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Establishing and Improving Permanent Pastures in North Carolina

Eight Steps to Good Pastures

1. Plant more legumes.
2. Use lime, phosphate, and potash to get better growth of legumes.
3. Improve soils with lime, phosphate, potash and lespedeza before seeding grasses.
4. Seed on a shallow, firm seedbed.
5. Vegetative mulches help prevent drying and crusting of seedbeds on eroded, clay soils.
6. Dallis grass, Bermuda grass, orchard grass, Kentucky bluegrass, lespedeza and white and Ladino clover are the best adapted pasture plants for North Carolina.
7. Keep down weeds and brush.
8. Avoid overgrazing. Develop supplemental pastures during the late fall, winter and early spring and during drought periods.

Agricultural Experiment Station

North Carolina State College

Raleigh, N. C.

J. H. Hilton, Director

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Establishing and Improving Permanent Pastures

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Introduction

Good pastures are recognized in all of the major livestock producing areas of the world as the basis of a sound livestock program. The need for more animal products makes it more essential than ever that the livestock program of this state be built on this sound basis.

Pastures are one of the cheapest sources of forage. Their growth requires less attention than most other crops, and the harvest is taken care of by the animal. Good pastures also supply the animal with minerals and vitamins in a more satisfactory manner than do other types of feed.

Very little attention has been given to permanent pastures in this state until recent years. With the increasing interest in pastures which has accompanied expansion of livestock farming, a number of problems concerning establishment and improvement have arisen.

In an attempt to answer some of these problems the North Carolina Agricultural Experiment Station in 1937 started a pasture research program which has been gradually expanded since that time. It is the purpose of this publication to present some of the data from these experiments that appear to have immediate practical value. Since many of these experiments are still in progress, this publication will be in the nature of a progress report. No attempt will be made to give all the detailed data.

All experiments were replicated and randomized and the data subjected to statistical analyses. Only those differences that have been found to be significant will be treated as real differences in this report. Yields were determined by periodic clipping with a power lawn mower. The plant population studies were made in the spring and fall of each year. The inclined point quadrat was used in making these botanical analyses.

Fig. 1. The effect of lespedeza on seasonal growth of permanent pasture sods.

The Objective in Pasture Improvement

A good permanent pasture should give high yields of nutritious forage over as long a grazing season as possible. If it fails in any one of these essentials, part of the advantage of pastures has been lost.

Practically all the evidence available indicates that at least one legume must be grown with the grasses to get maximum returns. This is particularly important for high yields and good seasonal distribution as shown by the data in Figure 1.

A legume in the sod has doubled the yield of Dallis grass during April, a time when pasturage is badly needed. This additional growth in April was due entirely to the effect of lespedeza on the grass, as the lespedeza did not contribute directly to the yield during that month. These increases in length of grazing season and total yield might be further enhanced by the use of a legume that could utilize the cooler weather and which would not complete so directly with this grass.

It is usually recognized that higher yields are obtained from a grass-legume combination than from either when grown alone. The

introduction of a legume into a grass sod also results in forage of higher nutritional value, since the protein and mineral contents of legumes are usually higher than those of grasses.

The time and steps necessary to attain this objective of a well-balanced grass-legume sod will depend upon the soil fertility level, the species available, and the prevailing climatic conditions. For example, in areas where Kentucky bluegrass is adapted it is comparatively easy to establish a Kentucky bluegrass-white clover sod on soils capable of supporting a good stand of alfalfa. In fact, it is often difficult to keep the grass from crowding out alfalfa under these conditions. On the other hand, the establishment of a productive sod on an eroded hillside in the lower Piedmont will probably require considerable fertilization, liming, manures, use of soil improving crops, and perhaps several years time.

It is a fact, however, that whether the starting point be an alfalfa field, a broomsedge hillside, or a thick stand of carpet grass, the ultimate objective should be the same. *In all cases legumes must be maintained in the sod to get maximum production from the pastures of North Carolina.* Nitrogen, the fertilizing element most needed by the grasses, fortunately is the one that legumes can transfer from the atmosphere to the soil.

Liming and Fertilization

Soil Fertility Is The Problem

Soil fertility is the main problem of pasture production in this area. Much of the pasturage necessary to increase animal production in North Carolina must come from lands that are now very low in fertility. Many such soils have been severely depleted through cropping and erosion. Others were never very fertile, even in their original state.

Furthermore, animals and animal products removed from these lands in the future will carry with them varying amounts of the elements necessary for plant and animal growth. Leaching will take its toll of certain elements. These elements must be supplied if pastures are to succeed. This cannot be accomplished without the use of lime and fertilizers.

Type of Fertilizer and Lime Response

The response obtained from any fertilizer element will depend largely upon (1) the degree to which that element is the limiting

Fig. 2. The effect of level of fertility upon fertilizer response.

factor; (2) the general fertility level; and (3) the type of plants present in the sod.

The data given in Figure 2 illustrate the fact that general fertility level and the level of the individual elements have a direct bearing upon the response obtained.

The data in the chart on the left (from the Bent Creek watershed of the Appalachain Forest Experiment Station) are from a badly-

eroded and depleted area. It is more or less representative of many thousands of acres of unimproved pasture or depleted crop land in the state. Phosphate alone had no effect, and limestone alone had little effect upon yield. The addition of both materials more than doubled the yield the first season.

The chart on the right shows the results from a pasture study in Cherokee County that are somewhat in contrast to the above. In this case the soil used was rather poor but not severely eroded. The level of fertility was high enough to permit a response from either limestone or phosphate applied individually. However, both were necessary for maximum benefits.

Another of the important factors affecting fertilizer response is that of the type of plants present in the sod. This fact is well illustrated in Figure 3.

Under the conditions of this particular experiment, mineral fertilizers and limestone had no appreciable effect upon the grasses in pure stands. This agrees with results with other grasses. Pure stands of grasses, in general, are affected little or not at all by applications of fertilizers other than nitrogen.

The addition of a legume, lespedeza in this case, to the grass sod changed the yields materially. The same treatment that had no effect upon the grass alone increased the total vegetation in the grass-legume sod by one-third. In other words, the effects of these fertilizer materials upon the pasture sod were due almost entirely to the legume present in the sod. In most cases little benefit will be realized from applications of mineral fertilizer to pure grass sods unless attempts are made at the same time to introduce legumes.

Lime and Fertilizers in Pasture Establishment

Seeding and cultural practices are often the main factors considered in pasture establishment. While these factors are important, actually the failures in pasture establishment are more often the direct result of insufficient fertility. If enough fertility is present, adapted pasture plants will gradually enter and become established in many areas of the state without seeding. In the absence of proper fertility no amount of seeding will produce a good sod.

The data in Figure 4 illustrate the effect of lime and fertilizers upon the establishment of some of the common pasture plants on three of the poorest soils of the state. These soils were severely

Fig. 3. The effect of mineral fertilizers and limestone upon grass alone and a grass-lespedeza sod.

eroded. Before these seedings were made the vegetation was mostly weeds.

The values represent the average condition of these fields in September, 1941 in so far as vegetation was concerned. Two of

Fig. 4. The effect of limestone and fertilizers on pasture seedings.

these experiments had been established two years, one having been grazed and the other clipped. The third field was seeded in the spring of 1941. Although the vegetation was not the same on the three fields the response was quite similar.

It is evident from these figures that seedings on the untreated soil were unsuccessful. Over half of the vegetation was weeds, and

almost no grasses and clovers were obtained.[1] Under a treatment of mineral fertilizer and limestone weeds were considerably reduced, lespedeza more than doubled, and grasses and clover increased. The total vegetation was increased about one-third, and the amount of desirable species increased from about 25 to 60 per cent.

The addition of nitrogen to the lime-mineral fertilizer treatment appeared to benefit the grass stands, particularly the first season. However, it was detrimental to lespedeza and, consequently, did not result in an increase in total vegetation. This indicates that, while the application of nitrogenous fertilizers will increase grass stands, it is questionable whether the over-all effect upon the grass-legume combination will be beneficial. In this connection it is important to consider the small amount of grass and clover obtained from the seedings on these experiments. Even where seed are available at very low cost it is questionable whether the benefits obtained from seeding these plants under such conditions justify the cost. Other experiments in this area indicate that *it is comparatively easy to introduce grasses into sods after fertility has been improved by the growth of the more tolerant legumes or by the use of much larger amounts of fertilizer.*

Lime and Fertilizers in Pasture Improvement

As previously pointed out, fertilization is necessary to build up and maintain the fertility of North Carolina pasture soils. Fertilization will play an important part in any successful pasture improvement program in this area. Proper fertilization of established pastures brings about improvement through higher yields, improvement in kind and density of vegetation, earlier growth, more uniform distribution of grazing, and higher feeding value.

Increase Yields: Results from experiments conducted in four widely-separated areas are presented in summarized form in Figure 5. They show the effects of limestone and mineral fertilizers upon pasture yields.

These results were taken from experiments on different types of sods which had been fertilized from one to four years. The cost of these treatments on a per year basis was relatively low. The increases in yield varied from about 1,000 pounds to 1,500 pounds per acre per year. This is a very profitable return on the fertilizer invested, yielding three to six dollars per acre for each dollar spent

[1] These seedings consisted of a number of grasses seeded with lespedeza and white clover. Orchard grass was the most promising one included.

Fig. 5. Increases in yields produced by limestone and fertilizers on fields located in different areas of the state.[1]

on fertilizer. Even if this increase in yield were the only benefit derived from fertilization, it would be a profitable practice.

Improve the Type of Vegetation: Another benefit from fertilization is the increase in the proportion of more desirable types of

[1] The above figures from four different experiments are cited to illustrate that response to lime and fertilizers has been obtaind in various sections of the state. They are not cited for the purpose of comparing one section with another.

Fig. 6. The effect of lime and fertilizer on plant population of pasture sods.

plants and the accompanying increase in sod density. These, of course, contribute to the increased yield but also improve the quality of feed, and reduce erosion losses. Population counts on two fields are given in summarized form in Figure 6 to illustrate the

effect of phosphate and limestone in improving the type and density of vegetation.

There was a marked improvement in both quality and density of vegetation on each of these fields. The desirable species (lespedeza, white clover and Kentucky bluegrass) were increased from 17 to 52 per cent in one case and from 36 to 66 per cent in the other. Total vegetative cover was increased by at least one-third in both locations.

Increase Feed Value: The slowness of development of the livestock industry in the South has been attributed by many to the low feed value of forage produced on Southern soils. Experiments in this state indicate that definite improvement in this respect may be obtained by fertilization. The use of mineral fertilizers and limestone has resulted in very marked increases in the protein content of pasture herbage. Lesser, but just as definite increases, in the percentage calcium and phosphorus have been obtained with these treatments. This means that pasture fertilization will result not only in increased yields but in more thrifty, more profitable animals. The increases in nutritive value are just as important in many areas as the increases in yield of forage that are obtained.

Affect Seasonal Distribution: The value of a legume in increasing the length of grazing season of a pasture sod is shown in Figure 1. The charts in Figures 4 and 6 show the necessity for limestone and mineral fertilizers for satisfactory legume growth. The introduction of legumes to the sod through fertilization will not only increase total yields but will provide earlier growth in the spring and result in a longer, more uniform grazing season. This is the result of not only of the growth of the legumes themselves but of the increased vigor of the grasses.

A striking example of the effects of soil fertility level on the vigor of grass is seen in the Johnston County results for 1939-40 and 1941-42. Winter killing of Dallis grass occurred on all of the plots but was serious only on the unfertilized areas. This reduction in stand by winter injury not only delayed the spring growth but reduced the yields for the entire season.

Using Lime and Fertilizers

In the short time since these experiments were started it has not been possible to investigate pasture fertilization on all soils of the state. It is believed, however, that the data presented in the follow-

Fig. 7. Increases due to the nitrogen, the potash, the phosphate and the limestone in a NPKL treatment.

ing charts are fairly representative of the pasture soils of North Carolina.

Order of Importance of Nutrients

In fertilizing any crop a knowledge of the effect of each element upon that crop should be very helpful in making the best use of

Fig. 8. Increases due to the potash, the phosphate, and the limestone in a PKL treatment.

fertilizers. Certainly where only limited amounts of fertilizers are available, the element or elements of most importance in the growth of the crop should receive first consideration. The data presented in Figures 7 and 8 are given in an attempt to show the order of importance of limestone, phosphate, potash, and nitrogen in pasture fertilization on North Carolina soils.

These charts show that limestone was the most important single factor in both of these experiments. This is believed to be generally true over the state. Exceptions to this are known, particularly on rather productive soils that have been heavily-fertilized previously for row crops. The relative importance of limestone is also influenced to some extent by the type of legume present. Clovers such as white and Ladino have a higher requirement for lime than legumes such as lespedeza.

Phosphates were found to be second in importance from the standpoint of effect upon yield. As in the case of limestone, this may be modified by the previous history of the soil and the type of legume grown.

Potash was third in importance on both these fields. Although this is believed to represent the general condition, in areas where there are acute potash deficiencies potash may be just as necessary as limestone or phosphate. The removal of large quantities of herbage from pastures tends to deplete the supply of this element and make its addition in fertilizer more necessary.

As shown in Figure 7 nitrogen, applied in the fertilizer, was the least effective of the elements considered in this experiment. Under average pasture conditions its use on grass-legume sods is not justified.

Applying Limestone

Rates: Data on rates of liming pastures are limited at present. The data in Figure 9 illustrate what appears to be the normal response to rates of limestone on most North Carolina soils.

These results show that the largest increase per unit of limestone[1] was obtained with 1,000 pounds, and the maximum response was obtained with 2,000 pounds of finely-ground limestone per acre. These and other results indicate that, while some soils of the state have higher limestone requirements than this, the major part of the limestone response on pastures will be obtained with the first 2,000 pounds applied. *In other words, on most soils two tons of limestone are worth much more, applied on two acres than applied on one acre!*

At the present rate of limestone use in the state it will be several years before all pasture lands will receive an initial application of this amount. It will be sound farm practice if North Carolina farmers get this application of one ton of limestone over all their

[1] Finely ground dolomitic limestone applied broadcast to surface of the sod followed by light scarification with a disc.

Fig. 9. The response to rates of limestone.

acres as soon as possible, rather than making heavier applications on fewer acres.

Intervals and Methods: No definite determinations have been made in this state as to the proper intervals for reliming different soils. There is, however, considerable indirect evidence to indicate that it will not be necessary to relime pastures oftener than every five to eight years. For example, in the experiment cited in Figure

9, there is no indication that additional limestone above the 2,000 pounds is needed four years after its application.

The proper rate and interval of application will vary with the soil, type of plants, and the amount of herbage produced. Sandy soils will allow faster leaching. High production will remove nutrients faster. Under either of these conditions more frequent liming may be necessary.

Limestone may be applied to pastures at almost any time that is convient to the farmer. Late fall, winter, or early spring seem to be the most desirable times. Spring applications should be made by mid-March to insure good results that season. This material is much more effective when mixed with the soil than when left on the surface.

Applying Phosphate and Potash

As shown in Figures 2, 7, and 8, phosphates are essential to the development and maintenance of good pasture sods on most soils of the state. Amounts of phosphate necessary will vary with kind of soil, kind of plants and amount of herbage removed. In general, Piedmont and Mountain soils appear to respond more readily to phosphates and to require larger amounts than do Coastal Plain soils. The phosphate requirements of good grass-legume sods on most soils of the state will amount to 60 to 100 pounds of phosphoric acid at seeding and 25 to 50 pounds per year for maintenance. Phosphates are essential to the development of young seedings and should always be applied prior to seeding.

As far as is known at present, periodic applications of phosphate are usually just as satisfactory for permanent pastures as annual applications. Probably the most practical plan to follow is that of making such applications every three to five years.

Potash has not been found to be nearly so important in pasture fertilization as lime or phosphate. On soils particularly deficient in this element or on pastures where large amounts of herbage are removed it will likely become much more of a limiting factor than it was in these experiments. Fifty to 100 pounds of K_2O (equivalent to 80-120 pounds of 60 per cent muriate of potash) should be applied on newly-seeded pasture. On soils known to be low in potash, or on heavily producing sods, additional applications may be necessary at one or two-year intervals.

Ladino clover, being a very vigorous plant high in minerals, will require relatively heavy rates of fertilization. Care should be exercised to see that adequate phosphate is applied for this plant at seeding, and that the potash supply does not become exhausted later on.

Pasture improvement demonstrations have been in progress for several years in all of the Mountain counties. Additional demonstrations were begun in the spring of 1940 in approximately 50 counties in the Piedmont and Coastal Plain. Actual yields and population counts have been determined from most of these demonstrations. The results from these individual farms have verified the experimental data reported in this publication.

Adaptation of Pasture Plants

Complete lists and descriptions of all pasture and forage plants known to be adapted to this region are available through a number of publications.[1] In view of this only those plants of most general adaptation and use for permanent pastures will be discussed here.

Legumes

Annual Lespedeza (Lespedeza stipulaceae and L. striata): These are low growing summer annuals having wide adaptation for use in permanent pasture sods on many North Carolina soils. They form abundant seed crops and, unless severely grazed, will reseed indefinitely. Lespedezas are widely grown in the state; seed is available locally and is relatively cheap.

Korean lespedeza *(L. stipulaceae)* germinates more readily and matures earlier than the other species. It is adapted to the higher altitudes and short growing seasons of the mountains. If mixed with longer growing species at lower altitudes, it will lengthen the grazing season by providing slightly earlier grazing.

Kobe lespedeza *(L. striata)* is a larger, coarser plant of somewhat more erect habit of growth than Korean. It produces a spreading type of growth when grazed. Its greater yielding capacity makes it a desirable pasture plant even though it may not survive as long under grazing as does the common variety.

Common lespedeza *(L. striata)* is a lower growing type than any of the others and consequently is able to persist under closer grazing. It does not have the ability to produce as high yields of forage as the larger more erect types such as Kobe. The growing period is approximately the same as that of Kobe.

With the execption of extremely high altitudes and very sandy

[1] U. S. D. A. Misc. Pub. 194. A Pasture Handbook.

soils lespedeza can be grown with the assurance of reasonably satisfactory yields on almost any soil in the state. There is no other legume as dependable. It is very valuable in improving worn out soils to a level that will support desirable grasses and other legumes. It produces a highly palatable and nutritious forage. It is valuable as a forage plant in grass sods since it makes its best growth in midsummer at a time when many pasture grasses and many other pasture legumes are almost dormant.

Lespedeza does not have as high requirements for lime and phosphorus as many of the clovers but responds readily to applications of both (see Figure 6). It is subject to losses of stand due to extreme drought at its early stages of growth or from competition from heavy growth of other forage plants and weeds at that period.

White Clover (Trifolium repens): White clover is a low growing perennial well adapted for permanent pasture on fertile soils. It has a higher fertility requirement than lespedeza and is capable of producing higher yields of forage. It makes most of its growth in the cooler weather and thus does not compete so directly with summer growing grasses as does lespedeza. It spreads both by seed and runners and is able to withstand rather heavy grazing.

White clover is rather erratic in its stand and growth from season to season. It is, therefore not always dependable as a permanent pasture plant. Part of its erratic behavior may be attributed to soil fertility variations, unfavorable weather and to diseases. The exact parts played by these and other factors have not been sufficiently investigated to enable the development of a sure formula for its growth in this state.

It should be introduced into all grass-legume sods where the fertility level has reached a reasonably high level. It does especially well with Kentucky bluegrass and orchard grass at the higher altitudes. It grows well with Dallis and Bermuda grass on the more fertile soils in the Piedmont and Coastal Plain.

Ladino is a large variety of white clover that has become extremely popular in this state within the past few years. It makes more growth than white clover and especially so during mid-summer or following temporary droughts. It is not as erratic and is also adapted to a wider range of soil conditions than white clover. Its greater capacity for growth requires that it be fertilized heavier than white clover. Special consideration must be given to the management of this legume, and best results are obtained when rotational grazing is practiced.

Ladino clover—orchard grass is now growing throughout the state.

Grasses

Kentucky bluegrass (Poa pratensis): Bluegrass is a sod-forming perennial belonging to the "cool climate" group of grasses. It spreads by seed and creeping underground stems, forming an excellent turf. It is adapted to fertile soils principally in the western half of the state, making most of its growth during the cooler weather of the spring and fall months. It ordinarily comes into sods on fertile soils, without seeding, in regions where it is adapted. *This grass should never be seeded unless the fertility level is fairly high.* It is relatively easy to establish on fertile soils, however.

Orchard Grass (Dactylis glomerata): Orchard grass is a rather erect, bunch type grass belonging to the "cool climate" group. It grows early and late in the season and is capable of producing high yields. Orchard grass has approximately the same climatic adaptation as Kentucky bluegrass, but is quicker to become established after seeding and will grow under slightly less favorable conditions of soil fertility. It stands grazing well considering its erect growth habit and is one of the most valuable pasture grasses in the state.

Tall Fescue (Festuca elatior var. arundinaceae): Tall fescue is a tall growing bunch grass that will grow under a wider range of soil conditions than orchard grass and may be substituted for it at the same seeding rate. It also remains greener during the winter months and will provide more grazing during that period than other perennial grasses. Ladino clover should be seeded with it. Kentucky 31 and Alta are varieties that appear equally adapted.

Redtop (Agrostis alba): Redtop is a perennial belonging to the "cool climate" group, but having more tolerance for high temperatures than orchard and bluegrass. It has a creeping habit of growth, forming a rather loose turf. It grows somewhat later in the season than orchard grass, but makes most of its growth before midsummer. It is tolerant of wet conditions, poor soils, and drought. Redtop does not produce very high yields and does not respond to increased fertility as well as orchard or Kentucky bluegrass. It is not as desirable as the latter two as a pasture plant. Due to its tolerance however, it is useful under a variety of conditions where the more productive grasses do not thrive.

Dallis Grass (Paspalum dilatatum): Dallis grass is a perennial bunch type belonging to the "warm climate" group of grasses. It is a very productive plant, responding readily to increased fertility. It starts growth about the earliest of any of the summer growing grasses, is fairly resistant to drought, and withstands reasonably close grazing. It grows well in association with lespedeza and white clover.

Dallis grass is subject to a disease of the seed heads (ergot) which causes a very low percentage production of viable seeds in this region. It has the further disadvantage of being difficult to establish even with the best seed available. It has the ability to compete very well with Berumda and may be expected to spread fairly fast in a Bermuda sod under favorable soil fertility conditions. *When it can be established it is the best pasture grass available for the eastern half of the state.* It is subject to some winter-killing and is not suitable for the western part of the state. Its use, particularly in the Coastal Plain, should be encouraged. Eradication is no problem with this grass.

Bermuda Grass (Cynodon dactylon): Bermuda grass is a perennial, sod-forming grass belonging to the "warm climate" group of grasses. It spreads by underground rootstocks, surface runners, and seed. Bermuda is well adapted to most soils in the Coastal Plain and Piedmont sections of the state. When grown with lespedeza or

Ladino clover provides grazing for all classes of livestock.

white clover it produces good yields of nutritious forage. It is the easiest and surest establishment of any of the grasses and responds well to increased fertility.

Bermuda is notorious as a pest on farms used principally for row crops. It does not become troublesome on lands used for forage production, small grains, and lespedeza. Certainly on lands where it is already well distributed its utilization for pasture should be encouraged. Even on farms where it is considered a pest it serves the very useful purpose of greatly reducing erosion losses. Improved strains have been developed which are capable of producing much higher yields. Due to their more erect growth habit they may be easier to control.

Carpet Grass (Axonopus affinis): Carpet grass is a low-growing perennial belonging to the "warm climate" group. It is well adapted to moist, infertile soils and is very aggressive and persistent. It is not so productive or nutritious as either Dallis grass or Bermuda grass and should not be sown where these grasses will grow.

Carpet grass spreads by seed and creeping stems, forming a very tight sod, and tending to crowd out legumes and more desirable

grasses. The production and nutritive value of the large acreages of this grass now in the state could be greatly improved by the introduction of legumes. This can be accomplished by fertilization, accompanied by cutting the sod with a disc and seeding lespedeza and perhaps white clover. Bur and low hop clovers are also useful under these conditions. Due to the dense habit of growth of this plant it may be necessary to redisc and reseed the legumes every few years. *Every effort should be made to introduce legumes wherever carpet grass is found as it makes a very poor pasture in pure stands.*

Seeding Practices

Seedbed Preparation

Reseeding on established sods requires very little seedbed preparation. Where desirable plants are already present, these should not be destroyed. Perhaps the best method under these conditions is to disc the sod with the blades set nearly straight. In this way the sod may be scarified without seriously injuring the established vegetation. On sloping land this should always be done on contour.

New seedings should be made on a well prepared but firm seedbed. On galled areas and soils very low in organic matter light vegetative mulches are very helpful in obtaining stands. For this reason it may be desirable to cut up the stubble with a heavy disc, leaving much of it on the surface when making new seedings. Whenever possible the seedbed should be firmed with a cultipacker or roller.

Rates of Seeding

Rates of seeding will vary considerably with the level of fertility, the cost of seed, and the rapidity of establishment desired. Additions of seed to established sods will usually require lower rates than for new seedings. It should always be borne in mind that regardless of the number of seed sown only those plants that the soil is capable of supporting will survive; seed will not substitute for fertility. There is no specific formula that can be used for calculating a particular seeding mixture for a specific location.

The following mixtures are recommended for Coastal Plain conditions:

Average sandy soils:

15 lbs. Dallis grass

15 lbs. Kobe lespedeza

Fertile, moist soils:

10 lbs. Dallis grass
5 lbs. orchard grass
15 lbs. Kobe lespedeza
1 lb. white clover

or

12 lbs. orchard grass
2 lbs. Ladino clover

Poorly drained soils:

10 lbs. Dallis grass
4 lbs. redtop
15 lbs. Kobe lespedeza
1 lb. white clover

Sandy, well drained soils:

Bermuda rootstock
15 lbs. Kobe lespedeza

Piedmont and Mountains

Good to medium soils:

10 lbs. orchard grass
2 lbs. Ladino clover

or

10 lbs. orchard grass
15 lbs. lespedeza
1 to 2 lbs. white clover

Medium to poor soils:

8 lbs. orchard grass
4 lbs. redtop
15 lbs. lespedeza

Three or four pounds of Dallis grass should be added to either of the above mixtures when used in the Piedmont. Dallis grass should be seeded in the spring regardless of whether the other grasses are fall or spring seeded.

No grass should be seeded on land that will not make as much as 15 bushels of corn per acre. Lespedeza alone should be used on such land until the fertility level has been increased. Experiments have demonstrated that much money has been wasted in North Carolina purchasing grass seed and sowing it on poor land.

Dates of Seeding

Lespedeza—should be seeded in early spring, February 1 to April 15. In general, proper dates by areas are—Coastal Plain, February

1 to March 1; Piedmont, February 15 to March 15; and Mountains, March 1 to April 15. Korean germinates more rapidly than the other species and consequently may be seeded slightly later than Common or Kobe.

White clover, Kentucky bluegrass, orchard grass, redtop—These pasture plants may be seeded in the early spring or fall. The most common practice at present is that of spring seeding. It is believed that, where care is taken to prepare the seedbed and where some form of mulch is used to overcome the hazards of a very dry fall, fall seeding will result in more rapid establishment of these species.

Dallis grass, Bermuda grass—These plants should be seeded in March or April. Bermuda may be established with seed, but the most satisfactory method is to sprig in rootstocks or runners three to four feet apart. This may be done almost any time during the spring or summer months when moisture conditions are favorable, but is usually more satisfactory in late April or early May.

Pasture Management

Proper management of pastures is very essential to their development and maintenance. Even after sufficient seed and fertility have been provided pasture plants must be given proper treatment if the sod is to be entirely successful.

Weeds and Brush Must Be Controlled

As pointed out earlier, any soil is capable of supporting only so much vegetation. Any space occupied by weeds and brush will mean just that much soil fertility and moisture that will not be effective in producing pasturage.

Where the land is smooth enough to permit the use of a mowing machine, control of most objectionable plants is quite simple. Wherever possible pastures should be clipped at least twice a year. Clipping when the principal weeds are in bloom but before they have set seed is usually more effective.

On pastures too steep to be mowed every effort should be made to control briars and brush by hand. Even on pastures that are clipped regularly some hand rogueing may be necessary. Weeds such as thistle should be removed by hand. Care should always be exercised to prevent introduction of weeds through seeding. Plants like yarrow are commonly introduced in grass seed.

Fig. 10. The effect of frequency of harvesting upon growth of grasses in the greenhouse.

Grazing Control Is A Vital Part in Management

Perhaps the most destructive single practice in permanent pasture management is that of overgrazing, particularly early in the season and during drought periods. Excessive defoliation weakens the plant, prevents rapid recovery after the drought is broken, and

leaves the soil surface unprotected leading to excessive drying and baking. Erosion losses are greatly increased, undesirable weeds come into the sod, and the general quality and quantity of pasturage deteriorates. The data given in Figure 10 illustrates the effect of grazing of different intensities upon individual pasture grasses.

These grasses were grown in the greenhouse and harvested every 10, 20 or 30 days. The harmful effects of frequent harvestings are readily seen from this figure. This is particularly true for Dallis grass, Bermuda grass and Kentucky bluegrass. No attempt is made to compare these results with grazing results. The data do demonstrate quite conclusively, however, the necessity of leaving some foliage on the plants at all times. Many pastures in this state are injured from over-grazing particularly in the early spring, during drought periods, or on Ladino pastures.

While not usually as serious as overgrazing, undergrazing, may be harmful to permanent pastures. Since a good permanent pasture depends upon the proper balance between two or more species, any practice that favors one species too much may upset this balance. Where grasses such as Kentucky bluegrass or orchard grass are allowed to make excessive growth in the spring, they will crowd out lespedezas. This was especially noticeable in the dry spring of 1941. Undergrazing usually seems to favor the grasses to the detriment of white clover. Excessive growth of carpet grass, particularly in the fall, also tends to crowd out legumes.

Rotational grazing is a system of pasture management whereby only a part of the area is grazed at any one time. The livestock are moved to new areas while the grazed part is allowed to recover. This management is especially applicable to the taller growing, more productive combinations as Ladino clover—orchard grass or Ladino clover—tall fescue.

Supplementary Feed and Grazing Crops

It is useless to suggest the removal of animals from pasture during drought periods unless other sources of feed can be found. There occurs invariably during every grazing season periods of drought when animals cannot obtain their forage requirements on permanent pasture without overgrazing. Reserves of hay and silage should always be kept on hand to provide for these emergency periods. Such provision is sound practice both from the standpoint of the animal and the pasture.