or power into blower silo filler.* The cutter-bar unit on the forage harvester is used where the crop is too mature or too dry to require wilting before chopping, but water and preservatives may need to be added to silage as blown into the silo. This method will require less time and labor than method No. 3.
5. *Mowing with or without a windrower attachment to the cutter bar and using a push-off buck rake to transport the long forage directly to a stack or trench silo.* This method requires a minimum investment in power equipment but produces a silage that is more difficult to pack adequately and to feed easily.

Labor and machinery costs of making grass silage

So many variable factors are involved in the harvesting of grass silage, such as management of labor and machinery, kinds of grasses used, moisture content of crop, maturity and yields, that it is difficult to present labor and machinery costs that can be used for estimating costs.

The following data are based on 1951 machinery and labor costs in filling upright silos of 70 to 100 tons capacity by equipment listed in methods 2 and 3.

Kind of silage	*Yield per acre*	*Cost per ton, Method 2*	*Cost per ton, Method 3*
Corn Silage	10 tons	(1) $4.42	$3.12 (2)
Grass, Legumes	4½ tons	3.63	3.29
Alfalfa	9 tons	5.45	4.95

(1) Corn cut with corn binder, bundles loaded and unloaded by men.
(2) Used chopper equipped with corn-cutting attachment.

More and more Kentucky farmers are using trench silos as a means of saving surplus spring forage for supplementary feeding later in the season.

Removal of silage from trench silo

Silage may be removed from a trench silo by loading by hand into a large feed bucket or box mounted on an overhead track, or onto an endless conveyor which will carry the ensilage direct to the feeding bunkers. Where the open end of the trench will permit, a manure loader scoop mounted on the front end of a tractor can be used to move silage to feed bunkers. Some farmers permit the cattle to self-feed at the end of the silage by using a hanging "creep" or an electric fence, to keep the animals off from the silage itself while permitting free access to the silage. For self-feeding, two to four animals can be accommodated per foot of width of trench.

Feeding Silage

Silage for dairy cattle

Harvesting crops as silage and feeding them to dairy cattle results in almost complete utilization of the crop. Silage is a highly palatable, succulent feed that can be used for dairy cattle with excellent results during winter and during late summer and fall when pastures are dry or short.

When cows are fed only hay-crop silage for roughage, with no hay, they will generally not consume as much roughage as when they are fed both silage and hay. If there is a more abundant supply of silage than there is of hay, the amount of hay fed can

Modern equipment makes the tack of handling green forage easier and faster, and enables farmers to save surplus forage which formerly would have gone to waste.

be reduced with entirely satisfactory results. Cows should be fed about 2 pounds of good quality hay for each 100 pounds of body weight. Silage can replace half of the hay at the rate of about 3 pounds of silage for one pound of hay. As an example, it is recommended that a 1,000-pound cow be fed daily 30 pounds of silage and 10 pounds of hay (preferably legume hay) as her allowance of roughage during the non-pasture period. But without silage the hay requirement would be 20 pounds or more daily. The experience of dairymen and results of experiments have shown that silage of good quality, when combined with early-cut, high-quality legume hay makes a winter roughage ration that is almost ideal for milk cows.

Legumes and grasses are gaining in popularity as silage crops. The excess spring growth from permanent pasture is being successfully ensiled by certain dairymen. By ensiling the hay crops, cutting can be done irrespective of the weather, and therefore before the plant becomes too mature. Curing often is difficult when these crops are put up as hay. Silages made from anything other than legumes or well-fertilized young grasses are low in protein content, and usually slightly more protein should be fed in the grain mixture than when a legume hay is the only roughage fed. If very little legume hay or good grass silage is being fed, each cow should receive a supplement of 50,000 International units of carotene each day to guard against a possible vitamin A deficiency. Local feed dealers and mixers can usually supply the dairymen with such a supplement. (See also Ky. Extension Circular 474, "Feeding Dairy Cows.")

Silage for beef cattle

Since they have lower protein requirements than most dairy cows, nonfattening beef cattle can utilize large quantities of medium and low-grade roughages. When a major portion of that roughage is grass silage, no protein supplements are needed. A mature beef cow will eat a maximum of 50 to 75 pounds of palatable silage per day. Such amounts will supply more than twice her daily needs for nutrients and, therefore, represent an extravagant use of feed, especially during and following severe drouths. Beef cattle and other livestock relish some dry roughage each day along with succulent silage. This craving can be satisfied with any sound, bright roughage such as wheat straw or grass hay, or of course with the better mixed and legume hays.

In the following rations, hay of similar quality can be substituted for grass silage at the rate of 1 pound of hay to replace each 2½ pounds of silage. The following rations have been set up to

utilize maximum amounts of grass and corn silage and point out the need for protein supplement where corn silage is used.

Rations for Cows Suckling Calves (per day)

28 pounds soybean silage
or 24 pounds alfalfa or fescue silage
or 20 pounds bluegrass or Ladino silage
or 18 pounds of corn silage plus 1 pound soybean oilmeal

Rations for Dry Cows, Yearling Heifers, Yearling Stocker Cattle, or Bulls (per day)

18 pounds soybean silage
or 15 pounds alfalfa or fescue silage
or 13 pounds bluegrass or Ladino silage
or 12 pounds corn silage plus 2/3 pound soybean oilmeal

Rations for Half-Fat Grass Cattle (to fatten moderately)

20 pounds good grass silage plus 7 pounds shelled corn
or 20 pounds corn silage plus 4 pounds shelled corn plus 1½ pounds soybean oilmeal

All cattle on these rations should have free access to salt, fine-ground limestone, and steamed bonemeal. Where no green pasture is available and where the roughage is all of low quality, a Vitamin A supplement may be needed. This should provide 10,000 units of Vitamin A per day for fattening cattle and 20,000 units of Vitamin A per day for rapidly growing animals, pregnant cows, and cows suckling calves.

Silage for sheep

Pregnant ewes not fortunate enough to have winter pasture can be wintered satisfactorily on 8 to 12 pounds of high-quality grass or corn silage per head daily as the only roughage. However, it is better to include at least 1 pound of dry roughage in the ration in place of 2.5 to 3 pounds of silage. Do not feed moldy or frozen silage because either tends to cause digestive disturbances in pregnant ewes.

After fall and early winter grazing is no longer available, adequate roughage plus 0.5 pound of grain per ewe daily should be fed before lambing and 1 pound after lambing until spring pasture becomes available. With grass silage the grain can be shelled corn, small grain, or a mixture of grains. The same grain can be used with corn silage, but 0.25 pound of protein supplement should be included in the grain mixture. If silage and other roughages are scarce, the grain allowance may be increased gradually to 2 pounds per head daily. For each additional pound of grain fed, approximately 1.5 pounds of hay or 4 pounds of silage can be replaced in the ration.

Ewes should have free access to salt alone and also to a mixture of 3 parts bonemeal and 1 part salt, to insure against mineral

deficiencies. Be sure to feed ewes adequately enough to keep them gaining in body weight up to lambing time in order to prevent pregnancy disease. This is best done by feeding enough grain and some high quality roughage in the ration.

Silage for hogs

Hogs, especially brood sows, can utilize some grass silage to good advantage when pasture or hay are not available. Hogs will utilize succulent, tender silage to much greater advantage than coarse, tough silage. They may be allowed to eat all they will, which will usually be not more than 6 or 8 pounds a day per mature animal.

Silage not for workstock

Both horses and mules are highly susceptible to forage poisoning. For this reason it is not advisable to feed them silage of any sort. It is almost impossible to detect all dangerous molds. Some farmers have fed silage to workstock for six or eight years without trouble only to lose several head overnight. The small saving from feeding silage to workstock is far too small to justify the great risk involved.

Internal and External Parasites of Livestock

Many internal and external parasites, such as stomach worms, mites, lice, and flies, commonly affect all classes of domestic animals. Most of these parasites are capable of causing serious losses in farm animals. Some animals may die as a result of severe parasitic attacks. However, greater overall economic losses are due to the general unthriftiness, stunting and inefficient feed utilization produced by less severe attacks. These undesirable effects on animals result in inefficient production of meat, milk, wool, eggs, and horsepower.

The resistance and tolerance of animals to many of the internal and external parasites is increased by a high level of general health, which is favored by the higher nutritive value of improved pastures. However, an increase in the number of animals per unit area, which may occur on improved pastures, produces conditions more favorable for the transmission of parasites from animal to animal and for the increase in numbers of parasites.

Internal roundworm parasites

These parasites are generally regarded as causing greater losses in animal production than any other group of internal parasites. Of outstanding importance in this group are the gastro-intestinal round-worm parasites of ruminants (cattle, sheep, and goats).

Infections with these parasites are often referred to as "stomach worm disease." Older animals commonly carry light infections of these worms, and in general young animals are more susceptible to severe infections. Pastures furnish the natural means by which these worms are spread or transferred from animal to animal. The infective larvae or transfer stages of these worms occur on the forage after they have developed from the worm eggs that are passed in the feces of infected animals. Animals become infected while grazing by eating the larvae along with the forage. Overstocking of pastures favors the development of severe infections with these parasites by increasing the number of larvae on the available forage. An improved pasture program which permits frequent rotation is highly desirable, because the larvae of these worms will largely be killed off during a relatively short period while a pasture is rested.

A detailed account of the symptoms, diagnosis, treatment and control of these infections in sheep and cattle is available in Circulars 55 and 56, and Leaflet 133.

External parasites

Flies—which include the horse fly, stable fly, horn fly, and the cattle grub—are the most important single group of external parasites of livestock in Kentucky, as well as in the rest of the United States. It is estimated that about 500 million dollars is lost to farmers in the United States from the attack of external parasites of livestock. Over two-thirds of this loss is due to the attack of flies. Horse flies can cut milk production as much as 20 percent and can reduce beef cattle gains half a pound daily during periods of heavy infestations.

With the development of new insecticides, many farmers have come to rely increasingly upon applications of these chemicals to their animals for insect control. As effective as some of these materials are, it should not be forgotten that proper sanitation, especially around barns, is the first step in the control of pests such as stable flies and house flies.

Because of the migration of adult flies, proper sanitary and chemical control programs for house flies and cattle grubs are most successful when set up on a community or area basis rather than by individual efforts. Cattle grubs are effectively controlled only by applications of rotenone to cattle in the spring when the grubs are visible as bumps in the backs of the infested animals. This treatment is easier and much less dangerous to the animal than squeezing out the grubs by hand. The applications of rotenone kill the grubs after they have done their damage and are

useful only in reducing the number of adult flies and the grub infestation in the following year.

The newer insecticides are generally much more effective in controlling external parasites of livestock than those used before the end of World War II, but some of them are also very hazardous to use—both for the farmer and the treated animal. Directions on the label of the insecticide containers for the method of application and precautions to be taken with the insecticide should be read thoroughly and followed exactly. Because of the absorption of many of these insecticides through the skin and their accumulation in the fatty tissues and the milk, most of the synthetic organic insecticides should not be applied to animals which are to be slaughtered within 30 days or to milk-producing animals. For these animals rotenone, methoxychlor, or pyrethrins are the only insecticides which should be used.

Insecticidal programs for control of livestock pests change from year to year because of the development of new and more effective compounds and build-up of resistant strains of some insects to many of these insecticides. Circular 477 of the Kentucky Agricultural Experiment Station should be consulted for more complete information and recommendations on the control of external parasites of livestock.

Poisonous Plants

(See page 41)

Bloat

Rank growing legume pastures that contain less than 50 percent grass have caused most of the bloat trouble. Most bloat trouble comes when pastures look the best in spring and fall. It seems that the greatest loss occurs when the soil is fertile and rainfall inadequate.

The forages that have caused most bloat trouble in Kentucky are Ladino clover and White Dutch clover. In other states where alfalfa is grazed extensively, it is considered the worst bloating forage. In some European countries, grasses which have been heavily nitrated have caused bloat, but grasses and lespedeza are not considered to be bloating forages in Kentucky.

Prevention is the best cure for bloat. This should start when the pasture is established, by getting at least 50 percent grass in the mixture. If the grass-legume ratio is heavy on the legume side, then closer supervision of the animals is necessary. When cattle or sheep are turned in on a new field of clover, the first day

or two are often the worst for bloat. It seems that either the animal overeats at first, or else needs time to adapt itself to the new feed. Some farmers feed the animals their fill of dry feed before turning them in on clover the first time, and then leave them there day and night. Other farmers have a field of grass near the clover pasture and leave the gate open so the cattle can mix their own grass and legume. The feeding of dry hay in the field, or else mowing a strip through the field for dry hay, has been reported as a good bloat preventive. Ready access to salt, fresh water, and shade also seems to help in the control of bloat.

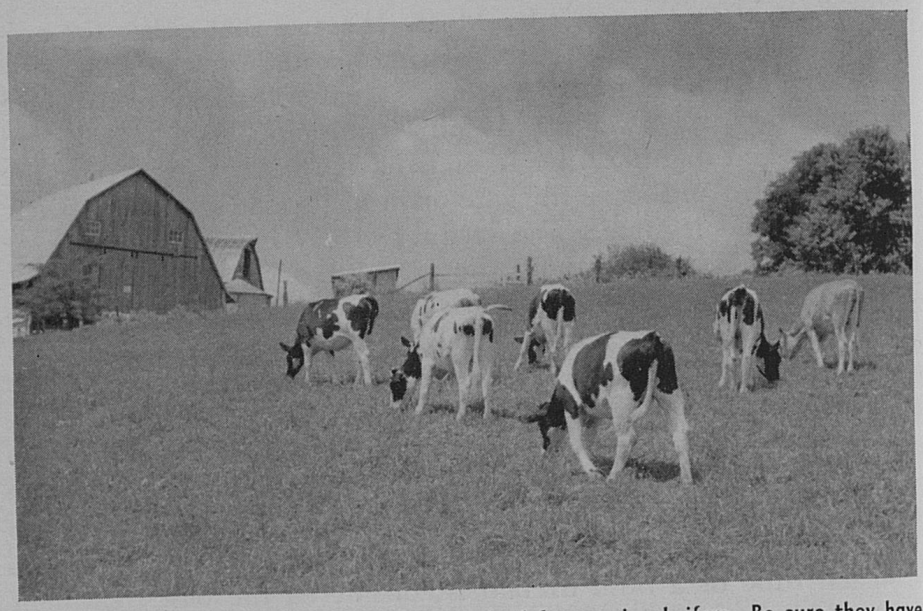
If you have cases of bloat in spite of good management practices, here are some of the treatments that have been reported as being successful. First of all, if the bloat case is severe and the animal is down, he is not likely to recover unless treatment is given very quickly. As long as the animal is up and you can keep him moving he will usually recover with most any treatment. A stomach tube or a mild drench is considered the best treatment by many veterinarians. The liquid or the tube may help by simply opening the cardiac valve between the esophagus and the stomach to let gas escape. The use of a trocar or knife in the left flank may be the last resort but this procedure is not recommended except as a last resort, because the animal may never be a "good doer" after this.

Pastures for Dairy Cattle

Milking dairy cows react in a very sensitive manner to the quality of pasture available. High quality pasture appears to be the key to high milk production. Such a pasture consists of grasses and legumes which are highly nutritious, very palatable, and yield an abundance of forage. High quality pastures are relished by dairy cows and as a result the herbage is eaten in large quantities and stimulation of milk production usually results. Among these pasture crops that apparently give this stimulation can be listed Ladino clover, white clover, crimson clover, bluegrass, orchard grass and bromegrass.

Milk-stimulating pasture

Milking cows when turned into spring pasture receive a big stimulation in milk production. What concerns dairymen most is how to prolong this period of stimulation. Experimental results have shown that no amount of supplemental feeding of hay, silage, or grain will entirely prevent the midsummer drop in milk production which is due principally to the lack of high-quality pasture. It appears that pasture mixtures which will yield high-quality forage throughout the pasture season will partially



High-quality roughage is the most economical feed for growing heifers. Be sure they have plenty of shade, water, and minerals.

prevent this drop in milk production in midsummer. Including one or more palatable grasses such as orchard grass and bromegrass, and a legume such as Ladino clover or white clover appears to be excellent in a pasture combination for late spring and summer grazing.

Using a milk-stimulating legume such as Ladino clover or white clover in combination with less palatable grasses, such as fescue, gives results that are much better than the same grass without the legume. Experimental results have shown that as long as the stand of clover can be maintained the results appear to be reasonably satisfactory. However, when soil and climate permit, the results favor having a more palatable grass such as bluegrass, orchard grass or bromegrass with the Ladino.

The two-year results of an experiment in progress on the Kentucky Agricultural Experiment Station farm at Lexington will serve to illustrate this point. In this experiment four pastures of 3.12 acres each were seeded during late August of 1950. Soil treatment, based on laboratory tests, consisted of applying 200 lb of 50 percent muriate of potash per acre at time of seeding on all plots, and on the straight fescue plot 100 lb nitrate of ammonia (33% N) in April and again in July or August of each year. Barnyard manure was applied to all plots at the approximate rate of 5 tons per acre during the late winter of 1951-52. The seeding rates per acre for the plots were:

Plot 1. 8 lb orchard grass and 1½ lb Ladino clover
Plot 2. 8 lb Ky 31 fescue and 1½ lb Ladino clover
Plot 3. 18 lb Ky 31 fescue
Plot 4. 16 lb Ky bluegrass and 1½ lb Ladino clover

The grazing procedure called for rotating Holstein and Jersey cows from one plot to another every four weeks. An effort was made to follow a systematic plan of doing this, but dry weather during each year made it necessary to remove cattle from all plots during different periods, thus upsetting original plans. Measurements of persistency were based on the ratio (as a percentage) of the amount of milk produced during the 4th week of a test period, as compared to production during the week prior to that period, as shown in Table 11.

Table 11.— Persistency of Milk Production on Pastures

Special attention should be given to the notations below the table for they apparently help explain some of the results secured.

Kind of Pasture	*Plot No.*	*Two-year Persistency for 4th week on plots*	*Two-year yearly yield of TDN per acre*
Orchard grass-Ladino[1]	1	95.8	1,616
Ky 31 fescue-Ladino[2]	2	87.5	1,605
Ky 31 fescue[3]	3	76.6	2,233
Bluegrass-Ladino[4]	4	87.0	1,780

[1] A good stand of Ladino (or white) was maintained in the orchard grass pasture.
[2] The initial stand of Ladino clover (or white) with fescue was about the same as in the orchard grass-Ladino pasture in 1951 (about 20%) but in 1952 it had reduced to around 7%.
[3] Some volunteer white clover (about 5%) was present in the "pure" stand of fescue during 1952.
[4] During 1951 Ladino clover (or white) covered 30% or more of the area, but in 1952 it had reduced to less than 10%.

For both years the most satisfactory persistency in milk production was shown by cows grazing the orchard grass-Ladino pasture. A persistency for the fourth week averaging 95.8 percent for the two years indicates that such pasture apparently must contain ample quantities of "milk-stimulating" ingredients. The bluegrass-Ladino pasture in 1952 failed to rank as well as it did in 1951, and this can be partially explained by the drastic reduction in stand of clover due to winter-killing. A light volunteer stand of white clover that appeared in the straight fescue pasture in 1952 apparently helped this pasture so that it was better than the year before and about equal to the fescue-Ladino and bluegrass-Ladino pastures. The fescue-Ladino pasture had about the same initial percentage of clover in 1951 as was present in the orchard grass-Ladino pasture, but competitive growth of fescue in 1952 apparently reduced the clover present to about one-third of its original stand.

Records of estimated yield of total digestible nutrients (TDN) have been kept for the four test pastures and are shown in the right-hand column of the foregoing table. Any compari-

sons made should consider in particular the notations below the table. The TDN yields were calculated from nutrient requirements for milk production, body maintenance and body weight changes.

Ky 31 fescue alone produced the most total digestible nutrients (TDN) for both years. Apparently, the nitrogen fertilization was an aid to its production each year. Also, in 1951 this area was grazed one month earlier than the three other areas in which an effort was being made to establish stands of Ladino clover. The data for the other three areas would indicate no particular superiority for a given pasture. Experience to date, however, has shown that one should heavily graze orchard grass in early spring and that this grass produces less growth for late fall grazing than does Ky 31 fescue or Kentucky bluegrass.

Irrigation increases yield

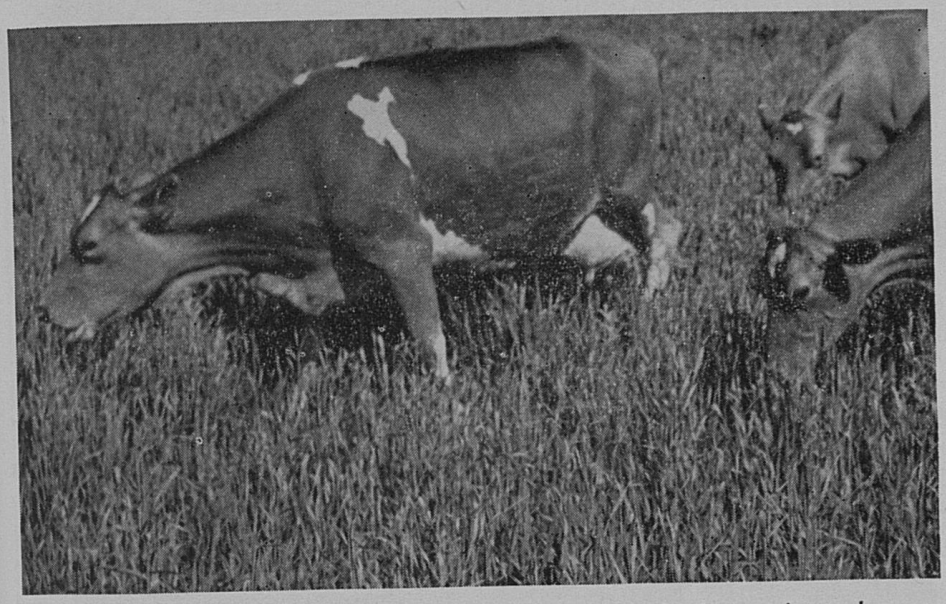
Irrigation of Kentucky pastures has promise of improving both the quality and quantity of pasture on farms having a supply of water. Experiments at Lexington during the last two years using 7 to 9 inches of water per season, has increased yields of dairy pastures 40 to 58 percent. Irrigation is an especially effective method of extending the period when permanent pastures can be grazed.

Using supplemental pasture

The use of supplemental pasture such as Sudan grass gives a milk-stimulating effect similar to that of spring pasture. Cows like the Sudan and eat large quantities of it. The Sudan in turn likes hot weather and grows fast when supplied with adequate fertilizer high in nitrogen. As cows are changed from a less productive pasture on to Sudan grass, an increase of around 20 percent in milk flow is a common experience.

Annual lespedeza (Korean or other adapted varieties) makes rapid growth during the hot summer months when most permanent pasture plants are less productive. When grazed in an immature form it can be rated as a good pasture for use in late summer and early fall. If allowed to become too mature, annual lespedeza tends to become woody, less palatable, and much less valuable as a grazing crop. Sericea, a perennial lespedeza, has been found in most cases to be less desirable as a grazing crop for milk cows than is annual lespedeza. It is a heavy yielder of forage, however, and when kept closely grazed may give satisfactory pasture, espcially for dry cows and heifers.

Kentucky dairymen can profitably make use of more supplemental pastures during fall, winter, and spring. The cereal grain



Supplemental pastures are excellent for stimulating milk production at times when permanent pastures are more or less dormant.

crops such as oats, barley, or rye of approved varieties, grown either alone or in combination with a legume such as crimson clover, make excellent "milk-stimulating" feed during the season that permanent pastures are more or less dormant. Cows grazing such pasture tend to be stimulated in their milk production in a manner similar to that secured when cows during midsummer are turned from dry permanent pasture into a Sudan grass pasture.

Choosing best grasses and legumes

It appears that one must choose between those grasses and legumes that will grow satisfactorily on his farm, and give preference to those most nutritious and palatable, if he is interested in maximum milk production. One of the most important problems that a dairyman is faced with is the formulation of a balanced pasture program—this being a program that will furnish the most pasture the year round. If the less valuable pasture crops are needed for other purposes, such as for use in early spring, late fall, or or dry cows and heifers, they may still be profitably used.

Pasture management

A well-planned and well-executed pasture program can save dairymen 50 percent or more on their grain feed needs. When milking cows go onto spring pasture there is little need for grain to be fed during the first 30 to 60 days. Even after this period the amounts fed can be reduced by as much as 50 percent from cus-

When drouth strikes, more feed is needed than can be supplied by an "ordinary" pasture. High fertility of soil and selection of pasture grasses well adapted to withstanding drouth are aids in combatting drouth. Compare this picture, for example, with the one on page —. Both were taken in August, 1953, in an area hard hit by severe drouth, but the pasture shown on page — was highly fertile and was supplying plenty of forage even durign the drouth.

tomary rates whenever pasture is in a fast-growing succulent condition. Likewise dairy heifers and dry cows do well on such pasture and usually no supplement need be fed.

The management of dairy pastures so as to secure maximum usage is important. Some type of rotational grazing is usually advisable. One plan is to permit the milking cows to have first chance to graze new areas where fresh growth of succulent forage is available. As soon as the milk cows have consumed the most palatable forage, they are moved to another "fresh" pasture while heifers and dry cows graze the less palatable herbage remaining on the first pasture. Today's trend in successful grazing plans is to allow the milking cows to graze only small areas of fresh growth at one time and to continue to move them to new areas after they have consumed the choice forage.

Minerals, water and shade

Dairy animals when on pasture should have free access to loose salt and steamed bonemeal. A good commercial mineral mixture or defluorinated phosphate and fine-ground limestone can be used in place of the steamed bonemeal. Clean water and

shade should also be provided for each pasture. If a pond is the source of water, it should be fenced and the water piped into a tank. This practice will protect the water from contamination and will aid in controlling udder infection of the dairy herd.

Off-flavors in milk due to pasture

Certain pasture crops and weeds when eaten by milking cows cause objectionable flavors and odors in milk. This is especially true when they are eaten just before milking. The pastures most commonly giving off-flavor to milk are green rye, cabbage, turnips, rape, kale, and green cowpeas. At times objectionable flavors are imparted to milk when cows are first turned onto various grass-legume pastures. Some of the off-flavor is caused by the overindulgence of cows in the forage. Another main cause is cows' eating certain weeds when they first go to pasture. Wild garlic and onions are the most common. The control of weeds by following a good pasture program—reseeding, fertilizing, and mowing of weeds—is recommended. When it is necessary to use pastures that are causing cows to produce milk having off-flavors it is recommended that cows be removed from such pastures two or more hours before milking. When possible, such pastures should be grazed during the forenoon only, with other pastures used during the remainder of the day.

Pastures for Beef Cattle

Beef cattle production in Kentucky is well suited to the maximum use of pasture forage and harvested roughage. Plans such as the Kentucky Cow and Calf plan or the grazing of feeder calves to approximately two years of age and 1100 to 1200 pounds in weight can produce good to choice beef economically and profitably with very little if any grain. Such plans carry much less risk than do those using quantities of grain, especially in a period of declining prices.

Pasture needs vary with age and use of cattle

The various classes and ages of beef cattle differ in the quality and amount of pasture forage required for them to perform satisfactorily. For instance, a yearling steer that is expected to fatten on grass alone during a six month grazing season must consume a maximum amount of the most nutritious forage throughout the season. Otherwise he will be lighter, thinner, and less desirable from the market standpoint and, therefore, less profitable to his owner. Cows nursing calves, especially those on the Kentucky Cow and Calf plan, also require a maximum intake of highly nu-

Highly fertilized pasture stays productive during drouth longer than pasture not so fertile. This picture was taken in August, in the midst of a summer-long drouth.

tritious forage in order to raise the heaviest, fattest and most profitable calves. On the other hand, a mature bull, an open heifer, or a first calf pregnant heifer all have moderate requirements for energy intake. Such animals will perform satisfactorily on less palatable and less nutritious forage.

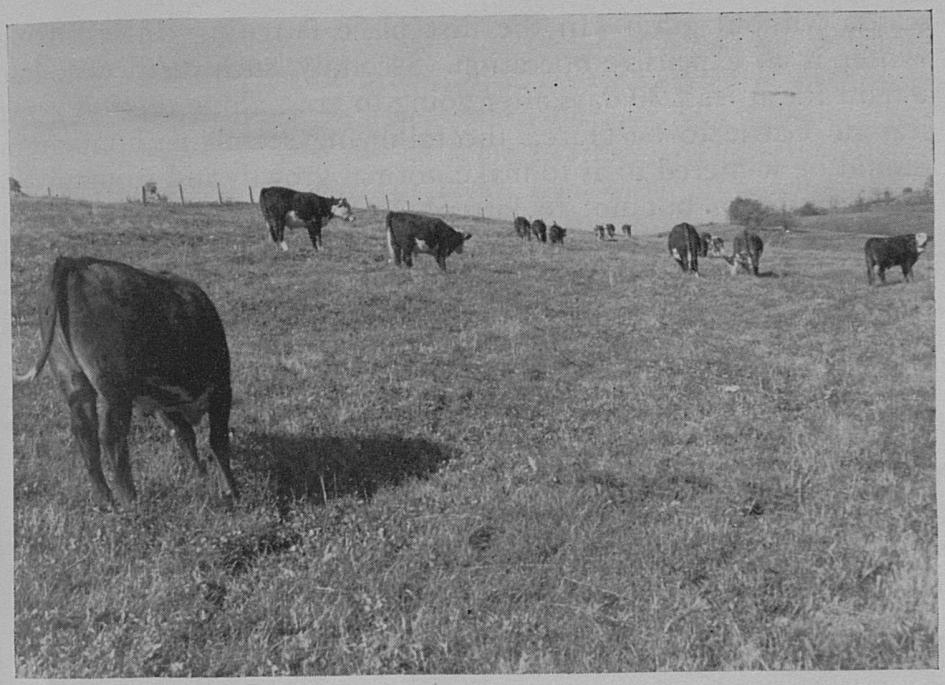
Palatability affects efficiency of utilization

Farmers are becoming increasingly aware of the need for greater efficiency in utilizing their pasture forage. This stems from the fact that they are investing more money for land, fencing, seed, fertilizer, labor, and other expense items in producing pasture forage.

Daily intake of forage is definitely related to the efficiency with which pasture forage is utilized. This is due to the fact that a beef animal must consume a definite amount of forage each day to meet its maintenance requirements. Since maintenance alone will usually bring no profit to the owner and since gains or milk production are definitely related to amounts of forage consumed above the maintenance requirements, maximum effiiciency of pasture forage utilization can be obtained only through high forage intakes.

Older animals fatten more readily on pasture

As has already been indicated, one of the most important factors regulating profit in grazing beef cattle is their final condition



Feeder cattle make good use of grass. These cattle were bought at weights ranging from 600 to 700 pounds in September, to be grazed and fed lightly during winter, and finished on pasture the next summer. Photo taken in October, soon after purchase.

or fatness. Grass cattle are discounted more for lack of fatness than for any other one thing. Young animals that are still growing rapidly do not fatten as rapidly as older animals that have already made most of their growth. This is because most of the limited capacity of the young animal is needed for growth and maintenance with very little left over for fattening requirements. They, therefore, need concentrated feeds if they are to fatten rapidly. It is also true that fat cattle weighing over 1200 pounds face a slow and unprofitable market every few years. With these factors in mind Kentucky farmers should have their cattle weighing between 700 and 800 pounds at the start of the grazing season if they are to be fat enough and yet not too heavy to sell well that fall.

More Kentucky farmers may find it desirable to put their cattle through two winters and two summers in order to get them fat without grain at around 1100 to 1200 pounds in weight. The intensified grassland program should provide plenty of harvested roughages for wintering these cattle. Kentucky farmers can now do this just as cheaply as western ranchers.

Winter moderately cattle to be grazed the following season

It definitely increases cost of beef production to fatten cattle during the winter if they are to be turned on grass the following

season without grain. In the first place fattening cattle during winter is an expensive operation. Secondly, such cattle will lose weight for at least 30 days after going to grass alone the following season. Cattle to be grazed the following season without grain should be wintered so as to make normal growth and to maintain their condition but not to fatten. In doing this, calves should average a gain of 1 pound a day, yearlings ½ pound a day, and two-year-olds no gain per day. The following rations should produce those gains. Winter grazing will reduce the roughage needs of cattle in proportion to the quality and availability of the forage. These rations are for the days when no grazing is available.

Daily Rations for Wintering Stocker Calves:

(a) 8 lb legume or mixed hay
5 lb ground ear corn

(b) 10 lb grass hay
2 lb ground ear corn
1½ lb soybean or cottonseed meal

(c) 22 lb corn silage
6 lb legume hay

(d) 18 lb grass silage
7 lb grass hay, stover or straw

Daily Rations for Wintering Stocker Yearlings:

(a) 8 lb legume hay
10 lb grass hay, stover, or straw

(b) 16 lb grass hay
1½ lb soybean or cottonseed meal

(c) 30 lb corn silage
5 lb legume hay

(d) 20 lb grass silage
12 lb straw or stover

Daily Rations for Wintering Stocker Two-Year-Olds:

(a) 6 lb legume hay
14 lb straw or stover

(b) 20 lb grass hay
1 lb soybean or cottonseed meal

(c) 36 lb corn silage
4 lb legume hay

(d) 20 lb grass silage
14 lb straw or stover

Salt, fine-ground limestone, and steamed bonemeal should be readily available to the cattle at all times.

Stocking rates

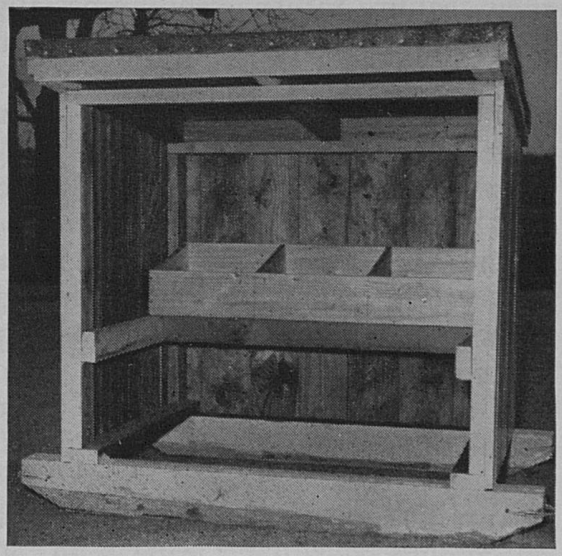
Overgrazing is a common fault in pasture utilization. Heavy stocking causes the cattle to graze the desirable plants very closely and allows the weeds to grow. This weakens the desirable plants and finally results in too little ground cover, erosion, and heavy weed growth. Undergrazing is also detrimental as it allows the plants to become more nearly mature. As the forage approaches maturity it is lower in calcium, phosphorus and protein, and is much less palatable and digestible than young actively growing forage. The best pastures during the spring and early summer can carry one long-yearling steer or mature cow per acre. Poor, unfertilized pastures may require up to 6 or 8 acres per animal. In an average season, however, a good pasture should be stocked at the rate of one animal unit per 2 to 4 acres.

Shade and water

Livestock in humid areas fail to do well on even the best pasture during the hot summer months unless provisions are made to help them combat the extreme heat. Shade is essential, as is an abundant source of fresh, clean, cool water. Trees furnish the cheapest and best protection from the sun, but simple, economical shades should be built where trees are not available. If ponds are used as a source of water, they should be fenced and the water piped to a trough or tank. Good, clean water must always be available.

Minerals and salt

Loose salt should be available at all times. Block salt is convenient but may not provide adequate intake unless loose salt is also available. The only other mineral likely to be lacking on pasture is phosphorus, which is simply and cheaply supplied by feeding steamed bonemeal free choice. Defluorinated rock phosphate is also suitable. Some livestockmen prefer to provide ground limestone, steamed bonemeal and salt free choice in separate containers as a cheap insurance against any possible deficiency. Need for the so-called trace minerals has not been established in Kentucky.



Salt is needed by cattle at all times. Steamed bonemeal and fine-ground limestone are needed mainly in the winter, but may be offered to the cattle at all times as cheap insurance against unexpected deficiencies. This covered mineral feeder on skids can be moved easily to the pastures where cattle are grazing.

Quality of grazing animals

One factor occasionally overlooked in the utilization of good pastures is the quality of the livestock used to harvest them. The best pastures will not make profitable animals from inferior ones. A balance of fertile soil and a good stand of desirable plants well

managed and properly stocked with well bred, healthy animals will pay dividends; will be as safe an investment as possible; will conserve your soil and will give the immeasurable satisfaction that comes from a job well done.

Pastures for Swine

In comparison with cattle and sheep, hogs consume relatively small amounts of pasturage. Yet its importance in keeping production costs at low levels is well known by producers generally. Good pastures are a cheap source of protein and minerals and an indispensable source of vitamins. Because they provide succulence, and because animals must exercise when grazing, pastures can make a great contribution to the general health of hogs. Experienced producers report that bred sows grazed continuously on good pasture during the gestation period farrow with less difficulty than those kept in drylot. Pasture-fed hogs tend to scatter their manure rather evenly, especially when the location of the feeders and waterers is changed frequently, thus accounting for less loss of fertility than on drylot. A sanitation program can be more readily and more effectively carried out on pasture than in drylot. From 12 to 15 percent of the grain and 50 percent of the supplement is saved in fattening hogs on pasture. An acre of good hog pasture saves from 800 to 1,000 pounds of corn, plus 500 pounds, or more, of tankage, much more when grazed by sows with small pigs. Fed on pasture, hogs gain about 17 percent faster than those fed in drylot, which frequently means getting pigs ready for market by late summer when prices are at or near peak.

Open or bred sows on good pasture need little or no additional feed. Indeed, excellent litters have been reported from large bred sows that spent the gestation period on good Ladino pasture and received only a simple, home-made mineral mixture, salt and good drinking water.

Long a subject of frequent experimentation, no fact is better established than that exclusive corn-alone rations for hogs in drylot are unprofitable. Corn has in it hardly enough protein, and it lacks two of the 10 essential amino acids needed for the health of the pig. It is low in minerals and vitamins. All these deficiencies are made up in good pastures. Probably the most important contribution from good pastures is their variety of vitamins, consisting of A and B-complex, principally. Grazing pigs get their D from the sunshine. The vitamin content of pastures and some probably unknown nutritional factors, is thought to be the reason for the failure of drylot rations to equal in value good pastures or legume hay when fed in rations to bred sows, and growing pigs.

An acre of good hog pasture saves about half a ton of corn and around 500 pounds of tankage when grazed by cows with young pigs. Hogs gain faster on pasture than in dry-lot feeding.

The carrying capacity of pastures varies with the kind and quantity of feed fed to hogs. If hogs are full fed, an acre of good alfalfa or Ladino will graze 20 to 30 hogs, but a smaller number if the feed is limited. Some farmers graze only 10 to 12 full fed hogs per acre on alfalfa and cut a crop one to 1½ tons of hay. This results in keeping new, tender growth available. Coarse pasturage is of little value for hogs. All pastures should be kept short by either grazing or mowing.

Experiments indicate that an acre of good alfalfa pasture will produce at least 500 pounds of gain on full-fed hogs; red clover at least 450 pounds; rape, 400 or more pounds. If only a limited feed of grain is fed these figures would be greater. All legume crops, as well as small grains and grasses, when short and tender, provide excellent grazing. In a survey, 40 Kentucky hog producers reported that they graze hogs an average of 10 months, during years of normal rainfall. The secret of successful fall and winter hog production is good pasture. There are few days during a mild winter when hogs will not do some grazing.

How much or how little grain is fed on pasture must be dictated largely by the time it is desired to market the hogs. Certainly, a limited grain-alone allowance, encourages pigs to eat more pasturage than when they are full-fed a balanced ration, but the slower gains resulting usually put the animals to market weight too late for peak prices. That is why spring-farrowed pigs must be kept constantly on a full feed of grain and supplement

to get them ready for the late summer and early fall, when prices are highest. But, if pigs are farrowed early enough, they can be carried to 75 pounds on a full-fed balanced ration, after which they are finished on corn, minerals, and pasture. At the Purdue Experiment Station, 75-pound pigs fed in this way gained 1.49 pounds daily, and required only 310.5 pounds of corn and 2 pounds of minerals per 100 pounds of gain. At the Kansas Experiment Station, on a ration of corn self-fed, and tankage hand-fed at the rate of 1/5 of a pound per pig daily, 60-pound pigs fed to a weight of approximately 200 pounds gained 1.52 pounds per pig daily, and made 100 pounds of gain on 305 pounds of corn and 13 pounds of tankage. If such a plan of feeding is to be successful, pasture forage must be good throughout the feeding period. In case of drouth, it may be necessary to feed as if pigs were in drylot.

Alfalfa meal is not needed in supplement fed to pigs on good pasture. Tankage, or tankage and soybean oilmeal half-and-half, is a most satisfactory supplement to grain for hogs on pasture.

Antibiotics are of little value for healthy hogs receiving good rations on clean pasture.

Pastures for Sheep

Sheep probably fit in better with seasonal pasture production and can make better use of pasture forage than any other class of livestock. Many of the grasses make their greatest growth and are in their most palatable condition in spring and fall. It is at these times that pasture demands of sheep are at their highest. In spring succulent pasture growth can be utilized in finishing market lambs. In the summer after lambs have been sold or weaned, the normal drop in pasture production actually is ideal for maintaining ewes without excessive fattening. Following this, the fall stimulated forage is good to get ewes in a thrifty gaining condition commonly thought necessary for maximum breeding effiiciency.

After spring growth starts pasture forage alone is utilized effectively enough by ewes and their suckling lambs to produce top market weight and finish on the lambs. Pastures used properly are also nutritious enough to maintain the breeding flock throughout the growing season. In general the only time feed other than pasture forage is needed is at times when sheep cannot be left continuously on pasture.

Bluegrass along with a legume such as white clover, is one of the best pastures for sheep and has long been a standby because of its seasonal production and palatability in the growing stage. Other grasses such as bromegrass, orchardgrass, timothy, and red-

Sheep production fits well into the seasonal pattern of pasture production in Kentucky perhaps better than any other livestock enterprise.

top can be used in much the same manner as bluegrass. However, these grasses should be rotationally grazed in order to keep them in the proper growth stage for most rapid gains on lambs and to maintain their stand.

Most of the legumes are quite palatable to sheep and should be used along with the grasses to increase yield and to lengthen the time good succulent pasture forage is available. This is particularly important for fattening lambs born late in the lambing season and for growing out weaned lambs for breeding stock. Ladino clover, alfalfa, and red clover are ideal for these uses in rotation pastures. White clover, Ladino clover, and birdsfoot trefoil are good in permanent pastures. Korean lespedeza, an annual legume, can be used advantageously to furnish forage late in the season.

In many instances during the summer growing season, good results can be obtained by providing productive temporary pastures for ewes and fattening lambs. A mixture of spring oats and rape is good. Rape alone may be used but has a tendnecy to cause scouring and bloat. Sudan grass is another very productive annual which is used in this manner, but it should not be grazed when under 6 to 8 inches in height or when frosted or wilted, because of possible poisonous amounts of prussic acid. In all cases, most favorable results with temporary pastures are obtained when soil of high fertility is seeded. Poor or erodible soils should not be used.

During the fall, winter, and very early spring, small grain crops such as barley, rye, wheat and oats make very nutritious forage for sheep. Harvested roughage needs for sheep can be reduced at least half and in many cases even more by wise use of these forages. Fall accumulated growth of grass on permanent pastures should be available in addition, to provide feed when conditions do not permit turning on these temporary pastures.

If possible, relatively small fields should be used for pasturing sheep. Sheep like fresh pasture forage which can be provided by rotational grazing of several fields. With tall-growing grasses and legumes this is of even more importance, as sheep graze very closely and may injure the plant if it is not permitted to make regrowth.

Another pasture consideration is the possibility of bloat. Grasses should be included with most legumes and sheep should be well fed before being turned on to succulent pastures in the spring. Along with this, plenty of salt, water, shade, and in some instances dry roughage along with pasture, should be provided.

Pastures for Horses and Mules

Good pasture forage will supply much of the feed needed by horses and mules throughout the year. Any pasture forage that is suitable for other livestock will serve equally well for horses and mules. Due to their selective grazing habits, however, it is frequently necessary to graze either cattle or sheep with or after horses and mules in order to bring about more complete use of the pasture forage. Another system that can be used to advantage is to spread manure on heavily grazed areas, forcing the animals to graze elsewhere.

Horses and mules are also troubled with internal parasites, which can become quite a problem where the acreage of pasture is limited. This hazard can be reduced through the use temporary pastures or by rotating horses and mules with other livestock.

Salt, fresh water, and shade should be available at all times.

Pasture for Milk Goats

The pasture requirements for milk goats are very similar to those for milk cows. A pasture program should be followed that will produce, during all months of the growing season, forage that is succulent, tender, and highly palatable. This type of herbage is especially needed by lactating does if a high level of milk production is to be maintained.

Pasture for Poultry

Many grasses and legumes are suitable for poultry pasture. However, poultry cannot utilize mature, tough pasture even if it is green. Since young, tender, succulent forage is needed, poultry pasture should be mowed three to six or more times during the summer to keep down weeds, to keep the grass from going to seed, and to maintain succulence.

Regardless of the type of forage seeded, the ideal poultry pasture is one that permits complete separation of growing and adult birds. It should be well drained, keeping in mind that it should be uncontaminated by surface drainage from polluted areas above. Use the same pasture for only one year and allow at least a 3-year interval before using the pasture again. This will break disease and parasite cycles.

Range shelters should be located about 200 feet apart and may be moved once each month. The birds should be encouraged to use all available pasture. If the shelters are not relocated on the range, move the feeders and waterers farther and farther from the house to make best use of the pasture and to limit contamination.

A good pasture will support 200 to 500 birds per acre depending on the quality of the pasture and the season. A good second year growth of Ladino has supported 500 to 600 chickens per acre. While Ladino clover is generally considered the best all round pasture for poultry, excellent results are obtained from alfalfa,

Both hens and pullets make good use of tender, succulent pasture forage. By using good pasture and good management, poultrymen can save 10 to 20 percent of the usual feed costs in producing good laying pullets.

red clover, lespedeza, bluegrass and other grasses. In general, a mixture of grasses and legumes will supply the best pasture, since one or more of the constituents will be tender and green at all times.

By the use of good pasture and good management the poultryman may save 10 to 20 percent of the feed cost in producing good laying pullets. Since pasture properly managed includes freedom from parasites and intestinal diseases, loss of birds in the laying house is lowered and egg production and hatchability are increased.

In general, the use of pasture for large laying flocks is not recommended. For the farm flock of 30 to 50 pullets, pasture may be used to good advantage. Two or three yards to be used in alternate years should be provided. In order to produce clean eggs it is best to use pasture only after noon.

Economic Aspects of Pasture Utilization

(See also pages 92 to 94)

The problem of forage utilization has become one of major importance in profitable farming. For largest profits, the farmer must use each unit of his scarce resources where it will bring the greatest net return. He has many choices to make. He must choose among different types of livestock and among many kinds of cropping systems, and these choices are related to each other.

Relationships among rotations

Grasses and legumes contribute both directly and indirectly to the income of Kentucky farmers who grow primarily grain or row crops (1) by increasing or maintaining yields of other crops, (2) by furnishing feed for the production of livestock, and (3) by providing income from production of seeds. Sod crops in a rotation with row crops help row-crop production by (1) increasing fertility, (2) improving soil structure, (3) helping to control soil erosion, plant diseases, and damages from insects. On the other hand, grain or row crops may contribute to profitable production of forage by (1) aiding in control of weeds, bushes, etc., (2) assisting in re-establishing proper plant populations, and (3) producing a feed of direct value to livestock production or for sale.

Such relationships are said to be "complementary." Row crops and forage are complementary when an increase in the output of one results in an increase in the output of the other from a given

quantity of farm resources. A complementary relationship between grain and forage crops develops only over one or more rounds of the rotation. Within any one year grain and forage crops are always competitive. Over a period of several years grain and forage crops eventually become competitive. Forage becomes competitive with grain when the per acre increase in grain yields from growing more forage on a given land area no longer offsets the effect of a reduction in grain acres. Similarly, grain crops become competitive with forage crops when the per acre increases in forage yields from growing more grain no longer offsets the effect of a reduction in forage acres. In general, a farmer should always grow as much forage as will maximize total grain production—or as much grain as will maximize forage production.

Feed substitution

The profitability of growing more forage where it is competitive with grain depends on the value of forage obtained, relative to the value of grain it replaces. The rate at which forage and grain substitute for each other in livestock feeding becomes extremely important in determining (1) the best and most economic ration for each type of livestock and (2) the right amount of grain and forage to grow in order that the maximum value of livestock may be produced.

Livestock and livestock products can be produced with different combinations of forage and grain. In general, it pays to substitute one feed for another whenever the cost of adding a unit of that feed is less than the value of the other feed saved in maintaining a given level of livestock production. When the most profitable combination has been determined, the greatest return above feed cost is obtained by feeding this combination as long as the value of added product is greater than the added cost of the ration fed.

Labor

While farm production possibilities and feeding systems are perhaps the most important factors in cost of producing livestock, the labor cost perhaps ranks next. Labor costs for any one type of livestock depend in part upon the system of feed utilization, which in turn affects the labor requirements in crop production. Distribution of labor requirements throughout the year is important in deciding the feeding system if the farmer is to avoid periods of low employment and the hiring of additional labor during seasonal peaks. A limited or inflexible labor supply may restrict a farmer's ability to utilize a large quantity of forage.

Capital

A farmer has the problem of distributing his scarce capital in such a way as to gain the largest net retuns. When forage competes with grain, and the forage is fed to livestock, a livestock system large enough to utilize all the forage is required. The investment needed to handle a given quantity of forage depends upon kind of livestock, the proportion of forage in the ration, and the type of housing facilities used. Some types of livestock produce a steady income over the year to make pay-as-you-go possible, while others require a considerable time before income is returned. Where this latter type of livestock is kept it often is necessary to borrow money for operating costs and family consumption. Some livestock systems, like beef grazing and dairy systems, require a relatively low investment for a given quantity of forage consumed, but the returns per dollar invested often are relatively low also. Farmers who are short on capital place a higher premium on present income and want quick returns. Short-term tenant operators are also in this position.

Risk and uncertainty

Risk and uncertainty faced by farmers are extremely important in forage utilization, and different systems of utilization involve different degrees of risk and uncertainty. Young farmers, or those in a low capital position, often prefer a livestock system such as the Kentucky Cow and Calf Plan which, while it may not return as much as others, gives a steady and more certain return. Farmers with plenty of capital may choose a more risky livestock system. They can afford an occasional loss in order to make a good return in the long run.

Farming based on a high proportion of forage involves risk or uncertainty because of (1) the capital invested in both forage and livestock; (2) the length of time needed to produce a given output (the longer the time the greater the number of unanticipated costs which may occur). Not all farmers react to uncertainty in the same way. Their reactions may be influenced by their capital position, previous training, and willingness to take a chance. The ideal combination of forage and grain would be one which gives the maximum net return over time and involves the least risk. Often this cannot be had, for high returns often are made in the face of risk and uncertainty.

Variability of returns in the past may give some indication of the variability in the future for various feeding systems. Farmers are interested in the amount of variation. There is apparently no significant variation within a particular type of livestock fed

different forage-grain combinations, but the differences in variability of returns from different kinds of livestock are important. Returns from feeder cattle may fluctuate widely, while from dairy cattle the returns are usually stable.

Farmers usually are not in position to shift quickly from one type of livestock to another because of fixed investments in specialized facilities the useful life of which extend years into the future. However, they can alter the system of feeding by changing the proportions of forage in the ration. No single feed combination is likely to be most profitable over a long period of time, but a high grain ration for dairy cows has been more profitable generally, over time, than an all-forage ration. In times of severe drouths, farmers find it profitable to substitute grain for forage in rations fed. On the other hand, in times of low-cost forage production relative to grain, farmers may substitute a larger quantity of forage for grain. The higher the quality of forage the closer it comes to substituting at a constant rate.

Even after the farmer has settled on a best combination of roughage and grain, he still is faced with the problem of determining the most profitable level of production, which depends on the value of the increase in the product due to adding a unit of the ration and on the cost of that unit. Any change, either in the price of the product or the cost of the ration, will alter the best level at which to produce. Since this is true, the seletion of the level of production involves considerable risk and uncertainty. Great day-to-day variations in prices make it difficult to make the right adjustments in rations and levels of production. Because of this dairying permits easier and more ready adjustments than most other systems of feed utilization, as the time span between feeding and sale of product is shorter than for beef or sheep.

Another important problem in forage utilization is associated with the variation in production. Farmers must decide whether to spend money to provide for a stable supply of forage or stand the cost in maintaining flexibility in his needs for forage. Farmers often take a combination of these.

CHAPTER 4

PLACE OF PASTURE IN KENTUCKY FARMING

Pasture crops make a major contribution to the income of Kentucky farmers and to the welfare of Kentucky people in general. Kentucky farm income from pastureland is influenced by conserving and improving the soil, by increasing livestock numbers and production efficiency through complementing grain crops, and by making more complete use of farm land.

More of Kentucky's cropland is used for pasture than for harvested crops. The proportion varies by type-of-farming areas. For example, in 1949 the Bluegrass region (type-of-farming area III) used almost 2 acres of cropland for pasture for every acre used for harvested crops. On the other hand, the Lower Ohio Valley corn-livestock-tobacco area (type-of-farming area VII) had only a little more than one acre of cropland used for pasture for each 2 acres of harvested crops.

Forty-four percent of Kentucky's farm land is used for pasture production. Additional grazing is furnished by aftermath, small grain, and cover crops on farms, and pasturelands outside of farm units. This additional grazing very probably adds as much as a third to the acreage usually available for pasture.

Over 77 million acre-months of grazing was available on all Kentucky land used for pasture in 1949. With improved pasture seeding, fertilizing and management methods, substantial increases in livetock carrying capacity could be made on the same pasture acres used in 1949. In addition, about half of Kentucky's 1.2 million acres of idle land could be used for improved grazing.

About 1.75 million animal units were grazed in Kentucky in 1949. About 9 animal units were kept, on the average, for each 100 acres of farm land. In the various type-of-farming areas the average ranged from 5 to 13 animal units per 100 acres of farm land.

About 5 acres of pastureland, in addition to aftermath, small grain and cover-crop pasture, was available for each animal unit in Kentucky in 1949. Much of the 5 acres was medium to low in production of forage, and the grazing livestock averaged medium to low in production. Improvement of pasture affords an opportunity of increasing livestock production without increasing livestock numbers. Further improvement of pasture leads to the carrying of increased numbers of higher producing livestock.

See the charts of pasture in Kentucky in the several type-of-farming areas, on page 103.

Pasture Is Soil-Conserving

Pastureland should furnish a grass-legume sod cover that will protect and improve the soil. Sods are the principal means of restoring and increasing soil organic matter. The very extensive root systems, together with the residue of tops, as manure or otherwise, supply more organic matter than can be supplied by any other means. Without this continued restoration, the physical condition of the soil deteriorates to the point that crop yields are seriously reduced regardless of treatment. If physical condition of soil deteriorates the soil becomes subject to greater erosion.

Most erosion starts with the splash of raindrops as they fall on bare soil. The force with which they hit dislodges soil particles, which are carried in the splash to make the water muddy. As the rainfall soaks into the land this sediment fills the pore spaces of the soil, and reduces the rate of infiltration. As the muddy water runs off, the sediment scours the surface and causes more soil to be carried away.

Scour erosion is mainly gully erosion. Soil loss from gully erosion is ordinarily much less than with sheet erosion, but cutting up of fields may cause great inconvenience of working, and expense of renovation.

Vegetative cover dense enough to catch the fall of raindrops is the only effective means of preventing erosion on sloping land. Contouring and terracing will reduce erosion a great deal on gentle slopes, but will not prevent it.

On land subject to severe erosion this means that continuous dense cover of sod or forest is the only means of controlling erosion. On land subject to only slight or moderate erosion, occasional cultivation with proper water-management practices will not produce more damage than can be repaired by good sod the rest of the time. On such land the dense mat of roots in the soil is very effective in reducing erosion until they decay, so the effect of good sod carries over during one year of cultivation.

In Kentucky as a whole, about 40 percent of the farmland is in forest, and, considering the control of erosion, practically all of this should remain in forest. Of the remaining 60 percent of agricultural land, about two-thirds is suitable for rotation cropping and the other third should be in permanent sod. Of the rotation land a small amount is suitable for continuous cropping, but most of it should have sod at least half of the time. Some of it should have sod a great deal more than half the time. These rough averages may be useful in seeing the importance of pasture to the state and in planning pasture programs on an area basis. They are of no use as guides for individual farms.

Unprotected land is ruined by erosion. Though modern heavy equipment would smooth off such land and restore its to usefulness, it may be doubtful economy to attempt the restoration of badly eroded land.

Rotation of Pastures Aids in Controlling Pests

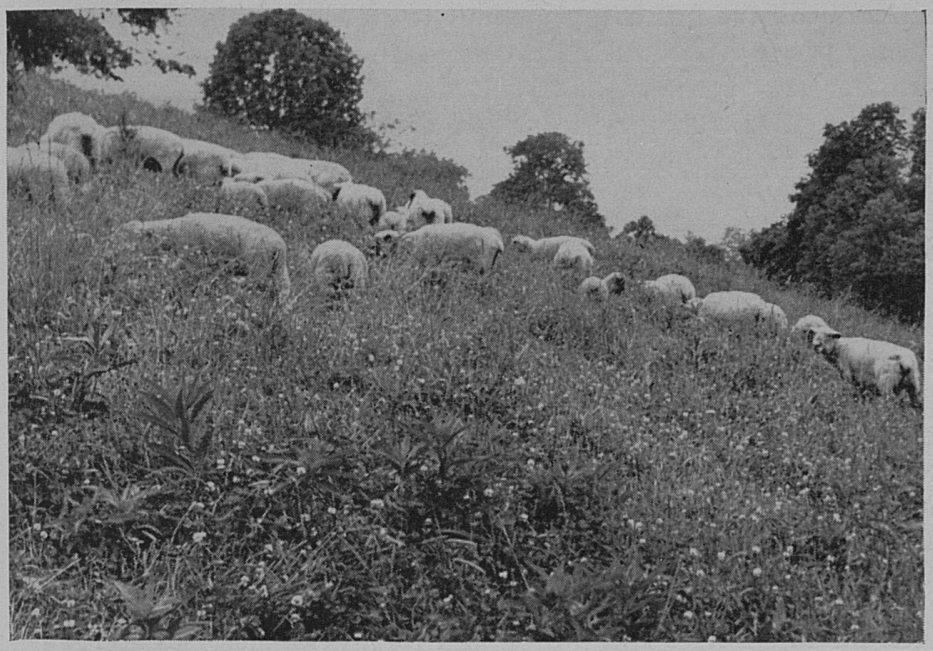
Rotation of sod crops and other crops helps to control diseases and insects. Certain diseases use a particular crop as a host plant. Sod crops such as pasture grown in rotation with an intertilled crop provide a means of breaking up the continuous living of the disease organisms on a particular crop.

Pasture Is a Major Source of Feed for Livestock

(See also pages 86-7)

Dairy cattle

Improved well-planned pastures may reasonably supply 70 to 100 percent of the feed for dairy cattle during the grazing season when adequate water and minerals are furnished. Good pastures, during the first 60 days or more of the pasture season, furnish enough nutrients to supply all the feed needs of dairy animals 12 months of age or over, including the producing cows. If a supplement is needed for the heavier producing milk cows during the early part of the grazing season, only very small quantities of grain are necessary. Improved permanent pastures consisting of palatable grass and legumes adequately fertilized to produce rapid growth over a long season and supplemented with special pasture in early spring, midsummer, and early fall may continue to sup-



Vegetative cover dense enough to catch the fall of raindrops is the only effective means of preventing erosion on sloping land.

ply 70 percent or more of the nutrients for milking cows throughout the grazing season.

Pasture for heifers under 12 months of age needs to be supplemented with grain or hay. When on excellent pasture, all other heifers and dry cows need little or no grain supplement, if they are in good condition, until shortly before calving, when some grain feeding may be profitable.

Beef cattle

Pasture may furnish 60 to 100 percent of the feed nutrients for beef cattle. For young growing animals or those being fattened for market, the pasture needs to be supplemented in order to furnish suffiicient energy. These animals cannot consume enough pasture to obtain the required amount of energy for economical growth. Additional grain, therefore, is needed in their rations, particularly during midsummer. On the other hand, cows and their calves may be carried on good pastures with no additional grain. Older cattle being held for fattening in the dry-lot in the fall and both dry and pregnant cows can be carried on pasture alone.

Sheep

In general, good pasture furnishes 80 to 100 percent of the feed nutrients for sheep during the grazing season. Grain may be

economically fed as a supplement to pasture for early lambs on spring pastures not fully developed and for late lambs on mid-summer pastures that have lost the palatability of good spring pastures. Grain may be used to condition the ewes for early fall breeding and to obtain maximum growth of young breeding stock.

Swine

Highly palatable pasture mixtures furnish protein nutrients for swine that increase the efficiency of grain, offsetting the purchase of high protein supplements. Thirty to 50 percent of the protein supplement required in fattening swine in drylot may be furnished by pasture. Sows and gilts can be maintained on rations in which as much as 50 percent of the feed nutrients are furnished by pasture.

Horses and mules

Pasture forage, during the grazing season, may furnish all the feed for idle horses and mules, and for working horses and mules pasture may furnish approximately 35 percent of feed requirements. Growing foals require some grain along with pasture, both before and after weaning, until two years of age, in order to make the most rapid growth. Some experimental work in which colts were fed no grain after weaning has shown that fair growth can be obtained.

Poultry

The value of pasture for poultry is not measured entirely by the reduction of feed costs. Pasture which provides plenty of succulent green feed will save 10 to 20 percent of feed costs. The vitamin-rich pasture permits the feeding of a simple, less expensive growing mash, and mash consumption is lower because part of the mash is replaced by insects and foliage. Probably a far greater value is that pullets housed from the range are healthier and more vigorous, and therefore more profitable. Pasture also provides the necessary isolation of young chickens from older birds during the growth period when the young are most susceptible to diseases and parasites of the older birds. Good ranges also provide other well recognized advantages, such as fresh air, direct exposure to sunshine and more exercise, all of which have a direct bearing on producing sturdier, healthier pullets.

Production Practices

Pasture production may be increased by rotating the animals from pasture to pasture. For dairy cattle rotation grazing offers

Fencing on the contour, between permanent pasture at the left and rotation cropland at the right, makes for best use of both pasture and cropland.

a means of maintaining a high level of milk production by keeping a fast-growing, succulent pasturage available during a larger part of the grazing season. More pasturage may be obtained by grazing the pasture first with the milking herd and then with the dry cows and heifer stock. This gives the milking herd the more succulent pasture, and keeps supplemental grain feeding to a minimum.

Greater carrying capacity of pastures may also be obtained by alternate grazing by two classes of livestock. Cattle and sheep, or swine and sheep, grazed alternately, make more complete use of pasture than either kind alone. Sheep will graze the more tender blades of grass while the cattle feed on the more mature grasses. In the case of swine and sheep, the swine would eat the more succulent plants and the sheep would clean up the more mature pasture growth.

Pasture as a part of a crop rotation generally produces more forage per acre than permanent pasture. Better stands of legumes usually are maintained in such pastures. The increased protein content of the pasture with good stands of legumes aids in milk production and in fattening of sheep and hogs. Further, rotation pastures including legumes increase the productivity of the land by adding fertility in the form of nitrogen and by improving the physical condition of the soil by the formation of sod.

Calculation of Costs and Returns

The real value of an acre of pasture to an individual farmer is its contribution to the net income of his far business. This net income may be gained not only from the pasture itself, but in the case of rotation land partly from the increased productivity of other crops.

Costs of establishing and maintaining pasture should therefore be charged partly against the benefits contributed to other crops sharing the land with pasture.

How costs and returns for pasture are figured may influence the manner in which a farmer uses his time, money, and land in the operation of his farm. Care must be taken in choosing a pasture accounting system. The evaluation varies widely, depending upon the method of calculation used, as may be seen in Table 12. Each method is used for a particular purpose, such as comparing the value of different feeds to produce the same livestock product. For further information on methods of calculating pasture value see Kentucky Bulletin 568.

Table 12.— Value of an Acre of Pasture Calculated by Different Methods of Pasture Accounting[1]

(1949 Price Level)

Method		*Value per acre*
Value of feed replaced by pasture forage	(Substitution)	$67.53
Clippings sold as hay from the field	(Clippings)	85.00
Rental value from TDN'S replaced by pastures	(Rental)	17.60
Corn equivalent value of feeds replaced	(Substitution)	56.00
Value of milk produced from pasture	(Product Value)	96.30

[1] Ernest J. Nesius, "Allocation of Farm Resources for Economic Production of Pasture Forage," Ky. Agr. Exp. Sta. Bul. 568, p. 18, June, 1951.

Most of the labor and money used in pasture production is expended before grazing begins. These outlays, once made, largely are fixed for any one year. This contrasts with row crops, such as tobacco or corn, where most cash costs and labor costs come while the crop is being produced. When costs are fixed for the period of production for an enterprise there usually is little opportunity to make big changes in that enterprise. However, this loss of opportunity for change may be offset by greater stability of income over a period of years. In the case of pasture production and use, the general pattern of production is determined far in advance of actual use. Also, the needs of livestock for pasture will be known in advance of the grazing season.

Grazing the Major Source of Pasture Income

The direct contribution of pasture to farm income is made by grazing the pasture with livestock. The class of livestock chosen

and the type of livestock product produced affect the over-all cost structure of the farm.

Livestock enterprises, like crop enterprises, vary in proportion of total cost fixed for the production period. In sheep and beef cow enterprises a large part of costs of production occur in setting up the enterprise. Also these enterprises depend heavily upon pasture forage. Where these classes of livestock are the major source of livestock income, the farming system will tend to have: (1) low gross returns per acre relative to farms having enterprises with a high proportion of costs occurring throughout the production period, (2) low total cash costs per acre during the period of production, (3) relatively stable return over the years, which means, of course, that both windfall profits and windfall losses will be small, and (4) a system of farming with relatively little opportunity for change. Flexibility to meet changing situations will have to be met by changes in capital cost.

Dairy cattle and fattening feeder cattle require larger expenditures of labor and money during the production period than sheep and beef cows. Hence the cost during the production period represents a large part of the total cost.

Risk of variation of returns is associated with kind of livestock and proportion of grain and forage fed, including pasture. For dairy cattle the returns over the years are relatively stable. Feeder cattle returns vary widely from year to year. Windfall profits and windfall losses are usually small for dairy farming, while with feeder cattle such profits or losses may be large.

Returns to investment in relation to proportion of feed furnished by forage, including pasture, varies with kind of livestock. In Iowa during a 32-year period, a study showed higher returns for the dairy herds consuming the higher proportion of grain in relation to forage (Table 13). Hogs showed higher returns with

Table 13.— Returns per $100 of All Costs for Various Livestock Feeding Systems, 1917-1948[1]

Livestock Feeding System	*Years of Loss*	*Years of Gain*	*Average returns per $100 costs*
Dairy cows: high grain	4	28	$119
medium grain	7	25	113
low grain	11	21	105
Feeder cattle:			
Feeder calves, high grain	10	22	106
Yearling steers, high grain	17	15	104
medium grain	13	19	112
high forage	12	20	113
2-year old steers, high grain	18	14	103
Hogs: medium forage	7	25	122
high forage	10	22	115

[1] Adapted from data presented in Iowa Farm Science, Vol. 7, No. 5, Nov. 1952, p. 7, Iowa State College, Ames, Iowa. For research analysis see Iowa Agricultural Experiment Station Research Bulletin 390, Sept. 1952.

a medium rather than a high use of forage. Feeder cattle on the other hand showed better returns with medium to high use of forage in proportion to grain. These data are based on assumption that if the land in a farm is used according to its best capability, a given amount of forage will be available for use through livestock. Using this forage with rations involving different levels of grain feeding provides a basis for the comparisons.

High Net Income Per Acre Is the Pasture Goal

In making decisions about pasture production a farmer is interested in highest net income from each acre, either through sale of crops, or through sale of livestock. A sound method on which to base decisions can be shown by comparing costs of the most economical rations on drylot with costs of the most economical rations on pasture.

In an experiment with pigs in drylot it was found that with corn at 2 cents per pound and protein supplement at 5 cents per pound, the most profitable ration to feed shotes weighing 75-130 pounds was 1 pound of protein supplement for each 4.8 pounds of corn. A 100-pound gain on this ration required 44 pounds of protein supplement and 212 pounds of corn. In another experiment, similar to the drylot experiment except that the pigs were on rape pasture, gains were most profitable when protein supplement was in the ratio of 1 pound to 14.8 pounds of corn. Using this ration, 100 pounds of gain required 16 pounds of protein supplement and 238 pounds of corn.[1]

At these prices for corn and protein supplement, pasture would reduce the cost of other feed 88 cents per 100 pounds of gain. If 3,500 pounds of gain were made by groups of pigs on an acre of pasture, the value of pasture to the farm operator would be $31 an acre. This value represents the difference in total feed cost between drylot and pasture, when the ration fed in each of the two cases balances the ability of the hog to use feed with the relative prices of the feeds used. Such a value is meaningful in deciding upon use to make of land to get highest value of production from it. Unfortunately not enough information is available to make similar comparisons for all kinds of livestock.

---

[1] T. B. Keith, R. C. Miller, and M. A. McCarty, "Level of Supplementing Protein for Pigs on Pasture," Pa. Agr. Exp. Sta. Bul. 407, 1941. When the pigs were on grass more corn and less protein was the most economical ration, because pasture is a more efficient substitute for protein than for corn, and protein is a higher priced feed.

CHAPTER 5

SUPPLEMENTARY AND EMERGENCY PASTURES

Supplementary and emergency pastures are used to provide grazing when permanent and semi-permanent pastures are more or less dormant or for some other reason are making too little growth to meet pasture needs of the farm. Supplemental pastures are seeded specifically for grazing in anticipation of needs that develop year after year because of the response of pasture plants to changes in seasons. Emergency pastures are those seeded to provide grazing where other pastures fail because of an unexpected situation such as drouth and insect damage.

Crops used for supplementary and emergency pastures in Kentucky are principally small grains, Sudan grass, ryegrass, millet, sorghum, soybeans, cowpeas, rape, Korean lespedeza, crimson clover, and hairy vetch. Small grains and Sudan grass are undoubtedly the most important crop for these kinds of pasture.

Balbo rye is the principal small grain used for temporary pasture in Kentucky, largely because of its general adaptability and dependability. It is winter-hardy and vigorous in growth, and therefore furnishes much pasture in the spring and early summer.

Wheat and barley are excellent pastures and furnish more grazing on highly productive soil. Winter oats are somewhat more widely adapted to soil than wheat and barley but less winter-hardy. They are useful for pasture primarily in spring and early summer. Spring oats furnish good grazing in late spring and early summer if seeded in early spring. Varieties recommended for grain production are satisfactory for pasture. These include Vigo, Thorne, and Clarkan wheat; Kenbar and Ky 1 barley; Atlantic, Forkedeer and Fulwin winter oats; and Andrew, Mo. 0-200 and Mo. 0-205 spring oats. Jackson 1 barley is recommended for the Pennyrile area.

Ryegrass—Italian or domestic—is a pasture plant similar to rye in adaptation. It furnishes excellent grazing in fall, spring, and early summer, and some grazing in the winter. Ryegrass may also be seeded in early spring for late spring and early summer pasture.

Crimson clover and hairy vetch may be seeded alone or together for fall, winter, and spring pasture. Usually it will be better to seed them with one of the winter grains or ryegrass.

To obtain good winter pasture from winter grains and winter legumes, the crops should be sown as early as possible on good soil at heavy rates, and seeded at the proper depth in a good seed-

bed. The grains and vetch should be sown with a drill if possible.

Under ordinary conditions the time, depth, and rate of seeding of these pasture crops in Kentucky are approximately as shown in Table 14.

Table 14.— Seeding Dates for Pasture

Crop	*Range*	*Best*	*Rate of Seeding*	*Depth (inches)*
Winter oats	Aug. 20-Oct. 1	Sept. 1-20	3-3½ bu	2
Barley	Sept. 1-Oct. 10	Sept. 1-15	2-3 bu	1½
Balbo rye	Aug. 15-Nov. 1	Sept. 1-Oct. 1	2-3 bu	1
Wheat	Sept. 15-Oct. 20	Oct. 5-10	2-2½ bu	1-2
Ryegrass	Aug. 1-Oct. 20	Aug. 10-Sept. 10	20-25 lb	½
Hairy vetch	Aug. 10-Oct. 1	Aug. 15-Sept. 10	20-40 lb	1½
Crimson clover	Aug. 10-Sept. 10	Aug. 15-20	15-20 lb	1¼

The amount of pasture obtained from winter crops varies greatly with soil productivity. In general the land should be limed if needed and fertilized with 30 to 40 pounds of nitrogen, 80 to 120 pounds of phosphoric acid, and 40 to 60 pounds of potash per acre. Approximately these amounts would be supplied by an application of 700 to 800 pounds of 4-12-8 fertilizer per acre.

Winter pasture crops may be seeded, of course, on any land that is available and suitable. Perhaps, however, old lespedeza fields offer the largest opportunity in point of acreage. These fields are easily prepared and are available for early seeding.

Sudan grass is an excellent supplemental and emergency pasture crop for Kentucky in the summer. It is drouth resistant, palatable, nutritious, and produces large yields, even on moderately productive soil. Though Sudan grass is much more useful during drouthy years than during seasons of normal rainfall there are few livestock farms in Kentucky that cannot use a small area of Sudan grass during the summer when permanent pasture grasses are more or less dormant. At that time a field of Sudan grass provides an abundance of pasture and permits farmers to avoid overgrazing the permanent pasture.

To get the most out of Sudan grass pasture, two areas of it should be grazed alternately. Managed in this way, one area makes new growth while the other is pasture. However, it is highly productive even when pastured continuously. Two to three head of cattle, or an equivalent number of other kinds of livestock, can be grazed per acre.

Sudan grass should not be seeded until about two weeks after corn planting time. August first is about as late as it should be

sown for pasture. A field is ready to pasture four to six weeks after seeding.

Seeding rates for Sudan grass are 3 to 5 pounds per acre when sown in rows, and 20 to 30 pounds when broadcast or sown with a grain drill. A wheat drill set to sow 2 pecks of wheat per acre will sow about 20 to 25 pounds of seed, which are satisfactory amounts for most seedings.

Unless the soil to be seeded to Sudan grass is highly productive it should be fertilized with 400 pounds per acre of 8-8-8 or other high nitrogen complete fertilizer. It is also advisable to follow Sudan grass with liberal applications of a complete fertilizer at the time of sowing the subsequent crop.

Tift and Piper varieties of Sudan grass are recommended. Sweet Sudan grass is less productive at Lexington and is less resistant to leaf disease, though it may be more palatable.

Prussic acid, a poison occuring rather often in Sudan grass in northern states, is rare in Sudan grass in Kentucky; nevertheless, it should be remembered that the poison may develop in crops grown under unfavorable conditions of weather or soil productivity. Therefore, stock should not be turned on when very hungry, and should be removed at the first sign of sickness.

Sudan grass and soybeans furnish good pasture where allowed to make more or less full growth before grazing. Sow about one bushel of soybeans and 12 to 15 pounds of Sudan grass per acre in close drills.

Sorghum planted thickly in close rows furnishes pasture about equal in value to Sudan grass. It should be seeded, fertilized and grazed as described for Sudan grass. Sweet sorghum is superior to grain sorghum for pasture.

Millet, a summer annual grass, has become less popular than earlier because of the introduction of Sudan grass and early maturing sorghums, both of which are much better in yield and feeding quality than millet. Millet is grown largely as an emergency catch crop. It is a hot-weather crop and should not be planted for three or four weeks after the usual corn planting time. Plantings can be made as late as August 1 in Kentucky. German millet is doubtless best for pasture in Kentucky. Millet should be seeded at the rate of about 30 pounds per acre. The seed should be covered lightly. Starr, a variety of Pearl millet, may be useful in Kentucky.

Soybeans are a summer annual crop that furnishes palatable and nutritious grazing though it does not stand grazing well. It is drought resistant and adapted to good, well-drained soil. To be most useful as pasture, soybeans should be grown to good size

and then grazed off completely. Usually, the field should be divided and a section pastured at a time. Less waste will occur this way than if the whole field is grazed less intensely. Perhaps it is usually better to drill soybeans solid for pasture though less of the crop is wasted, especially in pasturing sheep, if the crop is sown in rows 24 inches or more apart. The crop may be sown as late as July 20 for pasture. Wabash, Lincoln, Ogden, and other erect varieties are perhaps superior for pasture to Wilson, Virginia Brown, and other hay varieties.

Rape belongs to the cabbage family and therefore does not make a very satisfactory pasture crop for dairy cows, but is one of the best short-season pasture crops for hogs and sheep. Cattle and sheep may bloat on it. Rape thrives best during the cool part of the season, but furnishes good pasture at all times of the year except the very hot months and the winter months. For spring and summer pasture it is advisable to sow rape as early in the spring as possible, though seeding as late as the first of May may give satisfactory results. For fall and early winter pasture it should be seeded as soon as possible after August 15. Rape thrives only on a good soil. If it must be sown on a soil of low to medium productivity, it is advisable to apply 2 tons of limestone and 8 to 10 tons of good barnyard manure or four hundred pounds of an 8-8-8 fertilizer. The seedbed for rape should be very carefully prepared and the seed covered. Rates of seeding are 2 to 3 pounds per acre for sowing in rows, and 5 to 8 pounds per acre broadcast.

Under favorable conditions rape grows very rapidly and should be ready to pasture in 6 to 8 weeks. The best plan, perhaps, for pasturing rape is to divide the field into lots by temporary fences, and pasture them in rotation. Rape and oats are sometimes seeded together in the spring, but there appears to be little advantage to the mixture over rape alone for Kentucky.

The annual lespedezas may be used as supplemental pastures. A field sown for this purpose is useful in July and August when most permanent pastures produce little grazing. The crop should be sown alone on a special seedbed at about 25 pounds per acre.

CHARTS: PASTURE IN KENTUCKY

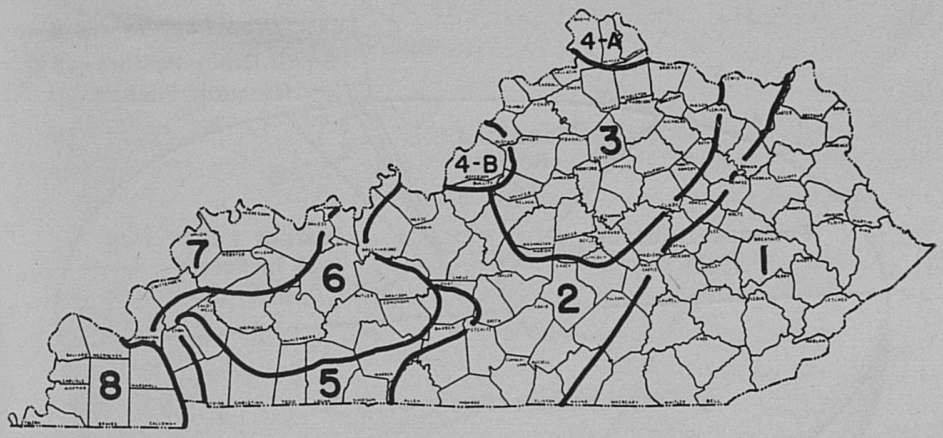


Fig. 1.— Type-of-Farming Areas in Kentucky

Area 1. Mountains, Subsistence Area (corn, hogs, subsistence).
Area 2. Eastern Pennyroyal and Knobs. General-Farming Area (corn, dairy cows, sows, poultry, tobacco, subsistence).
Area 3. Bluegrass. Livestock and Tobacco Area (bluegrass pasture, livestock, tobacco, crops).
Area 4. Urban-Influence Areas (truck crops, fruits, dairying).
Area 5. Pennyroyal Plain. Tobacco-Livestock Area (crops, tobacco, livestock).
Area 6. West Coal Field, Subsistence Tobacco Area (corn, hogs, tobacco part-time, subsistence).
Area 7. Lower Ohio Valley. Corn, Livestock, and Tobacco Area.
Area 8. Purchase Region. Tobacco-General-Farming Area.

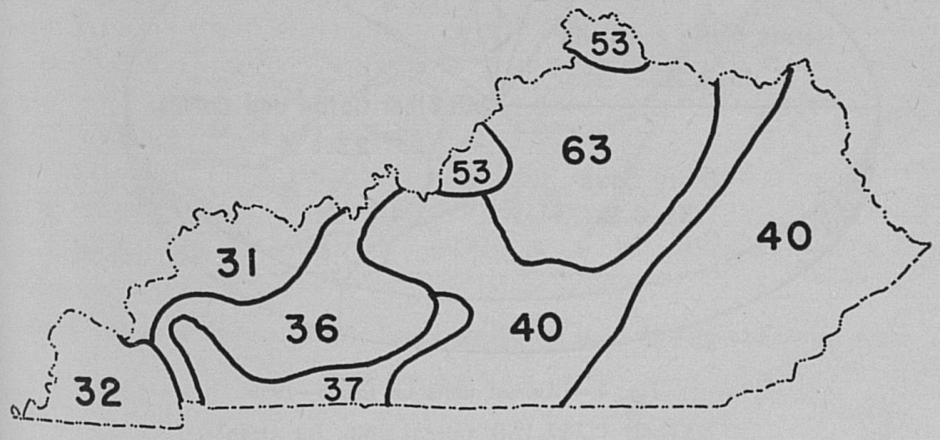


Fig. 2.— Acres of Pasture Land in Farms Per One Hundred Acres of Farm Land by Type-of-Farming Areas

(State average, 44 acres)

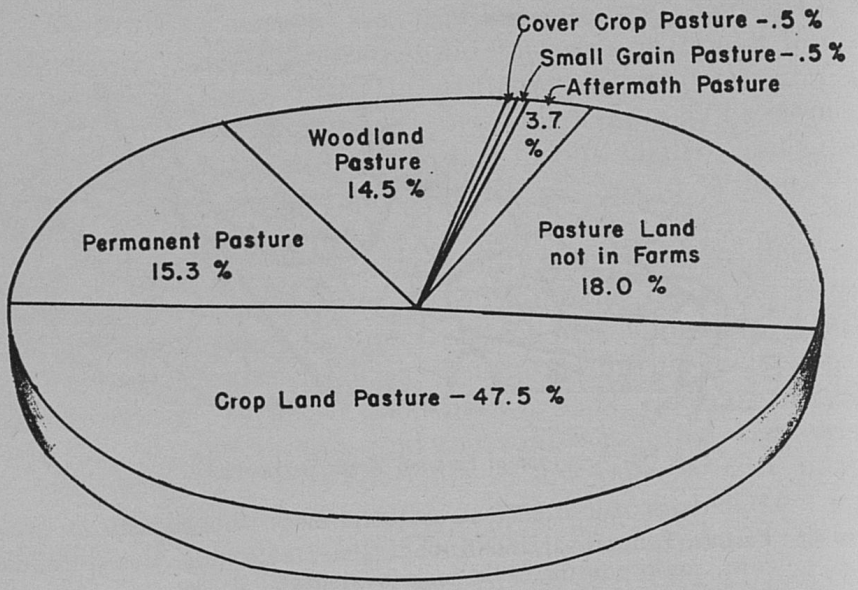


Fig. 3.— Acre-months of pasture in Kentucky—1949
(Total, 77,603,808 acres-months for state)

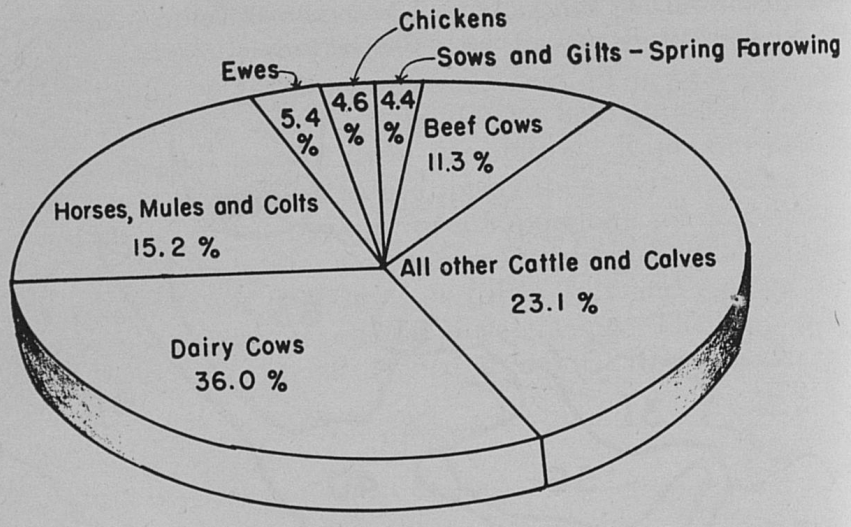


Fig. 4.— Animal units on farms—1950
(Total 1,767,160 animal units for state)

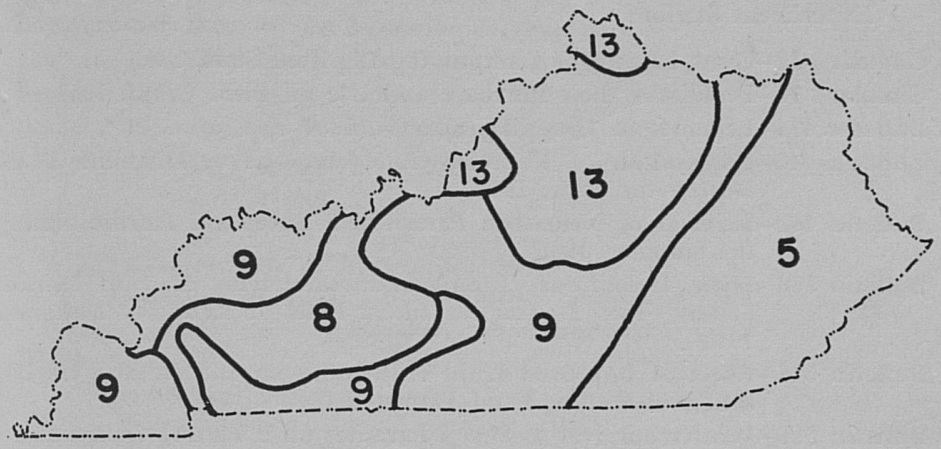


Fig. 5.— Animal Units per One Hundred Acres of Farm Land, By Type-of-Farming Areas
(State Average=9 Animal Units/100 Acres)

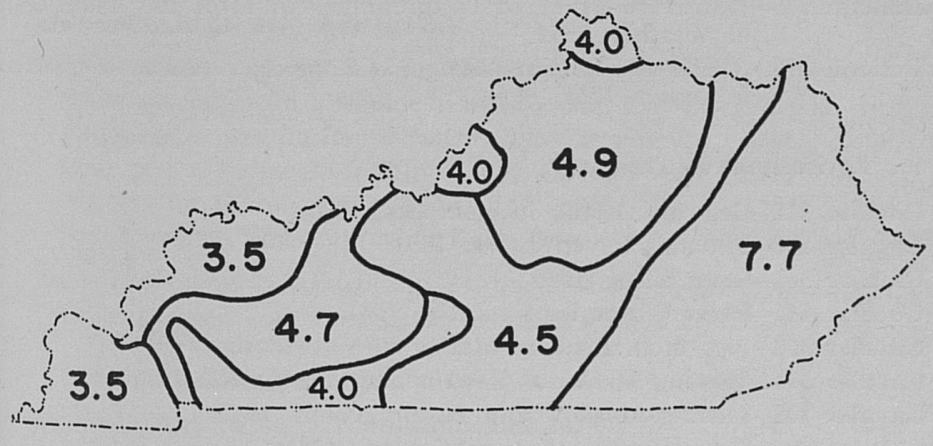


Fig. 6— Acres of Pasture Land in Farms per Animal Unit, By Type-of-Farming Areas
(State Average=4.8 Acres)

REFERENCES

Kentucky Publications

Experiment Station:

Circular 52—Grass Farming for Improving Depleted Soils, 1941
Circular 70—Fertilizers, their Purchase and Use on Field Crops, 1951
Bulletin 374—Legumes in Cropping Systems, 1937
Bulletin 440—Compositon of Kentucky Bluegrass Cut at Different Times During the Year, 1942
Bulletin 482—Survival of Nematode Parasites of Sheep on Pasture During the Summer, 1946
Bulletin 508—Miris Dolobratus (Linn.) and Amblytylus Nasutus (Kirschbaum). Two Destructive Insect Pests of Kentucky Bluegrass, 1947
Bulletin 516—Effect of Improved Land Husbandry on Income and Organization of Rolling-Land Farms, 1948
Bulletin 533—Winter Survival of Sheep Parasites on a Pasture in Kentucky, 1949
Bulletin 542—May Beetles and their Control in the Inner Bluegrass Region of Kentucky, 1949
Bulletin 554—Seed Production of Kentucky 31 Fescue and Orchard Grass as Influenced by Rate of Planting, Nitrogen Fertilization, and Management, 1950
Bulletin 568—Allocation of Farm Resources for Economic Production of Pasture Forage, 1951
Bulletin 573—Digestible Nutrient Contents of Corn, Bluegrass, Alfalfa, Ladino, Fescue, and Soybean Silages for Steers, 1951
Bulletin 575—How Farmers Make Pasture Plans to Meet the Uncertainty of Weather, 1951
Bulletin 579—Alfalfa and Bluegrass Silages as Roughages for Fattening Steers in Drylot, 1951

Agricultural Extension:

Circular 312—Growing Alfalfa in Kentucky, 1950
Circular 360—Minerals for Livestock, 1953
Circular 361—Grass Silage, 1949
Circular 366—Sweet Clover for Kentucky, 1941
Circular 368—Pigs, from Birth to Market in Six Months, 1953
Circular 375—Mowing Machines, Repairs and Adjustment, 1942
Circular 402—Seeding Meadow and Pasture Crops, 1949
Circular 406—Suggestions on Erosion Control, 1945
Circular 474—Feeding Dairy Cattle, 1949
Circular 477—How to Control External Parasites of Livestock, 1953
Circular 493—Kenbar Winter Barley, 1952
Circular 494—Kentucky Cow-and-Calf Plan, 1952
Circular 497—Kentucky 31 Fescue, 1952
Circular 498—Planning for Economic Production of Pasture, 1952
Circular 502—Some Plants of Kentucky Poisonous to Livestock, 1953

Leaflet 27—Managing Old Pastures, 1943
Leaflet 82—Sow Small Grain on Lespedeza Fields for Pasture, 1944
Leaflet 83—More Profit from Your Milk Cows, 1944
Leaflet 91—Soil Conservation Practices for Kentucky Farms, 1945
Leaflet 96—Raising and Fattening High-quality Feeder Calves, 1945
Leaflet 121—How Much Feed Does Your Livestock Need, 1949
Leaflet 127—Control of Tapeworm in Sheep, 1950
Leaflet 133—Stomach Worm Disease of Cattle, 1952
Leaflet 137—Starting and Managing Permanent Pastures in Kentucky, 1953

U.S.D.A.

"Grass — Yearbook of Agriculture, 1948"
"A Pasture Handbook," Miscellaneous Publication 194, 1946

Books

"Farm Management Analysis," L. A. Bradford and G. L. Johnson, John Wiley and Sons, Inc., New York, 1953
"The Pasture Book," W. R. Thompson, State College, Mississippi
"Pasture Production and Management," R. H. Lush, The Blakiston Company, Inc., New York

Publications from other states

(Each state publishes experiment station and extension publications primarily for its own citizens, but most states supply occasional copies to residents of other states if the supplies permit.)

Georgia—(College of Agriculture, Athens, Georgia)
Production of perennial grazing and forage crops in North Georgia, Agr. Expt. Sta. Bulletin 270. 1951.

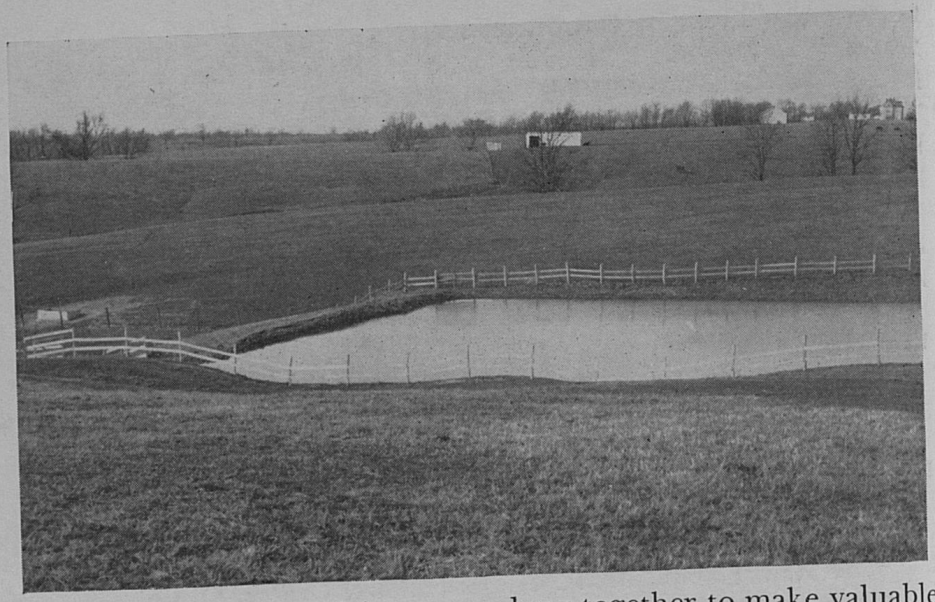
Illinois—(College of Agriculture, Urbana, Illinois)
Better farming with a legume grass program, Ext. Circular 649. 1949.
Five steps in pasture improvement, Ext. Circular 703. 1952.
Long Season Pastures for Illinois, Ext. Circular 682. 1951.
Pastures for Illinois, Ext. Circular 647. 1949.
Supplementing and Improving Dairy Pastures, Ext. Circular 553. 1943.

Indiana—(College of Agriculture, Purdue University, Lafayette, Indiana)
Grazing Trials with Beef Cattle at Miller-Purdue Memorial Farm, Agr. Expt. Sta. Bulletin 581. 1952.
Milk Production from Pasture, Ext. Circular 386. 1952.

Ohio—(College of Agriculture, Columbus 10, Ohio)
Choosing and Sowing Meadow and Pasture Seedings, Agr. Ext. Bulletin 261. 1948.
Permanent Pastures, Agr. Ext. Bulletin 283. 1948.

Virginia—(College of Agriculture, Blacksburg, Virginia)
Good Pastures—Your Cheapest Feed, Agr. Ext. Bulletin 194. 1952.

West Virginia—(College of Agriculture, Morgantown, West Virginia)
Pasture Improvement with Tillage—Treatment—Seed, Agr. Expt. Sta. Bulletin 327. 1947.



Water, shade, and good forage go along together to make valuable pasture. Note that the livestock are fenced away from this pond, and that a water tank for the livestock is placed (at left) below the dam. This helps to keep the water clean and to prevent silting of the pond.

Lexington, Kentucky
April, 1954

15M–7-53
4M–4-54
11M–4-54