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Proceedings of the 41st Southern Pasture and Forage Crop Improvement Conference

Held at Raleigh, North Carolina
May 20-22, 1985

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PREFACE

These Proceedings include most of the reports and papers presented at the 41st meeting of the Southern Pasture and Forage Crop Improvement Conference held May 20-22 at Raleigh, North Carolina, with North Carolina State University as host. The Regional Forage-Beef Modeling Group (Project 156) met May 20, prior to the main conference. On the morning of May 21, Information Exchange Groups (formerly Work Groups) met with many presentations which will be reported in subsequent pages.

During the afternoon of May 21, the group toured the forage-animal research facilities at Raleigh. Equipment was displayed for seeding, spraying, harvesting and processing forages as well as facilities for animal research. Many research projects were discussed. A banquet was held on the evening of May 21.

On May 22 after welcoming remarks by Dr. D. F. Bateman, Director of Research, North Carolina Agricultural Research Service, participants were introduced state by state. The research program of the North Carolina Experiment Station for animals and crops was discussed as was the Cooperative Extension Service Program.

The Conference concluded with a General Session for papers and a General Business Meeting on the morning of May 22. Details of the Business Meeting and a List of Conference Registrants are at the end of these Proceedings.

CONTENTS

BREEDING ALFALFA FOR THE SOUTH

J. H. Bouton[1]

The subject of alfalfa breeding in the South has been discussed by members of this conference and notable papers and discussions can be found in the 1949, 1952, 1955, 1966, 1972, 1974, and 1979 conference proceedings. In this regard, the conference proceedings probably reflect the cyclical interest in the crop in a majority of the member states. Since the extensiveness of any major breeding effort is tied to interest in and potential for a crop, then this paper will investigate topics such as acreage trends, past successes of breeding programs, and objectives of current alfalfa breeding programs to give an insight on this topic.

ACREAGE TRENDS

Although total alfalfa acreage has decreased about 4.5% across the region during the past 12 years, there has clearly been a redistribution of this acreage (Table 1).

Table 1. Alfalfa production acreage in the Southern Region.

State	1972 †	1984 ‡
Alabama	3,000	10,000
Arkansas	72,000	80,000
Florida	1,000	1,500
Georgia	3,000	25,000
Kentucky	189,000	230,000
Louisiana	16,000	12,000
Maryland	70,000	66,000
Mississippi	8,000	10,000
North Carolina	12,000	35,000
Oklahoma	575,000	350,000
South Carolina	2,000	5,000
Tennessee	50,000	130,000
Texas	202,000	180,000
Virginia	91,000	100,000
Average	1,294,000	1,234,500

† From Busbice, 1972.

‡ From J. H. Bouton (unpublished survey of extension specialists).

In 1972, half the acreage was found in Texas and Oklahoma. However, in 1984, a noticeable acreage drop was seen in Oklahoma and Texas and gain seen in Tennessee, Georgia, North Carolina and Kentucky. This acreage realignment is important because it indicates the interest in alfalfa is now more widespread throughout the region. This widespread interest could be used to support the need for more and intensive alfalfa breeding programs.

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BREEDING PROGRAMS - CURRENT AND PAST

Busbice (1974) listed four major alfalfa breeding programs in his discussion of this subject with these being located in the states of Arkansas, Florida, North Carolina, and Virginia. Today breeding programs are found in the states of Virginia, Oklahoma, Maryland (USDA), Georgia, and Alabama. Since many of these programs are part time in alfalfa, then there has probably been little change in the total effort across the region.

Busbice (1974) also discussed the subject of alfalfa cultivar release from southern breeding programs. The cultivars Williamsburg, Team, Arc, Florida 77, and Victoria were noted as being good products of those breeding efforts. Since the success of a breeding program is usually related to the success of cultivars released from the program, then it is reasonable to investigate how successful "Southern" bred cultivars have performed. Some of these cultivars have not been widely used because of a lack of interest by seedsmen in the leading seed producing states resulting in delays in prompt seed increases. The reason for this lack of interest is the limited acreage throughout the South when compared to the Upper Midwest and Far West. However, the use of exclusive release was felt by Busbice (1974) to be a good alternative to this problem. With Florida 77, one sees a variety with excellent performance and persistence in the lower South - an area thought outside alfalfa's range of adaptation (Table 2).

Table 2. Performance of Florida 77 alfalfa when tested at two locations in the lower South.

Location	Yield Increase Over Check †	
	3rd Production Year	Total Yield
	(%)	
Tallassee, AL ‡	70	28
Tifton, GA §	52	29

† Apollo

‡ From Hoveland et al. (1981)

§ From Bouton and Monson (1985)

Another secret of Florida 77's current widespread use in the area was its exclusive release to a private seed company. This insured a dependable seed supply. Cultivars therefore need to have excellent characteristics, but without dependable and aggressive marketing of seed they will not get very far. Florida 77 showed that both are possible.

Another demonstrable trend which shows an interest in alfalfa is the development and marketing of cultivars by major seed companies for the region. In fact, the vast majority of the alfalfa grown in the South is from private

companies. These cultivars contain multiple pest resistance for those pest problems endemic to the South.

Of course, not all breeding success can be measured with cultivars. Germplasm releases with excellent characteristics for the region are also being developed. Many germplasms containing resistance to prominent pests of the region have been released and are being used by both public and private breeders in their cultivar development programs.

BREEDING FOR PEST AND PRODUCTION PROBLEMS

In the past, the primary breeding objectives with alfalfa have been adaptation, yield, and pest resistance (Busbice, 1972). From a current survey, it was found that these objectives are still primary.[2]

Major diseases in the region are still Phytophthora root rot (Phytophthora megasperma) followed closely by Fusarium wilt (Fusarium spp.), anthracnose (Collectotrichum trifolii), Sclerotinia crown rot (Sclerotinia trifoliorum), and common leaf spot (Pseudopeziza medicaginis). Rhizoctonia stem blight (Rhizoctonia solani) and bacterial wilt (Corynebacterium insidiosum) are felt to be of minor importance. The major insect pests are the alfalfa weevil (Hypera postica) and potato leafhopper (Empoasca fabae). The three cornered alfalfa hopper (Spissistilus festinus), spotted alfalfa aphid (Therioaphis maculata), pea aphid (Acyrthosiphon kondi), and fall armyworm (Spodoptera frugiperda) also cause major problems. Nematodes are also considered to be major problems; especially in the coastal areas (Haaland et al., 1979). Most of the breeding effort in the region therefore still centers on developing pest resistant alfalfa. This will probably continue for the future.

Although breeding for high yielding, multiple pest resistance hay cultivars will continue to be important, development for better grazing tolerance could be an important avenue for future development (Busbice, 1972). This is true because beef cattle numbers are much greater in the South than dairy cattle and beef producers would opt for more direct grazing than hay making. Besides, when alfalfa hay is produced, it is still more economical to sell this hay on the open market than allow the beef steer to eat it and sell him. Therefore, a "flexible" legume which has enough yield to be cut for hay when desired, to intercrop with perennial grasses, and to yield, recover, and persist, during the after intense grazing, would be needed. Alfalfa may fit this need, but it will probably take a different type alfalfa than one currently used for hay production. To this end, creeping rooted alfalfa was felt for a long time to be the desirable grazing type because of an ability to regenerate in existing stands. However, the association of this trait with poor yield (Busbice and Hanson, 1969) and the inability to see a true "creeping" habit in different environments (Leach, 1978) was troublesome. The finding of variation among different cultivars for persistence under continuous grazing was encouraging in this regard (Counce et al., 1974). Some of these grazing tolerant cultivars were creeping rooted, but some were high yielding upright types. The common trait possessed by all grazing tolerant cultivars was their persistence and an ability not to deplete carbohydrate reserves in initial regrowth. Therefore, a good breeding approach to increase grazing tolerance would be to expose broad based populations, including both upright and creeping types, to intense grazing pressure and recurrently select on the basis of persistence and yield. In other words, let the cow and the environment impose the selection and the survivors would be the ones retained.

Another characteristic which needs to be considered in the region is the proper dormancy. In the South, alfalfa grows over a very long season and one could lose a great deal of production by not having the proper dormancy; especially in the fall of the year. However, in areas which experience cold winters, some dormancy is needed to insure good spring growth.

It was found that a nondormant variety gave excellent fall production at both a northern and southern location in Georgia, but in the northern area where winters can be cold, the nondormant cultivar showed winter damage as seen by poor spring yield (Table 3).

Table 3. Relative yield of nondormant and dormant alfalfa cultivars when tested for three years at two Georgia locations (from Bouton and Monson, 1985).

	First Harvest in Spring	Last Harvest in Fall
	Rel. Yield (%)	
North Georgia (Athens)		
Dormant Cultivar †	100	100
Nondormant Cultivar ‡	74	112
South Georgia (Tifton)		
Dormant Cultivar †	100	100
Nondormant Cultivar ‡	98	238

† Apollo

‡ Florida 77

This winter damage was not as noticeable where winters are not severe (South Georgia). When winter damage was observed in North Georgia, the nondormant variety compensated by giving better fall yield. Developing cultivars for a long

[2] J. H. Bouton, unpublished survey.

growing season (especially in fall), yet with winter dormancy where needed, should be investigated.

In addition to extending alfalfa's growing season by selection and breeding, another useful and probably related objective would be to even out its seasonal yield distribution. In Georgia, on a per harvest basis, we see the highest yield in the spring, then a steady yield decline throughout the summer (Bouton and Monson, 1985). This was true even with adequate moisture during that time. This decline in alfalfa production is probably related to several interdependent factors including the dormancy mentioned above; but, mainly it is tied to the effects of cutting frequency and high temperature and humidity on carbohydrate storage and use (Bula and Massengale, 1982). A breeding objective to develop alfalfas which are more productive during the summer may therefore be worthwhile. In this regard, we screened alfalfa clones by testing their polycross progeny and found some which gave significantly more summer production, but equal spring production, than commercial checks. A germplasm from these clones is now being seed increased for testing.

Finally, a condition endemic to the South which curtails alfalfa production is acid, infertile soils. This condition can, of course, be easily overcome with proper liming and fertilization. However, subsoil acidity is rarely changed by liming leading to poor rooting resulting finally in poor water and nutrient extraction, especially during short term droughts. In fact, Sumner et al. (1985) reported a 47% total yield increase over conventional liming and fertilization when acid soils were limed and amended to a depth of 1 meter. These data confirm the magnitude of the problem. However, unless ways are found to economically lime and fertilize the subsoil, genetic selection of alfalfa for acid soil tolerance offers a good means to overcome this problem. It was found that acid soil tolerance was a heritable trait in alfalfa (Devine et al., 1976). Recurrent selection in acid soil resulted in a germplasm which yielded better than one selected in limed fertile soils when tested in both acid and limed soils (Bouton and Sumner, 1983). These data are encouraging and demonstrate that acid soil selection may be a worthwhile plant breeding objective for both acid soil tolerance and overall productivity. This objective also is amendable to using cell culture techniques to find a more direct, cellular tolerance.

SUMMARY

There is sufficient interest in terms of production acreage (1.2 million in 1984) to warrant alfalfa breeding programs for the South. Especially noteworthy is the redistribution of this acreage across the region during the past 12 years. The success of a Florida 77, a cultivar developed in and for the lower south, also indicates that southern based breeding programs can be successful.

Breeding for adaptation, yield, and re-resistance to insect, disease, and nematode pests have been and will continue to be important objectives for any Southern breeding program. It is also hoped that as new pests are found, or unique combinations of pests are identified, then these will be investigated and resistant germplasm developed. However, the South has other unique features such as being a traditional beef cattle area with a need for direct grazing, long growing seasons, hot, humid summers, and acid, infertile soils. If alfalfa could be bred to mesh with some of these features, then interest and acreage would surely increase with the need for further breeding efforts being enhanced.

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ALFALFA MANAGEMENT FOR HAY AND PASTURE

Vivien G. Allen[1]

INTRODUCTION

Alfalfa is considered one of the oldest cultivated forages, and its use predates recorded history. Primarily adapted to harvesting as hay, it has also been used as a pasture legume. Although much is known concerning managing alfalfa as a hay crop, management schemes for grazing are less well understood. Coburn (1906) reported that alfalfa did not appear to be a natural pasture plant due to its delicate stems and its inability to survive compacted soils and crown breakage. It has been suggested that grazing systems should simulate hay cutting as closely as possible. Such systems necessitate intensive management and physical inputs to allow for well controlled rotational grazing. Less intensive systems would have many advantages such as lower input costs, fewer management demands and less stress to animals resulting from frequent shifting of paddocks and crowding of animals (Wall, 1982). Continuous grazing, on the other hand, has generally resulted in either rapid thinning and stand loss or considerable waste of valuable forage due to low grazing pressure. Recent information has suggested that interacting factors of soils, plant physiology, animal factors and climate may offer possibilities for more flexible management in alfalfa grazing systems.

HAY PRODUCTION

There are a number of excellent papers on the subject of management for hay harvesting and it is not the intent to present a review of the subject in this paper but instead to point out certain principles that have possible application to grazing management. Frequency of cutting has become accepted as an important determinant of alfalfa yield and stand maintenance (Graber, 1927; Bryant and Blaser, 1964; Reynolds, 1971; Smith, 1972; Janson, 1982). Highest yields of alfalfa are usually obtained when cut at full bloom stage but highest yields of nutrients per unit of land area are generally obtained when alfalfa is harvested at the 1/10 bloom stage (Smith, 1972). Harvesting near maturity has been shown to allow sufficient storage of root carbohydrates for rapid regrowth and maintenance of plant vigor, while harvesting at immature growth stages has resulted in stand losses (Graber et al., 1927; Grandfield, 1935). The minimum storage point for root carbohydrates appears to be approximately 2 to 3 weeks after growth begins while the maximum storage of carbohydrates occurs near the full bloom stage (Grandfield, 1935; Smith, 1962).

Late summer and fall harvest management have been shown to be especially critical for winter hardiness and regrowth during the following year, but autumn management required varies with the climate. Much of the early research that established principles for fall harvest management was conducted in northern climatic regions (Graber et al., 1927; Grandfield, 1935; Smith, 1968) and demonstrated the importance of carbohydrate root reserves for winter survival. Harvesting during the 4- to 6-week period prior to killing frost was found to critically reduce the carbohydrate reserve needed to provide energy during the development of cold resistance during winter dormancy. In Kansas, a top growth of 20 to 25 cm was needed during autumn to assure maximum root reserves (Grandfield, 1935). Harvesting after killing frost was less detrimental but sufficient growth was recommended to catch and hold snow cover for adequate insulation (Smith, 1972).

In less severe climates, fall harvest management appears more flexible and the presence of green leaves during winter may make carbohydrate levels at the end of the fall growth period of less importance in determining the vigor and productivity of alfalfa stands the following year (Reynolds, 1971; Mays and Evans, 1973; Sholar et al., 1983).

Increasing the cutting height has generally reduced dry matter yields of hay (See review by Smith, 1972). A tall stubble and residual leaf area appears advantageous only with the most frequent cutting schedules. Brown et al. (1966) suggested that older leaves at the plant base have lower photosynthetic activity and may retard regrowth by shading the plant base and interfering with new shoot growth.

GRAZING

Grazing management has generally developed following these principles of cutting management and although it has often been suggested that "grazing should simulate mowing" it would be a serious error to presume that reaction of plants to the grazing animal will be the same as their response to the mowing machine.

Most studies have indicated that alfalfa requires rotational grazing, and 35 to 42 days of recovery between grazing is often recommended (Van Keuren and Martin, 1972). The grazing duration may be more flexible than the interval between grazing (Leach, 1978; Janson, 1982). Grazing durations of up to 14 days have resulted in little harm to stands although total production may be slightly reduced (Janson, 1982). Leach (1978) suggested that spreading defoliation over a longer period of time could result in a continued supply of assimilates to the crown via partly grazed and ungrazed shoots while bud inhibition is diminished in grazed shoots, thus encouraging regrowth and shortening the period with too little leaf area for light interception. The work of Brown et al. (1966) suggest that the effectiveness of this should be largely dependent upon the age of the leaf material remaining after grazing.

Season of the year and environment also appear to affect the response of alfalfa to grazing.

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Alfalfa appears better able to tolerate grazing in dry than wet seasons and climates (Janson, 1982). During moderate moisture stress plants may have some adaptation with fewer shoots and comparatively little growth, which would minimize water usage (Leach, 1978). Grazing drought-stressed plants for extended periods of time has resulted in stand thinning, however, presumably due to increased crown and root rot disease (Talbot, 1982). Heinrichs and Nielsen (1976) suggest that alfalfa may be more persistent in spring, compared to summer, due to favorable soil moisture and temperature. Other research has indicated that spring may be the most detrimental time for grazing alfalfa (Janson, 1982).

GRAZING MANAGEMENT IN VIRGINIA

Studies were undertaken in Virginia to investigate systems of grazing management of alfalfa during spring and summer.

Spring Grazing

An established stand of 'Arc' alfalfa was grazed by sheep in spring during two years beginning on 6 April when alfalfa was approximately 13 cm in height. Alfalfa was grazed for 0, 2, 4, and 6 weeks at two grazing pressures; light (to maintain an LAI of about 1.0) and heavy (to maintain an LAI of about 0.5). Residual effects of grazing on hay yields at two hay harvests were measured during the third year when no grazing was imposed. Non-grazed alfalfa was harvested for hay at late bud at the same time that grazing was terminated following 6 weeks grazing. Regrowth on all systems was harvested for hay at 1/10 bloom during the remainder of the season. Mean stocking rates were 73 and 53 sheep ha^{-1} in the first year and 39 and 34 sheep ha^{-1} in the second year for heavy and light grazing pressures, respectively. Herbicides were applied to all plots in years 2 and 3 to control weeds.

Alfalfa grazed at the light grazing pressure was essentially removed as grazed forage rather than harvested as hay (Table 1). Grazing up to the normal time of first hay harvest appeared to have little effect on alfalfa stands or future productivity.

Table 1. Influence of 0, 2, 4, and 6 weeks of spring grazing at two grazing pressures on subsequent hay yields of alfalfa.

Grazing system	Component	
	Alfalfa	Weeds
	--------Mg/ha---------	
Light grazing pressure		
Non-grazed	12.62 (7.84)[1]	0.30
2-week	10.84	0.54
4-week	9.62	2.07
6-week	7.46	0.96
Heavy grazing pressure		
Non-grazed	12.12 (8.04)[1]	0.56
2-week	10.79	0.64
4-week	8.68	2.30
6-week	5.89	3.28

[1]Excludes first hay harvest.

Grazing at the high pressure was more detrimental, particularly when the grazing duration was extended to 6 weeks. Yields of alfalfa were reduced and plant density decreased in response to this treatment. Alfalfa yields also tended to decrease with 4-week grazing duration. Weed encroachment was increased by grazing by both these systems. Herbicides were effective in controlling weed competition and there was little effect of any grazing treatment on hay yields in the third year (Table 2).

Table 2. Hay yields of alfalfa in year-3 after 2 years of spring grazing for 0, 2, 4, and 6 weeks at two grazing pressures.

Grazing system	Component	
	Alfalfa	Weeds
	--------Mg/ha---------	
Light grazing pressure		
Non-grazed	5.50	0.52
2-week	5.53	0.43
4-week	4.56	0.84
6-week	5.90	0.54
Heavy grazing pressure		
Non-grazed	5.78	0.30
2-week	6.22	0.17
4-week	5.54	0.32
6-week	5.11	0.40

Root total non-structural carbohydrates (TNC) declined initially during early spring growth but then increased until hay was harvested on non-grazed systems. Grazing prolonged the decline in TNC but root carbohydrates increased rapidly after grazing was discontinued. The TNC in roots of alfalfa subjected to light grazing pressure declined less than was observed with heavy grazing pressure. The greater amount of leaf area, present with light grazing pressure, apparently partially offset the drain on root reserves. The TNC in alfalfa roots measured in December of each year was not influenced by any grazing treatment.

Regrowth following grazing at either pressure began more rapidly than when plants were not grazed and were cut by mowing. The response of grazed plants appeared to support the suggestion by Leach (1978) that grazing prevents apical dominance from suppressing growth of laterals and that remaining leaf area can provide a continuing source of photosynthate for energy supply. The difference in initial regrowth rates had little influence on the time required to reach hay cut stage, however.

Summer Grazing

An established stand of 'Arc' alfalfa near the area where spring grazing experiments were conducted was grazed during summer of two years by the following six systems: (1), (2), and (3)-grazing began approximately 14 days after second hay cut and continued for 2, 4, and 6 weeks, respectively; (4)-grazing began at early bud stage and continued for 10 days in year 1 and 7 days in year 2; (5)-grazing began at early bloom and continued for 7 days; (6)-no grazing and hay was cut at 1/10 bloom. Following grazing, hay was cut if regrowth

reached 1/10 bloom before killing frost in fall. Residual effects of grazing were measured on three hay harvests in the third year with no grazing imposed. No herbicides were applied to summer grazed alfalfa.

Grazing systems that do not simulate mowing appear more detrimental to alfalfa stands in summer than in spring (Table 3). Increasing the grazing duration beyond one week also appears to have less potential for summer grazing systems.

Table 3. Alfalfa hay yields and weed encroachment in fall as affected by summer grazing systems.

Grazing system	Component	
	Alfalfa	Weeds
	--------Mg/ha-------	
Non-grazed	1.23	0.15
2-week	1.15	0.49
4-week	0.44	0.53
6-week	0.18	0.34
Early bud	1.68	0.44
Early bloom	1.21	0.15

Alfalfa grazed at the early bloom stage for one week was not affected by grazing. Regrowth, weed encroachment and stand density were similar in this system to non-grazed alfalfa. Grazing early regrowth for two weeks or grazing at the early bloom stage appeared to be the next best grazing systems, although increased weed encroachment did occur. Hay yields were higher following grazing at early bud compared to the two-week system. Grazing for 4 or 6 weeks in summer prevented further hay harvests from occurring in the grazing year. Weed growth following grazing by these systems exceeded that of alfalfa.

In year 3, excellent growth occurred on all systems although effects of grazing were still apparent (Table 4). Increasing the grazing duration linearly decreased alfalfa yields and weed encroachment was increased. Effects of grazing at early bud stage were similar to the 2-week system.

Table 4. Alfalfa yields and weed encroachment in year-3 following 2 years of summer grazing.

Grazing system	Component	
	Alfalfa	Weeds
	---------Mg/ha---------	
Non-grazed	8.48	0.84
2-week	7.27	1.31
4-week	7.07	1.21
6-week	6.67	1.77
Early bud	7.27	1.03
Early bloom	8.70	0.88

Herbicides would undoubtedly have been beneficial in controlling weed encroachment and possibly would have improved alfalfa yields in these systems. Grazing at the early bloom stage had no measurable detrimental effects on alfalfa stands during year 3.

The LAI maintained during summer grazing for 2, 4, and 6 weeks was similar to that achieved by high grazing pressure during spring grazing. Perhaps a lighter grazing pressure with more leaf area to support photosynthesis would have helped to offset the detrimental effects on summer grazed systems. When grazing was initiated at the later growth stages, sheep selectively grazed leaves and a stemmy residue largely devoid of leaves remained after grazing. Increasing the grazing duration appeared to slow the rate of regrowth following grazing. Rate of regrowth following grazing on all systems was much slower than that observed in spring, perhaps due to the less favorable moisture-temperature relationships (Heindricks and Nielsen, 1966).

Quality remained higher in forage when grazing began at an early growth stage. The stemmy residue left after grazing at early bud or bloom was high in fiber and low in crude protein and IVDMD compared to other grazing systems.

Grazing alfalfa during spring for extended periods appears feasible from the standpoint of effects on alfalfa stands and future productivity. Grazing during summer offers less flexibility, but with good weed control measures several systems appear to have potential. The substitution of grazed forage for hay presents an economic question that must be addressed. The gain in animal product from grazing alfalfa will have to be superior to offset the potential value of alfalfa harvested and sold as hay. On the other hand, the use of grazing as a tool to shift harvesting dates, for use as pasture during periods of shortage due to dry weather, or for supply of high quality feed to animals capable of high productivity as a part of a total forage system, appears to have potential.

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NEW DEVELOPMENTS IN STORED FEEDS

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INTRODUCTION

Many technological inovations have been made in harvesting, processing, handling, storage, amendment and feeding of stored forages but only a few have been integrated into farming practice. Forage handling machinery has been readily adopted in contrast to many of the other expressions of technology. The farmer acceptance of the pickup baler in the 1940's, the hay conditioner in the 1950's and the large round baler in the 1970's are good examples of technological advances primarily designed to reduce the input of labor. High capacity modern forage handling machinery often improves the yield and quality of forage products because of timeliness in highly weather dependent hay operations. Recently farmers have been exposed to an arsenal of new technology designed to improve the quality of hay and silage. Much of this technology is based on sound scientific principles but a surprisingly high proportion of it is not. Some technology is inappropriate in the economic sense. Much of the new technology has a small impact and as such it does not seem as impressive as the hay conditioner when it was introduced. Labor requirements per ton of forage may actually increase with some of the new technology and, in many instances, the rate of operation may decline. It appears then, at least superficially, that technology which reduces the labor input per ton of product or increases the rate of processing has been readily accepted while there has been some resistance to other technology.

Despite all the technology available to farmers making forage products there are many opportunities for failure. Excessive losses in dry matter and quality in large round bales improperly formed and stored outside, along with uncontrolled feeding often illustrates the failure of two critical sectors of forage program. In this paper I will review some of the newer technology being promoted at the present time.

WATER RELATIONS OF THE SWATH AND WINDROW

When forages are made into hay and silage the moisture content (MC) needs to be reduced to an appropriate level. Small bales of hay are considered safe when the MC is below 20% or less while hay for large round bales should be baled at 18% MC or less.

Estimation of MC of swathes, windrows and bales is one of the weakest aspect of hay and silage technology at the present time. Accurate estimates of MC are needed to establish the appropriate times of windrow manipulation, baling, and the rates of application of preservatives and other amendments. Several techniques and instruments are available but the good ones are often tedious while the quick ones are often inaccurate. Variation of MC within the swath and about the field also make proper sampling rather difficult.

Rapid drydown (curing) is a primary objective of harvesting in order to minimize losses in yield and quality, growth in microflora and harvest costs. Generally forage is mowed when most of the surface moisture (dew, rainfall, gutation) had evaporated. It is usually mechanically conditioned and left in a wide swath with an aerodynamically rough surface.

The rate of water loss from a windrow is a function of the crop resistance and the drying capacity of the atmosphere (Jones and Harris 1980). As the management of drying is limited to crop factors I will concentrate on these. The crop resistance (Ra) of a windrow has three components, boundary layer resistance (Rb), stomatal resistance (Rs) and cuticular resistance (Rc): $Ra = Rb + Rs + Rc$. Drying forage has been characterised as a two phase process. During the first phase water is rapidly lost to the atmosphere from the plant surfaces (dew, rain, gutation) where the boundary layer is the primary limiting resistance, while most of internal plant water lost is routed through the open stomates (low Rs). Water fluxes through the leaf surface are small because of high cuticular resistance (Rb). Some water is lost through cut ends and, if the forage was mechanically conditioned, through the 'bruised' tissues. As the forage dehydrates wilting closes the stomates at 60% MC, or so, increases the stomatal resistance and initiating the slow drying phase in which cuticular resistance is the dominant feature. The typical drying curve of forage shows that about 3/4 of the plant water is lost in the first 1/5 of the drying time with the final rate of water loss being less than 1/100 of the initial rate (Jones and Harris 1980). Cuticular resistance is largely determined by the species and the expression of its genetic makup as affected by environment (including management). The morphology of the forage crop also affects the drying rate. Forage legumes contain more water than grasses and have a higher proportion of the slower drying stems (Clark et al. 1985). This is especially so when the stems are thick (Rotz and Thomas 1985).

MOWING AND WINDROW MANIPULATION

Introduction of the disk-type mowers into the grasslands of the south-east was quite slow compared with rest of the world and this may be partially attributable to the effective marketing of the conventional sickle-bar mower conditioner by U.S. manufacturers. With the successful integration of the disk mower and the conditioner the number of these machines should increase

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because of their many advantages. Mechanical handling of the swath and windrows to facilitate drying has also been neglected in the southeast. Reintroduction of the hay tedder in its many versatile and relatively cheap forms should be a primary objective of the forage industry. The raked or dense swath or windrow dries at a slower rate because of increased boundary layer resistance and because less radiation is absorbed by the crop. The first tedding should immediately follow mowing with the next tedding approximately 6 hours later when hay is at 60% MC or so and regularly until the swath reaches 50% MC after which tedding is not effective (Dernedde 1980, Jones and Harris 1980). Modern tedders have the much needed ability of windrow-busting for hay that has been "rained on".

CONDITIONING

Mechanical conditioning reduces cuticular resistance by bruising the epidermal cells, the cuticle and its wax surface and by increasing the number of cut ends. Cuticular resistance can also be effectively diminished and drying rates increased by chemicals which react with the hydrophobic substances in the cuticle and on the plant surfaces. The chemistry of the reaction is similar to saponification in which fats (hydrophobic) are de-esterified into hydrophylic constitutents by strong bases. Commercial products are usually based on equal parts of potassium and sodium carbonate although it has been demonstrated many times that the potassium compound is somewhat more effective (Rotz and Thomas 1985). Sodium carbonate is slightly less effective but considerably cheaper.

Chemical conditioners are effective in forage crops with true stems such as alfalfa and red clover. They should not be used on grasses either with stems or pseudostems. Chemical conditioners are usually applied as dilute aqueous solutions (about 2% by weight) and directed at the stems by pushbars and by the orientation and location of spray nozzles. Application rates vary with yield with 8-10 lbs active ingredient per ton or 30-40 gpa of solution being near optimum. Costs are in the range of $4-10 per ton.

Some formulators have expanded the concept of chemical conditioning by adding other substances to the commercial preparations. Additives such as surface active agents, spreaders, builders, and so forth have generally shown no advantage over simple solutions of sodium and potassium carbonates (Rotz and Thomas 1985). Addition of preservatives to the formulation are usually not worthwhile for the rate would be to low to be effective as an inhibitor of molds and yeasts, the volatility of most preservatives (Lacey et al. 1980), and because the acid may reduce the saponification effect of the carbonates.

Drying agents reduce the time for the windrow to dry down to safe moisture content for baling, but they do not compensate for poor drying conditions. Generally they have been less effective on first cut alfalfa when yields are highest and conditions for curing are poor. As with mechanical conditioning chemicals will increase the amount of rewetting following dew fall or rain. Chemical conditioners can be used in conjunction with mechanical conditioners and their effects are largely additive. The mechanical conditioners have their greatest impact on the first phase of drying (Dernedde 1980) while the chemical conditioners should tend to accelerate the second phase. Chemicals such as potassium and sodium carbonate are slightly caustic at the concentrations used but they are not harmful to livestock or the forage crop. Their low cost per ton and their effectiveness means they have a place in alfalfa and other high value hay crops.

MICROFLORA OF SURFACES OF FORAGE CROPS

About 1% of the phytomass of a forage crop is of microbial origin but not much is known about the species and populations of microorganisms infesting the surfaces of forage crops in the south east (or anywhere else) but they likely vary with location, season, and forage species (Pizarro and Warboys 1980, Moon and Ely 1983). As the swath dries down water-dependent organisms of the crop surface decline and species of microflora able to tolerate lower water activity grow in the absence of competition. In a British study spores of actinomycetes and bacteria were less active than fungi in the moisture range below 25% with Aspergillus species (especially A. glaucus) being dominant. Thus in hay the MC content is too low to support active growth of bacteria and actinomycetes, but adequate to support actively growing populations of yeasts and molds (Lacey et al. 1980). In forage in the silage category, bacteria and actinomycetes dominate the swath microflora with peak populations at near 50% moisture content. One of the primary objectives of rapid curing of hay swathes is to minimize the growth of microflora and their potentially harmful effects on man and beast and on hay quality.

HAY PRESERVATION AND AMENDMENT

Ammoniation

Ammoniation of low quality hays and straws of grasses with anhydrous ammonia has been tried by a few farmers in the southeast with generally satisfactory results. When nitrogen is added to forages with less than 7-8% crude protein or with low yields of rumen degradable protein, digestibility and animal productivity is usually improved (Moore et al. 1983). An additional benefit of ammoniation is expressed in hay with more than 18-20% MC. Ammonia inhibits growth of yeasts and molds and limits heating and deterioration (Hankins 1985). As a hay preservative ammonia costs about the same as acid preservatives but it is not as effective for ammonia-tolerant microflora (some mesophyllic and thermophyllic bacteria) may flourish (Benham and Redman 1980).

Outbreaks of bovine hysteria in cattle ingesting ammoniated hay have lead to the de-emphasis of this practice in several states. At this meeting, Werner Essig of Mississippi State University indicated that this potentially fatal disease was related to the production of toxic methyl imidazoles and their interference in thiamin metabolism.

Incorporation of urea into bales at baling has the potential of being more widely adopted in the southeast for urea is readily available, safer and easier to use than anhydrous ammonia. In bales some urea is hydrolysed by naturally occuring phyllosphere ureases to release ammonia (Dougherty et al. 1984). Fifty days after adding urea to bales of Kentucky 31 tall fescue at 33% moisture content yeast and mold populations were reduced from 2,700 M Colony Forming Units per pound to 24.5 M CFU/lb at 30 lb urea per ton and to 0.4 M CFU/lb at 60 lb urea per ton.

At the time of writing it would appear that ammoniation with anhydrous ammonia or urea should be limited to low quality hay and straws of grasses, where additional rumen degradable nitrogen is required.

Recently farmers have been subjected to intense commercial pressure to preserve hay with a wide range of products. An understanding of the causes of deterioration of hay is required for the proper implementation of preservatives. Without preservatives hay must be dried to 18% MC (large bales) or 20% small bales to reduce the water activity to a level where microfloral growth is minimal. Hay stored at moisture about these levels is subject to deterioration mainly by yeasts and molds, with little damage attributable to actinomycetes and bacteria (Lacey et al. 1980). Chemical preservatives can be used when hay is baled above 18-20% to maintain leaves on legume hays, to reduce baling and handling losses, to minimize the inevitable wet "slugs" in bales (especially big bales) caused by within windrow or field variations in moisture, to minimize curing time, avoid rain damage, and to improve managerial efficiency.

An effective hay preservation should control the harmful organisms for the duration of storage, should be of low cost with low cost per unit of active ingredient and low costs of applicator and application, be easy to apply and relatively harmless to man and beast. For most of the microflora involved propionic acid has proved to be the most effective hay preservative (Lacey et al. 1980). Propionic acid inhibits microflora by the toxicity of the anion and because of its acidity (Benham and Redman 1980). Thus one would anticipate that neutralized or half neutralized organic acids (eg sodium diacetate, ammonium propionate) would not be as effective as straight acid but this does not seem to be the case (Lacey et al. 1980).

Inhibition of microflora of hay requires an effective concentration of the preservative. British work indicates that 1.5% solution (W/W) organic acid is needed to limit the microflora causing the deterioration of moist hay, but the twice that rate should be applied to account for difficulties in distribution and losses due to violatility (Lacey et al. 1980). It is readily apparent that more organic acid should be applied to wetter hays. Organic acid should be applied at the rate of 3% of the weight of water contained in the hay. Thus hay at 25% moisture should be treated with 15 lb a.i. of organic acid. Some commercial products are labelled to show lower application rates and these products are likely to fail. Other products are diluted with water and other useless concoctions and their labels indicate rates of application at which they will not function as preservatives. Some dilution of acid is acceptable to facilitate distribution but the effective rate of active ingredient must be maintained.

As the concentration of organic acid must be maintained at a minimum level which is inhibitory to the microflora the rate must be adjusted to the forage moisture content. This requires accurate estimates of forage moisture content. The effective range for organic acid preservatives is in the 18-27% moisture range. Above these levels the hay is less stable, more species of microflora are active, and higher concentrations of preservative are required. Suboptimal rates of propionic acid may lead to increases in populations of microorganisms which metabolize propionic acid. When this occurs preservative capacity declines with time, which along with vapor losses shorten "shelf-life" of the hay in storage.

The organic acids used in hay preservatives are natural constituents of plants and animals and are readily metabolized. The concentrations of the commercial product are often high and potentially corrosive but the concentrations found in the treated hay are so low as to be harmless to livestock, including horses.

INOCULANTS OF HAY AND SILAGE

Hay

Many commercial products are being marketed for incorporation into hay at baling or at some later stage in the haymaking process. Products containing dead bacteria (such as lactic acid producers) incorporated into moist hay at a few ounces per ton are unlikely to function preservatives. Products containing live bacteria (such as lactic acid producers) are also unlikely to produce enough lactic acid to inhibit growth of microflora because the activity of water is too low to support the significant growth of bacteria needed to produce the volume of lactic acid needed. Both living and dead bacteria could inhibit growth of other microorganisms but the added bacteria would require enormous increases in populations to have a significant effect.

Silage

Forage in the moisture range 35-65% for silage can support active populations of aerobic and anaerobic bacteria. Many products are available for the inoculation of silage with lactic acid producing bacteria. The phyllosphere of forage crops generally contain adequate populations of lactic acid fermenters but the surface microflora of some crops may be suboptimal in terms of efficient types or of suboptimal in terms of population. Inoculants containing high populations of efficient live strains of homofermenters can be used in these situations. Research in Kentucky has shown that first and last cut alfalfa and tall fescue in late fall may have inadequate populations of natural inoculant for effective silage preservation, possibly because of low temperate "sterilization" of the crop surfaces. Silages made from these crops can respond dramatically to inoculation with appropriate populations of lactic acid producers (O'Leary, unpubl.). In most instances properly handled corn silage should not require inoculation (unless exposed to a hard freeze) but inoculation of other forage silages may be considered as relatively cheap insurance. Genetic engineering is likely to have its first impact on agronomic crops in the area of silage inoculants.

Many other substances are being promoted as silage additives. Some are extremely effective such the use of anhydrous ammonia or urea in corn silage as a nitrogen supplement. Energy supplementation is often promoted. Molasses and grain have been used for many years in situations where the growth of lactic acid producers is limited by energy supply, but additives such as small amounts of "food grade sucrose", vitamins, minerals, enzymes and similar compounds have yet to be proved effective in farm operations.

Products which contain crude enzymes are also not likely to promote favorable fermentation. Rupture of plant cells by cutting and conditioning and the loss of integrity of the plant cell membrane on dessication and death releases both fermentable substrates and hydrolytic enzymes in addition to those released from phyllosphere microflora. Commercial preparations that contain hydrolytic enzymes are not likely to improve fermentation kinetics for fermentation bacteria can synthesize and excrete hydrolytic enzymes on demand. Carbohydrases, such as amylase, could conceivably accelerate starch depolymerization in forage legumes and warm season grasses, but in cool-season grass silage, lactic acid should release sufficient fructose from the acid-labile fructosan. Products which advertise proteolytic enzymes as valuable constituents should also be suspect for it is unlikely the growth of fermentors is limited by nitrogen metabolism. One exception could be silages made from tropical grasses grown under extremely low nitrogen status. Protein degradation is usually excessive in silage and a characteristic of poor silage, hence added proteolytic enzymes even if they function should be regarded as a negative force in any silage additive.

THE FUTURE

Of the technology discussed in this paper the most useful to forage farmers in the Southeast is without doubt the use of propionic acid as a hay preservative. This proven technology permits the production of high quality hay in the humid southeast at a cost of $10-12 per ton. Perhaps the next generation of hay balers will have instruments to monitor bale MC and administer the appropriate doses of preservative to bales as MC varies across the hay field. The re-introduction of the modern variates of the hay tedder should also increase the capacity of the southern farmer to make quality hay.

In the near future hay is likely to be treated at baling to counter deficiences in quality and improve the product. An efficient application system for granules and liquids for big balers would permit correction of nutrient deficiences (eg sulfur in tall fescue or nitrogen in warm season grasses) while treatment (eg formaldehyde) of forages to reduce the proportion of plant protein degraded in the rumen should be feasible, and would represent a significant advance in future technology.

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TALL FESCUE - HISTORY AND FUTURE

J. Kenneth Evans[1]

Tall fescue (Festuca arundinaceae Schreb.) a long-lived grass with short underground stems, is presently grown on approximately 5.5 million acres and 35 million acres in Kentucky and the South Central United States respectively. It is a versatile plant used for livestock feed, lawns, turf and conservation purposes, and is adapted for a wide range of soil and climatic conditions.

Chemical analyses for forage quality indicate that tall fescue compares favorably to other transition zone grasses. Many livestock producers, however, have found animal response from grazing tall fescue to be erratic and often undesirable. Researchers at the University of Kentucky and many other universities have made and continue to make significant progress toward solving the forage quality problems of tall fescue.

DISCOVERY AND RELEASE OF KENTUCKY-31

In 1931, Dr. E. N. Fergus was in Eastern Kentucky (Menifee County) when a local farmer asked if he was aware of a good grass which was growing in the county. Dr. Fergus was taken to the W. M. Suiter farm where he observed several fields of this "wonder grass". One large hillside, protected against erosion and with livestock grazing on it, was covered with the grass. Although the weather had been cold, the grass was still green.

Dr. Fergus obtained about a pound of seed from Mr. Suiter which he seeded on the University of Kentucky Experiment Station farm in 1932. Seed for the original planting on the Suiter farm presumably had come from a seedsman in Virginia. The grass was likely growing on the farm when Mr. Suiter purchased it in 1887. Since it had been growing in Menifee County for many years, Dr. Fergus had no doubts about the plant's climatic adaptation.

Early seedings throughout Kentucky showed the grass to have a long life and hardy persistence. It was also noted to be unusually deep-rooted for a cool-season grass. From 1932 to 1939, seedings were made at U. of Kentucky outlying soil experimental fields and, in 1939, seed was distributed by W. C. Johnstone for trials by interested farmers. After testing, this grass was released in 1943 as the "Kentucky 31" variety. In 1945, it was included in the Kentucky seed certification program. In the mid 1960's tall fescue occupied an estimated 6.0 million acres of Kentucky's 7.0 million acres of forage crops.

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EARLY SHORTCOMINGS WERE OBSERVED

The new grass was not without its shortcomings, which became more evident with general farm use. Its seasonal unpalatability was observed in some of the early plantings at the Princeton, Ky. station (Fergus, 1970). In addition, cattle grazing on pure stands in fields grown for seed, occasionally suffered from lameness or even sloughing of tails, especially during fall and winter. It appeared that a toxic substance occasionally developed in the fescue which caused a temperature depression and perhaps a constriction of blood vessels in the extremities of the animal (Jacobsen et al. 1973). Dr. Lowell Bush and his associates at the University of Kentucky later found that an alkaloid (perloline) contained in tall fescue reduced the rate of cellulose digestion in the rumen (Bush et al. 1973; Bush et al. 1972; Bush et al. 1970). Researchers at the UK Agricultural Experiment Station attacked these problems through plant breeding efforts under the leadership of Dr. R. C. Buckner. Dr. Buckner increased seed of some low perloline breeding lines and established stands which were both low and high in perloline. After 6 weeks on the low perloline forage, lactating dairy cows dropped precipitously in milk production, lost weight and had high rectal temperatures and respiration rates (Hemken et al. 1976).

Johnstone, a low endophyte/low alkaloid variety, was released in 1982. Research in conjunction with Dr. Buckner's work was conducted by many members of the Departments of Animal Sciences, Agronomy and Plant Pathology.

SUMMER SYNDROME

Summer syndrome is a term used to denote poor performance by cattle grazing tall fescue during summer. It is characterized by one or more of the following symptoms: 1) reduced feed intake, 2) lower weight gain, 3) lower milk production, 4) rough hair coat, 5) rapid breathing, 6) increased body temperature, 7) increased water consumption, 8) more time spent in the shade, 9) excessive salivation, 10) greater urine volume, 11) reduced prolactin level, 12) possible reduced reproductive performance, and 13) nervousness. An endophytic fungus Epichloe typhina (=Acremonium coenophialum), known for several years to be in tall fescue, was found by Bacon and his co-workers in Georgia fescue pastures on which cattle showed the summer syndrome. Researchers at Auburn University, the University of Georgia and the University of Kentucky have shown this fungus to be associated with the occurrence of certain alkaloids in tall fescue.

In controlled temperature (86°F) experiments young cattle exhibited the summer syndrome when they were fed infected tall fescue seed or hay containing loline alkaloids. However, cattle fed non-infected tall fescue seed or hay without the alkaloids remained healthy. These feeding trials strongly suggest that fungus infection of

the grass and the associated alkaloid levels are important to the summer syndrome malady (Hemken et al. 1981).

OTHER MORE RECENT ANIMAL RESPONSES

Studies on lactating dairy cows consuming Ky 31 which was either 67% infected or clean, have shown reduced forage intake, body weight, milk production and serum prolactin when cows were consuming the endophyte infected forage. In this study, there is enough evidence to make one suspect there was reduced milk flow from cows consuming pre-release Johnstone which was between 6.7 and 11.0% endophyte infected (Jackson, 1984).

Similar results have been shown in beef cattle grazing studies at several universities. It appears that removing the endophyte from a given variety of fescue will result in about 0.5 lb/day increase in calf gains. Adding a legume to the endophyte free stand will add about 0.3 lb/day to gain. Adding a legume to the endophyte infected stand will add about 0.5 lb/day to gain (Boling et al. 1984; Fron et al. 1984).

Survey data collected several years ago at the University of Missouri, Columbia provided indictment of fescue as pregnant mare pastures. Subsequent unpublished data at the Universities of Kentucky and Missouri provide additional evidence for conviction.

Research has convincingly demonstrated that the endophytic fungus is by some means creating quality problems in tall fescue. Interdisciplinary teams at several universities are presently seeking answers to additional questions.

SOME QUESTIONS WHICH NEED ANSWERS

1. At what level of endophyte infection do the costs of killing and reestablishing clean stands exceed the benefits derived from a lower level of infection? Evidence now suggests that 6.7-11.0% infection is too high for lactating dairy cows. I personally believe that we should have zero infection as our goal for these animals.

2. How can you successfully kill an infected stand and replant with clean seed? Obviously the best way is to go through a year or two of row crops and then reseed with clean fescue or other grasses. Much of the fescue acreage is not row crop land. On this acreage we need a method to kill and reseed without plowing and without extended loss of productivity from the land.

   Spraying with two pints of paraquat and surfactant, waiting about 2-3 weeks and spraying a second time with one pint of paraquat and surfactant seems to have worked well in Tennessee, North Carolina in Western Kentucky. In Eastern, Ky. this treatment was applied in October 1984 and Johnstone fescue was drilled into what was apparently 100% killed sod after the second spraying. In December the sod yet appeared 100% dead. In the Spring of 1985 samples from the sod area showed a 40% infection level. A small area in the same field which had been in tobacco in 1984, was seeded with Johnstone into wheat. This area showed a 3% infection level in spring 1985.

   This procedure does not always work! We need more information on the relationships of environment and physiological state of plants to herbicide efficacy.

3. Do infected and clean plants have the same grazing management requirements for stand survival? We hear reports that endophyte free stands have survived on experiment station farms for 8 years. Were these stands grazed? If so, were they grazed as most farmers have become accustomed to grazing fescue? What is the relative soil fertility on experiment station farms and most farmer fescue fields?

4. Do infected and clean plants have different susceptibilities to insects and diseases? If they are different and one group of plants tend to be selectively removed, the other will increase as a fraction of the stand.

5. Does endophyte infection (or lack of) affect the quantity or viability of seed produced? Most farmers do not control seed head production. Any differences in viable seed would tend to shift the ratio of clean to infected plants.

6. Does the endophyte spread by any means other than seed? All present evidence says no. It would be a mistake to conclude that our present knowledge is perfect.

SUMMARY

There appears to be an unquestionable adverse effect of the fescue endophyte on animals. Seed of many varieties of tall fescue with low levels (sometimes zero) of endophyte are becoming increasingly more available. Farmers who plan to grow fescue for animal consumption should be encouraged to use low endophyte seed of an adapted variety. In view of presently unanswered questions, we should 1) be cautious in our assurance that "if your seed is 5% infected your stand will be and will remain at 5%" infection; 2) recommend more judicious grazing management on low endophyte stands; 3) recommend clover with fescue regardless of endophyte level; 4) continue to sharpen our knowledge of how to kill and reseed without plowing; and 5) continue to quantify animal performance of different endophyte infection levels so as to have a basis for determining an economic threshold of infection.

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UTILIZATION AND MANAGEMENT OF ENDOPHYTE-INFESTED TALL FESCUE: AFFECTS ON STEER PERFORMANCE AND BEHAVIOR

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Tall fescue (Festuca arundinacea Schreb.) is the predominant cool season perennial grass in the Southeastern United States and is adapted and grown throughout most of the eastern half of the United States (Buckner et al. 1979). It has many desirable agronomic attributes but numerous animal disorders are associated with it. These disorders have been referred to as fescue toxicosis and are generally categorized as fescue foot, fat necrosis and summer syndrome or poor performance (Bush et al. 1979). Bacon et al. (1977) reported the occurrence of an endophytic fungus, Epichloe typhina, subsequently reclassified as Acremonium coenophialum, Morgan-Jones et Gams, and associated its presence with reduced animal performance. This association was subsequently verified by Hoveland et al. (1980 and 1983). Prior to discovery of the endophyte it was noted that cattle with fescue toxicosis had altered behavioral patterns. Cattle with fescue toxicosis tended to seek shade early on hot days and to wallow in mud. Bond et al. (1984) reported that steers which grazed an experimental line of tall fescue (G1-307) containing high levels of the endophyte showed signs of fescue toxicosis and grazed 20% less than steers grazing low endophyte lines or cultivars.

Based on these observations, the following study was designed to determine the effect of high vs low endophyte infected Ky-31 tall fescue on steer grazing behavior and performance including residual effects on grazing behavior and performance.

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MATERIALS AND METHODS

Twenty yearling Angus steers (208 kg) were stratified according to weight and randomly allotted on April 4, 1984, to .81 ha paddocks of Kentucky-31 tall fescue fertilized with 336 kg nitrogen (N)$\cdot$ha$^{-1}\cdot$yr^{-1} as ammonium nitrate (NH_4NO_3). Equal N applications were made in March, April and August. Paddocks were fertilized with phosphorus (P) and potassium (K) in May in order to bring soil test levels to the medium range.

Samples collected from each paddock from March through October revealed that two paddocks had >95% (high) frequency of tiller endophyte infection and two had a <1% (low) frequency. Available forage (that above ground level) was estimated at monthly intervals with at least 1600 kg/ha maintained throughout the study period from April 4 through September 19, 1984.

All 20 steers were used in behavioral observations with 3 tester steers in each paddock (initial weight 204 kg) used to determine performance (ADG) from April 4 through September 19. Six steers were allotted to each of the high endophyte paddocks and 4 steers were allotted to each of the low-endophyte paddocks. Initial weight was determined by averaging 16-hour shrunk (off water) weights on two successive days. Sixteen-hour shrunk weights were obtained throughout the 168-day study at 14-day intervals. Portable shades (3.3 x 2.7 x 2.2 m), fresh water, and salt blocks (in covered feeders) were available in all paddocks.

Behavioral observations began at 1800 h on May 13 and were continuously recorded for 48 h. Night vision scopes were used during darkness. During the first 48 h observation time, individual animal identity was not maintained, however, animal activity was recorded. In all subsequent observation periods, individual animal identity was maintained day and night. On May 16 at 1800 h, one group (randomly selected) of steers grazing a high endophyte (H) paddock was exchanged with one group (randomly selected) of steers grazing a low endophyte (L) paddock. After exchange the four groups were those which grazed low (LL) or high (HH) endophyte paddocks continuously, or those moved from low to high (LH) or high to low(HL). Behavioral observations were then resumed for 48 H, no observations for 48 H, then monitored again for 48 H. Sets of 12 h (0600 to 1800 h) observations were taken May 29, June 5, and June 12. Behavioral observations recorded included grazing, lying, standing, drinking water, or consuming salt.

The percentage of time each animal spent grazing was examined using analysis of variance both within and across hours for each measurement date. Average daily gain for various time periods was examined by analysis of variance. Weight gain response was analyzed by computing the cumulative weight gain with time. Single

degree of freedom comparisons corresponding to HH-LL, HH-HL, and LL-LH differences were estimated for each measurement date. The dependence of these contrast estimates on measurement time was evaluated using a multivariate analysis of variance described by Evans and Roberts (1979).

RESULTS AND DISCUSSION

Behavioral observations from 0600 until 1800 hours showed that there was no significant difference in the percentage of time spent grazing by steers on either high or low endophyte fescue (Table 1). However, there was a trend for those grazing low endophyte fescue to spend more time grazing. Steers that were moved from high to low endophyte fescue spent the same amount of time grazing as those that remained on high endophyte material as late as 26 days after exchange. Likewise, those that were moved from low to high spent the same amount of time grazing as those that remained on low endophyte material.

Although there were no differences in the percentages of time spent grazing considering the 12-hour period from 0600 to 1800 hours, there were significant differences in the percentages of time spent grazing from 1200 until 1600 hours (the warmest part of the day). At each measurement date, steers grazing low endophyte fescue spent more ($P<.005$) time grazing than those grazing the high endophyte fescue (Table 2). Steers grazing low endophyte fescue spent from 43-65% of the time between 1200 to 1600 hours grazing while steers grazing high endophyte fescue grazed only 5-21% during that time. For at least 26 days following exchange, steers moved from high to low endophyte fescue grazed an amount of time similar to those remaining on high endophyte fescue (Table 2). This is indicative of a residual effect following grazing of high endophyte fescue. Steers moved from low to high endophyte fescue grazed less ($P<.06$) than those remaining on low endophyte grass. This effect was immediate. On the day following exchange, steers that were moved from low to high endophyte fescue grazed 40% of the time from 1200 to 1600 hours versus 60% of the time for those remaining on low-endophyte material. These results emphasize that time-of-day was important when measuring differences in grazing behavior with the greatest differences occurring during the hottest time of the day.

Average daily gains were different ($P<.05$ for animals grazing high and low endophyte fescue at 0.31 and 0.55 kg, respectively from April 4 through September 19 (Table 3). Following exchange, there was a very abrupt effect on gains of steers moved from low to high endophyte fescue. Prior to exchange the low endophyte steers gained 1.12 kg/day; however, during the 14 days following exchange they lost .11 kg/day while the steers that remained on the low endophyte fescue gained 1.40 kg/day. Steers moved from high to low endophyte fescue improved gradually for approximately 16 weeks following exchange as compared to those remaining on high endophyte fescue.

Examination of cumulative weight gain response with time by multivariate analyses of variance indicated that both the effect of the endophyte and the "exchange" effect, HH-HL and LL-LH, had a significant (alpha = 0.05) relationship with time. These analyses substantiating the observation of gradual recovery in weight gain by steers removed from high endophyte fescue. These results also indicate that the effect of moving steers from low to high endophyte fescue was very abrupt in terms of reduced weight gain response.

These data also suggest that if producers have fields of high and low endophyte infected tall fescue that some advantage may result from grazing the high endophyte fescue early in the season followed by grazing the low endophyte fescue during the warmer season. Our study also suggests that there may be significant residual or carryover effects on performance and behavior after having grazed high endophyte tall fescue.

SUMMARY

This study was designed to determine the effect of high versus low endophyte infected Kentucky-31 tall fescue on steer grazing behavior and performance and to investigate residual effects. During the hottest portion of the day (1200 until 1600 hours), steers grazing low endophyte fescue spent more time grazing than those grazing high endophyte fescue. For at least 26 days following exchange, steers that were moved from high to low endophyte fescue grazed an amount of time similar to those grazing high endophyte fescue, indicative of a residual or carryover effect following grazing of high endophyte fescue. Average daily gains were different for steers grazing high and low endophyte fescue at 0.31 and .55 kg, respectively. Gain response of steers moved from high to low endophyte fescue indicated a gradual improvement compared to those remaining on high endophyte fescue. Our data suggests an important residual or carryover effect due to grazing high endophyte infected tall fescue which may subsequently adversely affect animal performance on alternate sources of grazing.

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Table 1. Percentage of time spent grazing from 0600 until 1800 hours before and after exchange of one group of steers from low to high endophyte tall fescue and vice versa.

Date	Fungus Level High(H)	Fungus Level Low(L)	HvsL*	High to Low(HL)	HvsHL*	Low to High(LH)	LvsLH*
	%	%		%		%	
Before Exchange							
5-14-84	24.1	33.1	.7002	-	-	-	-
5-15-84	31.1	35.7	.0575	-	-	-	-
After Exchange							
5-17-84	29.9	39.0	.3475	29.2	.7617	30.4	.7825
5-21-84	29.9	40.4	.3948	29.6	.8214	31.5	.1772
6-12-84	26.6	31.9	.9210	27.3	.6811	30.9	.9170

*Probability of F >f for the associated single degree of freedom comparisons.

Table 2. Percentage of time spent grazing from 1200 until 1600 hours before and after exchange of one group of steers from low to high endophyte tall fescue and vice versa.

Date	Fungus Level High(H)	Fungus Level Low(L)	HvsL*	High to Low(HL)	HvsHL*	Low to High(LH)	LvsLH*
	%	%		%		%	
Before Exchange							
5-14-84	5.1	57.8	.0001	-	-	-	-
5-15-84	6.5	62.2	.0001	-	-	-	-
After Exchange							
5-17-84	4.0	59.6	.0001	10.1	.2834	40.3	0105
5-21-84	21.4	65.1	.0003	33.4	.1783	28.4	.0028
6-12-84	14.2	43.4	.0032	6.3	.3133	24.8	.0606

*Probability of F >f for the associated single degree of freedom comparisons.

Table 3. Average daily gains of steers before and after exchange of one group of steers from low to high endophyte tall fescue and vice versa.

Date	Fungus Level High(H)	Fungus Level Low(L)	HvsL*	High to Low(HL)	HvsHL*	Low to High(LH)	LvsLH*
	kg/day	kg/day		kg/day		kg/day	
Before Exchange							
4/4-5/16	.39	1.12	.0001	-	-	-	-
After Exchange							
5/16-5/30	.49	1.40	.0007	.97	.0216	-.11	.0001
5/30-6/13	.70	.22	.2165	.32	.3272	.11	.7732
5/16-9/19	.30	.40	.4525	.48	.1770	.22	.1770
Overall							
4/4-9/19	.31	.55	.0395				

*Probability of F >f for the associated single degree of freedom comparisons.

BEEF STEER PERFORMANCE ON ALFALFA AND SERICEA LESPEDEZA PASTURES

S. P. Schmidt[1], C. S. Hoveland[2], E. D. Donnelly[3], and R. A. Moore[4]

INTRODUCTION

Pastures of small grains (Anthony et al., 1971, Harris et al., 1971) and fungus-free tall fescue (Festuca arundinacea) (Hoveland et al., 1983) have produced high average daily gains (ADG) and gains per hectare for stocker steers during the cool season in Alabama. In contrast, gains of steers have been low on warm season perennial grasses such as Coastal bermuda (Cynodon dactylon) (Hoveland et al., 1971). There is a need for high-quality pastures that can provide rapid gains into the summer months when cool season forages are not available.

Serala, a fine-stemmed sericea (Lespedeza cuneata) variety is a productive legume that grows well during the warm season (Donnelly, 1963). However, the high tannin content of this cultivar reduces animal gains. The development of the low-tannin sericea cultivar, AU Lotan, offers the prospect of improved animal gains (Donnelly and Anthony, 1980). Previous small-plot research showed that continuous frequent cutting of sericea depleted stands and reduced productivity, while leaving a high stubble favored persistence (Hoveland et al., 1975). Information is needed on sericea persistence and production under grazing.

Alfalfa (Medicago sativa) is a highly productive hay plant. The high quality of this legume suggests that it should give excellent steer gains over a long season. No grazing data for alfalfa are available in the Southeastern United States.

EXPERIMENTAL PROCEDURE

Pasture Management

Twelve 1.2-ha paddocks on a mixture of Ora (Typic Fragiudults) and Greenville (Rhodic Paleudults) soils at the Upper Coastal Plain Substation in northwest Alabama were used for four pasture treatments: (1) Cimarron alfalfa, rotationally grazed; (2) Serala sericea, rotationally grazed; (3) AU Lotan sericea, rotationally grazed; and (4) AU Lotan, continuously grazed. Three paddocks of Serala sericea and six paddocks of AU Lotan sericea were planted during the spring of 1980 at 22.4 kg/ha with a cultipacker seeder after applying 3.4 kg/ha Eptam herbicide. In September 1980, Cimarron alfalfa was seeded similarly at 22.4 kg/ha. Pastures were limed and fertilized each year according to soil test recommendations. Only limited grazing was done in 1981 because of drought.

Rotationally grazed paddocks were cross-fenced into three 0.4-ha subpaddocks to allow grazing for one week before sequentially rotating steers to the next subpaddock, resulting in a 2-week rest period between grazing periods. Each spring and at the end of the third grazing season, shoot counts were made from ten .093-square meter areas in each subpaddock to determine stands. Grab samples of forage were obtained from grazed areas of each subpaddock at the beginning of each rotation (or weekly in the continuously grazed paddocks) for determination of in vitro dry matter disappearance (IVDMD).

Management of Grazing Animals

The grazing trials were conducted over 3 years, 1982 through 1984. All paddocks were stocked in the spring, when forage became available, with Angus x Hereford steers weighing approximately 225 kg. A put-and-take system of forage management was used to keep plant height between 10 and 20 cm. When not on test, put-and-take steers were maintained on either alfalfa or Serala sericea pastures. Water, salt and shade were available on all paddocks, and in addition, steers grazing alfalfa were provided poloxalene blocks for bloat control. Weighing was done at 28-day intervals, and ADG was calculated only on tester steers that remained on the pastures throughout the season. Animal grazing days were computed from the sum of the number of days that tester steers and added steers stayed on the pasture. Gain per hectare was computed from the ADG of tester steers and total steer grazing days per hectare.

RESULTS AND DISCUSSION

Pastures

Stands were generally good except in one rotationally grazed AU Lotan paddock where reseeding was not very successful. Weeds were not a problem except during late summer in alfalfa. Serala sericea paddocks were almost weed-free as animals selected weeds in preference to the high-tannin sericea. Sericea stands remained good throughout the test, even under continuous grazing of AU Lotan (Table 1). Shoot numbers of sericea declined the second year under severe drought conditions but generally recovered at the end

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Table 1. Shoot numbers of alfalfa and sericea lespedeza as affected by grazing.

		Shoots per square meter			
Legume species	Grazing system	May 6, 1982	May 25, 1983	June 8, 1984	Sept. 6, 1984
Cimarron alfalfa	Rotational	495[a]*(A)**	474[a] (A)	388[a] (B)	291[a] (C)
Serala sericea	Rotational	657[b] (A)	689[b] (A)	420[a] (B)	560[b] (C)
AU Lotan sericea	Rotational	560[c] (A)	517[ac](A)	409[a] (B)	495[c] (A)
AU Lotan sericea	Continuous	538[ac](A)	560[c] (A)	398[a] (B)	430[d] (B)

*Means within a column with different superscripts differ (P<.05).
**Means within a line with different capital letters differ (P<.05).

of the third grazing season. The generally good stand persistence of sericea under grazing is probably a result of keeping 10 to 15 cm of stubble in the pastures. Previous small plot clipping research showed that close, frequent cutting reduced stands while leaving a high stubble allowed rapid new bud development and forage growth (Hoveland et al., 1975). Alfalfa shoot counts declined each season, probably a result of inadequate time for recovery and replenishment of root carbohydrate reserves. Grazing studies on alfalfa in New Zealand (Langer, 1967) have shown that a 4-week rest between grazing periods is required to maintain grazed alfalfa stands longer than the 3 years of this experiment. However, even with the grazing system used, there were still six alfalfa plants per .093 square meter at the end of the third year.

Digestibility of alfalfa was consistently higher than sericea throughout the season (Table 2). Alfalfa maintained relatively high digestibility even during mid- to late summer. AU Lotan, although lower than alfalfa, had a consistent numerically higher IVDMD than Serala throughout the season, indicative of the lower tannin level of this cultivar.

Table 2. In vitro dry matter disappearance of alfalfa and sericea samples taken weekly from grazing paddocks.

Legume species	Grazing system	IVDMD, %
Cimarron alfalfa	Rotational	68.7[a]
Serala sericea	Rotational	41.7
AU Lotan sericea	Rotational	46.4
AU Lotan Sericea	Continuous	46.3

[a]Data from only the first 2 years. Means were not statistically analyzed.

Cattle Performance

The grazing season over the 3-year period averaged from March 30 to September 8 (163 days) on alfalfa and April 22 to September 8 (139 days) on the two sericea cultivars (Table 3). Carrying capacity did not differ among the four treatments (P>.10). During the drought of 1983, carrying capacity of alfalfa was affected more adversely than for either sericea cultivar.

The ADG of steers grazing alfalfa averaged .98 kg (Table 3) which is about double that obtained on Coastal bermudagrass (Hoveland et al., 1971). The high ADG and carrying capacity of alfalfa make it attractive for stocker steers on soils where this crop can be grown. Although daily gains of steers grazing AU Lotan sericea were lower (P<.05) than on alfalfa, they were higher (P<.05) than on Serala sericea and similar to those obtained on small grains (Anthony et al., 1971; Harris et al., 1971) and fungus-free tall fescue (Hoveland et al., 1983). Continuous grazing of AU Lotan resulted in daily gains similar to those with rotational grazing. The daily gains on all species were 19% lower during the drought year of 1983 compared to the average gains for 1982 and 1984, probably a result of high temperatures and less selectivity in forage available to the steers.

Beef gain per hectare on alfalfa was nearly double that on Serala sericea (Table 3), averaging 533 kg/ha. This high gain per hectare is excellent for a warm season perennial on a relatively droughty soil. AU Lotan was numerically better than Serala, and rotational grazing gave no advantage over continuous grazing. Although the gain per hectare was lower on AU Lotan sericea than alfalfa, it should be pointed out that sericea has the capacity to grow on acid, high-aluminum soils where alfalfa cannot grow unless heavily limed. The potential for low-tannin sericea in furnishing low-cost grazing for steers may make it attractive in many situations.

Table 3. Performance of steers grazing alfalfa and sericea pastures.

Legume species and grazing system	Days of grazing	Carrying capacity	Animal days/ha	Average daily gain	Beef gain per hectare
		steers/ha		kg	kg
Rotational grazing					
Cimarron alfalfa	163[a]	3.26[a]	534[a]	.98[a]	533[a]
Serala sericea	139[b]	3.13[a]	430[a]	.63[b]	278[b]
AU Lotan sericea	139[b]	2.97[a]	407[a]	.75[c]	310[b]
Continuous grazing					
AU Lotan sericea	139[b]	2.89[a]	403[a]	.85[c]	343[b]

[a,b,c]Means in a column with different superscripts differ ($P<.05$).

The excellent gains obtained with alfalfa and AU Lotan sericea indicate the potential of these perennial legumes for production of stocker steers during the warm season in Alabama and other Southeastern States. Since no nitrogen fertilizer is needed for these pastures, they offer the potential of lower cost of gain than on warm season grasses. These legumes offer the opportunity to extend the season for beef stockering to furnish feeder cattle to feedlots over a longer period of the year than now obtained with cool season pastures.

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PERFORMANCE OF STEERS ON YEAR-ROUND GRAZING SYSTEMS IN THE PIEDMONT OF SOUTH CAROLINA DURING 1982-83

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INTRODUCTION

South Carolina's beef industry consists mostly of cow-calf operations. A high percentage of the calves that are produced are shipped out-of-state for stockering and finishing. There are many instances when it is cost-effective to hold calves for stockering rather than selling at weaning. The Piedmont of South Carolina offers considerable promise for forage production for stocker enterprises. The fact that both summer and winter perennials thrive in the Piedmont gives some indication of the year-round forage production potential of this area. Also, soil erosion losses from marginal land in soybean production in the Piedmont give some impetus for considering alternative land uses with less potential for soil erosion.

In the Piedmont of South Carolina, late winter calving and, therefore, fall weaning of calves is recommended primarily because it closely matches peak herd nutrition requirements with peak nutrient production by forages. The objective of this study was to evaluate performance of steers on year-round grazing systems.

MATERIALS AND METHODS

Forty-eight Simmental or Charolais-Angus sired steers were randomly assigned by breed and weight to the following four fall grazing treatments: (1) fescue-Tillman clover, (2) fescue-red clover, (3) fescue-Tillman + red clover, (4) fescue-Louisiana S_1 white clover. After the fall phase, steers were reassigned by breed and weight to components of the winter phase and likewise for the spring and summer phases. The winter phase treatments were: (1) rye-crimson on prepared seedbed, (2) rye-arrowleaf on prepared seedbed, (3) rye-crimson sodseeded into Coastal bermudagrass sod, and (4) rye-crimson sodseeded into Tifton 44 bermudagrass sod. The spring grazing treatments were the same as for fall. The summer grazing treatments were: (1) sorghum-sudangrass, (2) Tifleaf millet, (3) Coastal bermudagrass, and (4) Tifton 44 bermudagrass.

Pastures were 2.5 acres each, and each treatment was replicated 3 times. Weights were taken at the beginning and end of each phase, and at 28 d intervals during each phase. Hay was produced from excess forage on all summer phase forages. If grazing conditions required, hay produced from the summer phase was fed.

At the end of the spring phase 25% of the steers (one steer-pasture) were selected for slaughter. A grazer animal was added to each pasture for the summer phase to replace slaughtered animals. At the end of the summer phase another 25% of the steers were selected for slaughter. The remaining animals were placed in a feedlot and finished on high grain diets.

RESULTS AND DISCUSSION

Eight of the twelve fescue-clover pastures were endophyte free. Performance data of steers are presented in Table 1. During the fall phase, the fescue-Tillman and red clover was the most productive treatment (237 lb beef gain/acre). A relatively high level of gain was sustained on all treatments (range = 2.12 - 2.60 lb/hd/day) during the fall phase. The average final weight of steers at the end of this phase was 681 lb. Some producers would market these cattle at the end of this phase. For the next phase (winter) the same cattle could be continued or a different group of cattle could be used.

The winter of 1982-83 was relatively mild, therefore, good growing conditions for winter forages prevailed. ADG ranged from 1.82 to 2.68 lb/hd/day for the winter phase treatments. Although rye and crimson clover on prepared seedbed produced more beef gain/acre (322 lb), beef production from rye and arrowleaf clover on prepared seedbed was similar (306 lb/acre). The unusually high rate of gain (2.68 lb/hd/day) on rye and crimson sodseeded into Coastal bermudagrass sod resulted in 300 lb of bee/acre, even though the stocking rate was only .8 steers/acre.

During the spring phase, ADG tended to somewhat lower for steers on fescue-La S_1 clover (2.06 lb/hd/day). However, rate of gain was considered to be excellent for heavy weight steers on forage. It was felt that several animals were approaching acceptable slaughter weights at the end of the spring phase. Therefore, 25% (1/pasture) of the steers were selected for slaughter.

At the beginning of the summer phase, grazer animals were allowed to replace slaughtered animals. These animals were lighter and, therefore, account for the lower initial weights in the summer phase. A constant stocking rate of 1.6 steers/acre was maintained throughout the summer phase. Forage production exceeded grazing needs during early summer. Therefore, excess forage was harvested as hay from each pasture. Although rate of gain tended to be higher for summer annual grasses (Tifleaf millet and sorghum-sudangrass), beef production/acre was higher for summer perennials (Tifton 44 and Coastal bermudagrass). Also, rainfall was unusually low during the summer of 1983. This limited forage production considerably.

These data suggest that year-round grazing systems are possible for the Piedmont of South Carolina. Also, several of the grazing schemes offer considerable potential for increased profits over currently utilized grazing schemes.

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Table 1. Performance of steers on year-round grazing systems in the Piedmont of South Carolina

Phase	Stocking rate, steers/acre	Initial wt, lb	Final wt, lb	ADG, lb	Gain/acre, lb
Fall					
Fescue-Tillman clover	1.6	546	680	2.36	215
Fescue-red clover	1.6	560	679	2.09	190
Fescue-Tillman and red clover	1.6	551	699	2.60	237
Fescue-La-S_1 clover	1.6	547	667	2.12	193
Winter					
Rye-Crimson clover	1.2	656	925	1.92	322
Rye-arrowleaf clover	1.2	642	898	1.82	306
Rye-Crimson (Coastal sod)	.8	701	1076	2.68	300
Rye-Crimson (Tifton-44 sod)	.8	693	986	2.10	235
Spring					
Fescue-Tillman clover	1.6	901	1085	2.22	295
Fescue-red clover	1.6	937	1129	2.30	306
Fescue-Tillman and red clover	1.6	960	1147	2.26	299
Fescue-La-S_1 clover	1.6	932	1103	2.06	274
Summer[a]					
Tifleaf millet	1.6	1000	1119	1.40	126
Sorghum-sudangrass	1.6	1040	1079	1.41	139
Coastal	1.6	1058	1142	1.00	134
Tifton-44	1.6	1032	1132	1.18	159

[a]Initial weight on summer grazing systems was affected by the lower weight of grazer animals.

SELECTION FOR STRESS TOLERANCE AND AVOIDANCE IN FORAGES

C. R. Tischler[1/]

"Forages" is a broad term, which includes monocotyledonous and dicotyledonous, annual and perennial, and cool- and warm-season plants. In discussing screening and selection techniques for forages, some techniques may not apply to a given species. However, I have attempted to list only those techniques and procedures that have broad applicability. Because literature regarding stress tolerance and avoidance is extensive, I have included only the more recent literature, and have tried to emphasize items of more practical interest to forage workers. This is not intended to be an all-inclusive review of the topic.

The ideal way to select desirable forage plants is to plant germplasm representative of a species at a number of locations, and measure yield, quality, persistence, etc. The goal of many breeding plant and selection programs is to utilize laboratory or greenhouse techniques to obtain the desired information, because the resources required to establish, maintain, and sample large, multi-location field nurseries are not available. To be useful, screening and selection techniques must allow rapid screening of a large number of genotypes at a minimum cost, and most importantly, the laboratory performance must be correlated with performance in the field. The following discussion will vividly illustrate that in many cases, correlation of laboratory results with actual field performance is often the missing link.

DROUGHT VS. HEAT EFFECTS

Drought and heat effects on plants are difficult to separate under field conditions. For warm-season plants, leaves of drought-stressed plants are subjected to high temperatures during the day because of drought-related changes in leaf energy balance. Conversely, leaves of well-watered plants are normally several degrees cooler than air temperature, demonstrating that maximum exposure to stressful temperatures is encountered only under conditions of limited water availability (Clarke and McCaig, 1982). The two topics will be dealt with separately in the following discussion, but the reader is warned that this separation is, in many cases, artificial.

HEAT TOLERANCE

Chlorophyll Fluorescence

In the past several years, the phenomena of chlorophyll fluorescence (photosystem II) has been described and implicated as a probe of chloroplast function and damage induced by various types of stresses (Papageorgiou, 1975). These include heat stress (Smillie and Gibbons, 1981), frost stress (Sundbom, 1982), chilling stress (Hetherington et al., 1983), and salt stress (Smillie and Nott, 1982). Chlorophyll fluorescence measurements are attractive for screening and selection work because large numbers of samples can be run in minimum time. A commercially-available fluorometer is on the market, and data acquisition systems to simplify data collection and analysis have been developed (Norrish, 1983). I have found that several problems are inherent with the use of chlorophyll fluorescense to assess heat tolerance. Extensive leaf-to=leaf variability in fluorescence parameters is observed, thus requiring added replication. Because fluorescence values vary as to position on the same leaf, leaves must be immobilized, and pre- and postheat treatment fluorescence measurements must be made on exactly the same location on the leaf. Also, response of fluorescence parameters to increasing temperatures is not linear. For example, we have found that dallisgrass leaves demonstrate heat-induced damage following heat treatment at 50°C (20 minutes), but this damage is not observed if the leaves are treated at 52°C. A primary problem with the technique is that fluorescence responses have not been correlated with field performance.

Membrane Thermostability (Solute Leakage Technique)

This is a classical technique used extensively to measure "temperature tolerance" and involves measuring the effect of heat on membrane permeability. An adequate treatment of the mechanics as well as problems and potentials of this technique is given by Martineau et al. (1979a) (also see references contained therein). In a subsequent paper, Martineau et al. (1979b) report the heritabilities for response in the test. In the 1979a paper, a negative correlation was observed between percent damage (following heat treatment) and soybean yield, suggesting the possible utility of this test. This technique is relatively easy to adapt to forages, and we have observed reproducible differences between various genotypes. Unfortunately, most papers describing results from solute leakage experiments do not describe the correlation of laboratory results with field performance.

Chlorophyll Stability Index

Apparently, this technique was first proposed by Kaloyeraes (1958). Like the Loch Ness monster, it makes periodic appearances in the literature. Forage workers should be aware that it is not a new procedure, and is probably of limited usefulness, because the temperatures employed are higher than a plant would normally experience. The procedure involves heat treating leaf disks, extracting chlorophyll, and comparing the chlorophyll content from the treated samples with the chlorophyll content of parallel samples which did not receive a heat treatment.

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Survival of Tillers

In a classical paper, Julander (1945) described a straightforward method for assessing heat tolerance of grasses. Plants were rolled in moist paper towels, placed in stoppered glass tubes, and subsequently placed in a water bath (48°C) for various periods of time. Following treatment, the plants were transplanted in the greenhouse and allowed to grow four weeks. Survival and growth were subsequently measured. While this technique violates the cardinal rules of screening methodology (time consuming, limited numbers of samples, not based on a specific molecular or cellular response), it is one of the few examples of heat tolerance being determined on the basis of plant survival.

Comparisons of Techniques

A void in basic knowledge exists in regard to our understanding of heat stress. We do not know the initial site of cellular damage resulting from heat stress. Obviously, heat can damage both the plasma membrane (measured by solute leakage) as well as the chloroplast membrane, antenna pigments of photosystem II, and electron transport proteins of both photosystems (determined by fluorescence). The questions are a) which types of damage occur at the lowest temperatures, and b) which types of damage are most devastating to the plant (not the enzyme, organelle, cell, or tissue)? The direct approach of Julander offers a method to assess the value of the various "sophisticated" methods of determining heat tolerance. We propose to compare results of the solute leakage technique and the fluorescence technique with actual survival of heat treated plants. If results from either or both "sophisticated" techniques are not correlated with plant survival, this offers a unique opportunity to "free up" lab space by throwing the appropriate instrumentation out the window.

DROUGHT RESISTANCE

Using the generally accepted terminology, drought resistance is divided into two components, drought avoidance and drought tolerance. In simple terms, drought avoidance mechanisms serve to maintain a favorable water content in the plant tissues, while drought tolerance mechanisms allow the cytoplasm to survive partial desiccation. Although they will be discussed separately, aspects of both topics are treated by Neal Wright and L.J. Streetman (1960) in a comprehensive bulletin entitled "Grass Improvement for the Southwest Relative to Drought Evaluation." Although terminology and methodologies have changed (in some cases several times) during the intervening years, the statement that "...Isolation of a specific characteristic as an accurate measure of drought tolerance has not been reported..." is as valid today as in 1960.

DROUGHT TOLERANCE

Desiccation Tolerance

If we make the assumption that drought stress results in desiccation of plant tissues (ignoring possible concomitant heat stresses), then desiccation tolerance should be a desired characteristic to pursue in a screening system. The topic of desiccation tolerance has been reviewed by Bewley (1979), who cites various types of desiccation-induced cellular damage. This review offers little practical information for the agronomist, because it is primarily descriptive. It is sufficient for us to realize that desiccation does cause cellular damage. As an example, Mohanty and Boyer (1976) observed damage in terms of reduced photosynthesis (CO_2 uptake) in both intact leaves and in isolated chloroplasts following desiccation.

Blum and Ebercon (1981) describe the application of the classical polyethylene glycol desiccation test to wheat leaves (other pertinent references are cited in this paper). Expectedly, "...The effect of growth stage on drought tolerance... was prominent...," with younger leaves exhibiting a greater tolerance. Since this test also is based on cellular damage measured by membrane leakage, one would hypothesize that results of the heat tolerance (solute leakage) and desiccation tolerance test should be correlated. However, this is not the case (Blum and Ebercon, 1981; Trapani and Gentinetta, 1984), and I am suspicious of whether both tests are valid.

Osmotic Adjustment

For several years, osmotic adjustment (and its regulation) has been advocated as a possible parameter to select for, with the goal of improving drought tolerance. This topic is probably of limited interest to agronomists because of the difficulty of making the measurements, and the conflicting reports of the best methods to make the measurements. Also, as a word of caution, I cite the work of Quisenberry et al. (1984) who state "...if selection pressure is directed towards enhancing osmotic adjustment under water stress, a reduced growth potential may result..."

Cellular Antioxidant Systems

John Burke, a USDA Plant Physiologist at Lubbock, Texas, is pursuing an interesting hypothesis. For various complex reasons, desiccation can result in damage to the cell because of lipid peroxidation and oxidation of other cellular components. To avoid these types of damage, the plant needs to maintain an adequate level of reducing compounds. Thus, in theory, screening for high levels of the enzymes that synthesize these reducing compounds should improve drought tolerance. Preliminary results of stress effects on the enzyme glutathione reductase have been published (Gamble and Burke, 1984). While still in the experimental stages, this concept could

potentially develop into a useful screening technique. Burke has also devised a first approximation field screening technique, whereby a dilution series of paraquat concentrations are applied to a leaf. Genotypes with highest levels of antioxidants tolerate higher levels of paraquat.

Techniques Utilizing Leaves or Whole Plants

A very enlightening paper by O'Toole et al. (1984) compared eight plant parameters (leaf water potential, leave diffusive resistance, transpiration rate, photosynthesis rate, canopy temperature, canopy minus air temperature, crop water stress index, and leaf rolling score) which have been suggested as measures of stress in plants. They provide an adequate treatment of all the techniques; I will not comment further on them.

Greenhouse, Growth Chamber, or Rainout Shelter Screening Techniques

While working with whole plants may violate the spirit of what we envision as a good screening system, this approach usually gives the most direct answers. Wright was an early advocate of growth chamber screening for drought tolerance (Wright, 1961). A pertinent question to be asked is what the forage researcher should select for. Voluminous literature indicates that the genotype which produces the most forage under moderate to mild stress is not the genotype that will survive if all genotypes are stressed to the point of death. This topic must be addressed by the individual for his or her particular situation. A common pitfall to researchers conducting controlled environmental stress studies is to plant genotypes in individual or separate containers. Invariably, differences in growth rates exist between the genotypes. When moisture is withheld, those genotypes with the greatest leaf area deplete their ration of soil water at a faster rate. All else being equal, if stress is maintained for a given number of days, the most vigorous genotypes are the ones that the screening system will reject. Our early experiences with "individual pot" stress experiments were of this type. Later we adopted a soil tray system (Tischler et al., 1984) in which all genotypes are planted in each of several soil trays. By interplanting entries, all genotypes are exposed to the same soil moisture conditions for the duration of the experiment. We obtained very consistent results using this technique.

The line source sprinkler offers another method of selecting for stress tolerance (Johnson et al., 1982), but this technique relies on "individual pot" plant culture, and stress experiments "to the death" face the peril described above. However, under moderate stress levels, many useful types of information can be obtained using this technique (Rumbaugh et al., 1983).

DROUGTH AVOIDANCE

Roots

A large body of literature has developed relative to screening for root growth and activity. An aging but useful summary of much of this work is Annotated Bibliography No. SK1854, "Methods of Studying Root Systems (1950-1976)," prepared by the Commonwealth Bureau of Soils, Harpenden, England. Screening for root growth is very labor intensive. One must consider if selecting for overall field performance would give the same information. Also, a common short-coming in screening for root system growth is that the experiments are performed in a deep, friable soil media (to facilitate removal), and performance in claypan or poorly aeriated soils may be quite different. Another problem (at least in some climates) relates to the rate of use of soil water. A deep, diffuse root system can quickly utilize available water, so that the plant uses all of the available water during a prolonged drought. Under these conditions, a less extensive root system would ration water to the shoot, hopefully allowing some water to be transported to the shoot until the drought ends. A good discussion of this situation is presented by Meyer and Alston (1978).

Water Conservation in the Leaf

A heavy deposition of leaf epicuticular wax is reported to reduce cuticular transpiration in plants. Work by Bengtson et al. (1978) demonstrates this point.

Descriptive work by Hull et al. (1978) also illustrates possible benefits of heavy wax deposition. Using the colorimetric procedure of Ebercon et al. (1977) Jordan et al. (1984) demonstrated a good relationship between wax load and cuticular transpiration. We have determined wax levels in several lovegrasses, but have found little relationship between wax levels and leaf water loss, probably because even the low leaf wax lovegrasses have considerably more wax per unit leaf area than most field crops (O'Toole et al., 1983). Dallisgrass biotypes appear to have wax levels more in the range of field crops (Tischler and Burson, unpub. observ.). Given the simplicity and speed of the wax determination procedure, this technique could be a useful screening tool in forage species with inherently low wax levels.

A novel approach to quantifying water retention in drying leaves was presented by Quisenberry et al. (1982). The transpiration decline curves developed by these authors may allow a simple determination of the ability of a leaf to retain water. Similar types of observations have been made for wheat (Clarke and McCaig, 1982). However, our experience has been that grass leaves (especially lovegrasses) exhibit differential rolling as drying proceeds, and this can be a confounding factor.

Leaf Rolling

As has been previously mentioned, leaf rolling can be a water conserving mechanism. A recent report (Renard et al., 1983) supports this assertion for tall fescue. Passing mention should be made of other types of leaf movements and their possible benefit. Ludlow and Bjorkman (1984) describe experiments that indicate paraheliotropic leaf movements in Siratro are a protective mechanism that prevents damage to the photosynthetic mechanism when the plant is under severe water stress.

CONCLUSIONS

A common theme appears to underline all the reports I have cited. Many techniques are proposed as being useful for screening and selection, but the techniques are often not validated by concurrent field testing of the purported superior germplasm. A more logical approach would be to perform the techniques on a range of germplasm which is known to differ in heat or drought tolerance. Also, there is a problem in selecting for stress tolerance. An old rule of thumb (especially for field crops) is that selection for performance under severe stress will yield genotypes whose performance under good conditions is below average. We have seen examples of this in our stress experimentation. Once again, the forage researcher must make the final decision about which considerations are most important for his particular situation.

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AUBURN UNIVERSITY FESCUE TOXICITY DIAGNOSTIC CENTER

Donald M. Ball[1], Richard A. Shelby[2], and Larry Dalrymple[2]

Tall fescue is one of the most important and widely-grown forage crops in the United States. It has been estimated that there are presently some 35 million acres of this cool season perennial forage grass within the nation.

Although the species offers many advantages, animal response to fescue has been a mystery. While laboratory analyses indicate reasonably good forage quality, the weight gains of animals grazing fescue has typically been poorer than these obtained from other perennial forage grasses. Symptoms associated with this lowered performance include: a rough hair coat, excessive salivation, low heat tolerance, lowered milk production, and an elevated body temperature. This problem, observed widely in areas in which fescue is grown, is referred to as "summer syndrome," "summer slump," "fescue toxicosis," or simply "fescue toxicity."

Research at several universities, including Auburn University, has correlated the presence of a fungus, Acremonium coenophialum, with the reduced performance of animals grazing fescue, and the fescue toxicity syndrome in general. Unlike most fungi, this organism is an endophyte which seems to affect neither the growth nor the outward appearance of the grass. Research has shown conclusively that the fungus is transmitted through the seed. In fact, this is apparently the only means by which the fungus spreads. Pasture surveys in several states where fescue is grown have revealed that a high percentage of existing pastures are infected with the fungus. Since the level of infection is apparently directly correlated with the extent of damage, pastures which are heavily infected produce inferior animal performance compared with others which have lower levels of infection or no infection. In some cases, beef cattle gains on fungus-free fescue have been 50 to 100 percent better than those by animals grazing fungus-infected pastures.

The difference in value of beef production can amount to $75 per acre, per year. Even if a group of animals grazing fescue look relatively good, the fungus may be keeping gains at a lower level than they would otherwise be. Therefore, if a livestock producer has existing fescue pastures, it would be very beneficial to him to know if they are infected and, if so, to what extent.

The fungus may also be involved in the problem known as "fescue foot," in which cattle develop a gangrenous condition of their feet, or sometimes lose portions of their ears and/or tails. Furthermore it is suspected to be involved in causing reproductive problems with horses. It is a common occurrence for mares on fescue to abort, produce stillborn foals, or produce an inadequate quantity of milk for their foals (agalactia). The only way to determine the infection level of an existing pasture is through laboratory analysis of a plant tissue sample.

In view of these problems or potential problems, when new pastures or hayfields are planted or when old ones are replanted, it is of great importance to use seed which are known to be fungus-free, or which at least have a low level of infection. This information can be important to both livestock producers and seedsmen. As with pastures, the only way to know the level of infection of a seed lot is to have it tested in a laboratory. Obviously, livestock producers and seedsmen need a means of checking whether their fescue pastures or fescue seed contain this fungus.

In response to this need, and as a service to livestock producers and seedsmen, Auburn University has established a special laboratory on the Auburn University campus. This facility, called the Auburn University Fescue Diagnostic Center, was the first of its type in the world.

The Diagnostic Center was opened to the public on June 1, 1983, and the response has been tremendous. Since that time, an average of almost 170 samples per month have been tested for the fungus. Table 1 provides, by state, a summary of the average percent fungus infection in producer submitted plant seed samples submitted between June 1, 1983 and May 1, 1985.

The average producer-submitted plant sample tested has had a 67% level of infection. However, the range has varied from 0% to 100%, thus emphasizing the value of testing.

There seems to be a linear response to the presence of the fungus; as the fungus level goes up, animal gains go down. It is impossible to state at exactly what level of infection the fungus becomes of significant economic importance. However, data obtained to date seem to indicate that when the fungus level is less than 20% the damage potential is low, when it is between 20 and 40% there is some damage potential, and that when it is more than 40% the damage potential is high.

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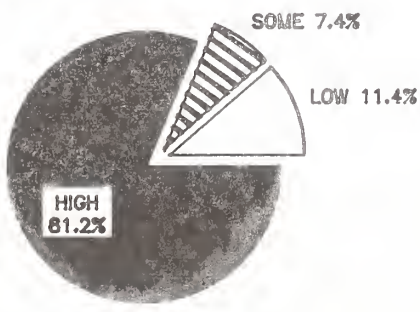
Table 1. Summary By States Of The Results Of Producer-Originated Samples Submitted To The Auburn University Fescue Diagnostic Center, 6/1/83 to 5/1/85.

	PLANT		SEED		TOTAL	
STATE	NO	PCT	NO	PCT	NO	PCT
AL	238	73	206	58	444	66
AR	41	84	10	51	51	77
CA	2	2	4	26	6	18
GA	28	82	19	67	47	76
IL	27	58	-	-	27	58
IN	11	35	7	27	18	32
KS	33	59	8	39	41	55
KY	21	46	4	29	25	44
LA	10	77	-	-	10	77
MD	3	54	7	71	10	66
MO	40	68	260	63	300	64
MN	-	-	1	0	1	0
MS	80	80	15	64	95	77
NC	268	64	7	69	275	64
NM	3	37	-	-	3	37
NY	-	-	1	0	1	0
OH	27	52	-	-	27	52
OK	6	90	23	70	29	74
OR	-	-	47	17	47	17
SC	183	69	5	30	188	68
TN	30	73	11	44	41	65
TX	3	80	-	-	3	80
UT	1	0	-	-	1	0
VA	87	69	15	60	102	68
WA	2	25	-	-	2	25
WV	2	82	-	-	2	82
		FOREIGN COUNTRIES				
ARG	65	38	-	-	65	38
ARG	-	-	1	-	1	0
TOTAL	1211	67	651	56	1862	63

Figure 1 shows the percentage of producer plant samples received which fall in these three categories. This dramatically illustrates the fact that the majority of existing fescue pastures are highly infected and, thus, implies that most producers are not obtaining the animal performance which they might otherwise obtain.

FIG. 1. PERCENT OF SAMPLES IN DAMAGE POTENTIAL CATEGORIES



LOW = 0 - 19% INFESTATION; SOME = 20 - 39%; HIGH = 40 - 100%

There are two tests available through the Fescue Diagnostic Center. The stain test involves taking a thin slice of recently-harvested seed or plant tissue, using a staining agent, and preparing a slide for examination under a microscope. This test can be used on either seed or fresh plant tissue.

The other test offered is referred to as the growout test and is used only on old seed. The growout process is needed to determine the live fungus status of carryover seed. It involves planting seed and establishing plants in a greenhouse. When the fescue seedlings are about two months old, the staining test is used to analyze for the fungus. The growout test is offered for use on old seed because a simple stain test only detects the presence of the fungus and not whether it's alive or dead.

Auburn University research has shown that under normal storage conditions, the fungus usually dies after about one year. Therefore, the stain test, which only detects the presence of the fungus, is not suitable for old seed. This is why the growout test is needed for carryover seed.

Obviously, many people have a need to sample pastures or seed lots. The next question is, "How should this be done?"

In order to obtain a plant tissue sample for the purpose of determining the fungus level in an established field, we recommend that several tillers be taken from different plants within each acre of fescue and that one sample represent no more than 30 acres. If various portions of a field were established with seed from different sources, they should be sampled separately.

One sample should actually consist of around 60 tillers, each coming from different plants selected at random. The first step in collecting a sample is to select a vigorous green fescue tiller. The tiller should be cut off at, or slightly below, the soil level. The top portion can be trimmed off at a point 3 to 5 inches above the point where it was originally cut. Roots and soil should be removed. This process of random selection of tillers should then be repeated until a total of 60 have been collected from the field.

For plant tissue samples, the ideal packaging method is to place the tillers in a slightly dampened paper towel, and seal them in a plastic bag. A sample submission form, available from the Diagnostic Center, should be completed and included. The sample should then be mailed via first class mail to the Diagnostic Center.

A fescue seed producer, or someone who is interested in buying or selling fescue seed may also want to know the level of fungus in a particular batch of seed or seed lot. If so, he can submit a seed sample for analysis.

If the seed to be tested is in bags, the best way to obtain a sample is to take small amounts of seed from the first five bags in a lot, plus small amounts from 10% of the remaining bags. A single seed sample should represent no more than 30 bags of seed. It's important to obtain a random sample containing seed from many different plants.

The seed should be mixed together and then not more than 2 ounces should be taken from the mixture to be mailed to the Fescue Diagnostic Center for analysis. Fifty or more individual seed will then be checked for the fungus. As with plant tissue samples, a sample submission form should accompany each sample. These are available free of charge from the Center. The address is: Fescue Diagnostic Center, Plant Disease Laboratory, Auburn University, AL 36849.

Current fees for analyzing samples are provided in Table 2. Fee levels are aimed only at covering the cost of analyses, not at making a profit. A higher charge is made for out-of-state samples because Alabama producers helped finance establishment of the Diagnostic Center. A check for the appropriate amount should be enclosed with any samples submitted.

Table 2. Fees For Fescue Fungus Diagnostic Tests

Type of Test	Alabama	Out-Of-State
Stain Test	$15.00	$25.00
Growout Test	$20.00	$30.00

(subject to change in 1986)

As soon as the results from an analysis of plant tissue or seed samples are available, they are reported to the person who submitted the sample. In addition to providing a report as to the percent of fungus infestation of the samples submitted, advice regarding the pasture or seed in question is provided based on the best information available.

The Auburn University Fescue Toxicity Diagnostic Center is a joint project of the Alabama Agricultural Experiment Station and the Alabama Cooperative Extension Service. It is operated as a service to livestock producers and seedsmen who wish to determine the approximate levels of *Acremonium coenophialum* infections in fescue seed or pastures. We believe this is a valuable service which can assist many producers in greatly improving animal performance from their fescue acreage.

A LOOK AT THE NEW BERMUDAS

Wade F. Faw[1]

Bermudagrass has been grown in the United States at least since the middle of the 18th century when its introduction to Georgia was recorded. Although long regarded as a weed by early crop farmers, its importance as a pasture and forage grass is no longer disputed.

Its primary area of adaptation in the United States is south of a line from Virginia to Southern Kansas. It is also grown in the Southwest wherever adequate moisture is available. In its area of production, bermudagrass is a highly productive warm season perennial grass. Its growing season is generally from March or April until autumn frosts. In Louisiana, peak growth rates are usually produced during May through August.

One of the inherent limitations of bermudagrass has been its relatively low quality compared to some temperate annual and perennial forages. A major objective of breeding programs with bermudagrass has been to improve quality in lines with suitable winter hardiness.

BERMUDAGRASS CULTIVARS IMPORTANT IN THE UNITED STATES

Several of the important bermudagrass cultivars should not be considered new as they have been available to growers for many years. Among this group is Common which is the naturally occurring bermudagrass. Coastal was the first improved hybrid and was released in 1943 by the Georgia Agricultural Experiment Station and the USDA-ARS. Other hybrids developed from that program include Midland jointly released with the Oklahoma Agricultural Experiment Station in 1953, Suwanee released in 1962, Coastcross-1 released in 1967 and Tifton 44 released in 1978. Alicia is a farmer selection released by the Cecil Greer Grass Farms of Edna, Texas in 1967. Pasta Rico is not a hybrid but is a seed blend offered for sale by the Northrup King and Co. Hardie and Oklan are hybrids released by the Oklahoma Agricultural Experiment Station in 1974. Callie was released by Mississippi State University in 1974.

This group of bermudagrasses will not be discussed in detail but in some instances will be referred to for comparison.

The group of bermudagrass cultivars that I have chosen to describe in some detail consists primarily of several hybrids developed in the breeding programs at Oklahoma State University and at the Georgia Coastal Plain Experiment Station during the last few years. Among those are Guymon from the Oklahoma program, Tifton 68, and Tifton 78 from the Georgia program. Additionally, Brazos, which was jointly released in several states, originated in the Oklahoma program and Grazer originated in the Georgia program. Lancaster is a farmer selection made by M.W. Lancaster of Rienzi, Mississippi.

CULTIVAR DESCRIPTIONS

The following descriptive information comes primarily from the descriptions used in release statements and registrations of the cultivars. The sources of production data are indicated.

Brazos Bermudagrass: Brazos is an F_1 hybrid of plants from Africa. It was released in 1982 by the Agricultural Experiment Stations of Oklahoma, Louisiana, Texas, and USDA-ARS and SCS (Eichhorn *et al*. 1984).

Compared to Coastal, Brazos has larger stems, rhizomes, and leaves, is faster spreading on heavy textured soils, slower curing for hay, has earlier spring growth, is more productive on heavy textured soils along the Gulf Coast (Tables 1,2), is more digestible (IVDMD), and is slightly more winter hardy. In Oklahoma, it has yielded less than Coastal [(7721 lb/A dry matter vs 11,217 lb/A for Coastal in two years) (Bates 1983)]. Differences in digestibility have ranged from 1 percentage point up to 5 percentage points better for Brazos (Tables 3,4). It is recommended in Louisiana.

Guymon Bermudagrass: Guymon is a synthetic cultivar from two parental lines - one from Yugoslavia, the other collected near Guymon Oklahoma (Taliaferro *et at*. 1983). It was released in 1982 by the Oklahoma Agricultural Experiment Station and the USDA-ARS. It is seed propagated. Compared to Common of Arizona or California origin, it is more winter hardy, has darker green foliage, wider leaves, larger stems, stouter racemes, and larger florets. It has yielded 25 to 40% less than Midland in Oklahoma (Taliaferro *et al*. 1983). In Arkansas, it has outyielded Common by about 400 lb/A dry matter (Hankins 1985). It is not recommended for planting in Louisiana.

Tifton 68 Bermudagrass: Tifton 68 is a fertile F_1 hybrid of two plant introductions selected for high digestibility (Burton and Monson 1984 a). It was released in 1984 by the Georgia Agricultural Experiment Station and the USDA-ARS. Tifton 68 is a giant type bermudagrass with large stems, long stolons, and no rhizomes. It spreads fast and has higher yields and digestibility (IVDMD) than Coastal. It has little freezing tolerance. It is not recommended for planting in Louisiana.

Tifton 78 Bermudagrass: Tifton 78 is a sterile F_1 hybrid from a cross of Tifton 44 and Callie bermudagrass (Burton and Monson 1984 b). It was released by the Georgia Agricultural Experiment Station and USDA-ARS in 1984.

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Table 3. Performance of bermudagrass cultivars at Homer Louisiana*

Cultivar	Dry Yield (t/a) 1975-77	% Of Coastal	IVDMD 1975-77	Different From Coastal
Hardie	8.10	82	56.9	+2.6
Oklan	8.31	84	56.0	+1.7
Tifton 44	9.93	101	55.3	+1.0
Brazos	9.33	95	56.2	+1.9
Grazer	7.49	76	59.1	+4.8
Coastal	9.83	100	54.3	0.0

*Yearly Fertilization was 500-150-300-90 lb/A ($N-P_2O_5-K_2O-S$) from La. Agricultural Experiment Station Bulletin No. 763.

Table 4. Dry matter digestibility (IVDMD %) of Brazos and Coastal bermudagrass in Texas*

Location	Years	Coastal	Brazos
Dallas	1978	54	56
College Sta.	1974-75	53	55
College Sta.	1980-81	50	55
Stephenville	1975-76	60	61
Chill.-Vernon	1975-76	55	59
Beeville	1975	58	62

*Texas Agricultural Experiment Station Publication L-2068.

Compared to Coastal, Tifton 78 is taller, spreads faster, establishes easier, has earlier spring growth, is higher yielding [(10,808 lb/A dry matter vs 8,624 lb/A for Coastal as a three year average) (Burton and Monson 1984 b)], and more digestible [(IVDMD of 57.6 vs 53.6 for Tifton 78 and Coastal respectively) (Burton and Monson 1984 b). Grazing results indicated a 30% increase in steer days per acre, a 36% increase in gains per acre, and a 13% increase in ADG when compared to Coastal (Burton and Monson 1984 b). Its Northern limits are undetermined but it is believed to have good winter hardiness. It has not been tested in Louisiana.

Lancaster Bermudagrass: Lancaster was selected by M.W. Lancaster of Rienzi, Mississippi and described in "Progressive Farmer", January, 1985. No published research evaluations are available and almost nothing is known about it.

Grazer Bermudagrass: Grazer is an F_1 hybrid of plants from Kenya and Italy (Burton et al. 1985). It was tested as Tifton 72-84, Georgia 72-84 and Tifton 84. Release is planned in 1985 by the Louisiana Agricultural Experiment Station in cooperation with others yet to be announced.

Compared to Coastal, Grazer has equal winter hardiness, persistence, and drought and disease tolerance, it establishes more rapidly, forms a shorter, more dense sod of darker color, and produces fewer rhizomes. Hay yields have been lower (Tables 1,3) but animal gains per acre have been equal ([(1192 lb/A vs 1136 lb/A for Grazer and Coastal respectively) (Eichhorn 1984)]. Digestibility is higher [(IVDMD of 65.2 for Grazer and 58.6 for Coastal in Georgia) (Monson and Burton 1982)], and average daily gains of grazing animals have been slightly higher for Grazer [(1.93 vs 1.85 for Grazer and Coastal respectively) (Eichhorn 1984)].

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Table 1. Forage yields of bermudagrass hybrids on a silty clay loam soil, Jeanerette, La. 1981-82

Cultivar	Dry Weight T/A	% Of Common
Brazos	13.35	171
Callie	11.68	150
Alicia	11.01	142
Coastal	10.00	129
Grazer	8.49	109
Tifton 44	8.43	108
Common	7.77	100

Source: La. Agricultural Experiment Station Bulletin No. 763.

Table 2. Brazos and Coastal bermudagrass yields in Texas (dry tons/acre)*

Location	Years	Coastal	Brazos
Dallas	1973-76	5.8	6.2
Dallas	1977-78	2.4	2.2
College Sta.	1974-75	10.8	10.7
McGregor	1974	4.9	5.1
Stephenville	1976-79	4.6	3.8
Chill.-Vernon	1975-76	3.4	2.7
Overton	3 yr. avg.	4.4	3.7

*Texas Agricultural Experiment Station Publication L-2068.

USE OF COMPUTER PROGRAMS TO CREATE FORAGE/ LIVESTOCK SCENARIOS

Nicholas S. Hill[1] and Gerry L. Posler[2]

INTRODUCTION

As forage specialist, one of the most frequent and difficult questions to answer that producers ask is, "How can I improve my forage systems to make fresh forage available on a year around basis". Of course, we all know the producer will experience "peaks and valleys" of forage production and a constant flow of fresh, quality forage is not likely to occur. The best we can do with our present knowledge of forage species available for use is to minimize the "peak and valley" effects. To properly address the question a complete farm tour is needed to obtain an inventory of pasture acreages and species, size, number and type of cattle, when they calf, are weaned and sold. Farmers who have one operation, say cow/calf or stocker, can rely on relatively simple forage systems to maximize the use of the animal to graze and harvest the available forage for them. More complex operations, where the farmer is continually buying and selling cattle, require more sophisticated analytical techniques to develop a recommended forage system.

Many times the problems that the producers confront are simple. Pastures are frequently under or over utilized or a particular pasture species is relied on too heavily and the constancy of available fresh forage interupted during various periods during the year. Although farmers may be attentive during the farm visit when a recommendation is made, a hard copy of the recommendation and how it will affect his/her forage production is not always presented and communication between specialist - county agent - farmer breaks down. Although the recommendations made are considered sound, the complexity of the given situation often inundates the producer which may discourage use of the recommendations presented.

To make a hard copy, the specialist or county agent must evaluate yield potential and distribution of forage production of all forage resources, as well as nutritional requirements of the various classes of animals for all stages of development. From this information one can calculate forage production and utilization on a weekly, monthly or seasonal basis. This practice is an extremely time consuming and laborious task which is subject to error based upon the number of incorrect entries made into the pocket calculator. With increasing occurance of computers in extension specialist's, county agent's and farm manager's offices the use of computer programs to simplify and hasten information output is inevitable. The objective of this presentation is to describe a program which can be used to provide hard copies of recommendations to the farmer for implementation.

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Building the Program

A forage/livestock program was developed at Kansas State University (Posler et. al. 1981) which calculates forage production and utilization as animal units on a monthly basis (AUM's). The program uses arrays of data for any number of forage species and through production curves allocates proportional quantities of the total yield to each month. Forage production data has been obtained from grazing experiments, species evaluation tests, variety trials, fertility and management studies to provide estimates of farm production in South Carolina. The data is set up in sub - arrays so that low medium and high productivity levels can be inputted to help fine tune the system analysis for particular farm situations.

The key to obtaining reasonably accurate estimates of forage production and distribution of growth is to input reliable information which describes production potential over wide regions. However, forage species and productivity are variable within as well as between state lines. Therefore the operator must change the forage program or add to the species list to accomodate local forage species, production curves and yield. This may require dividing the state into geographic or geophysical regions and developing a program for each.

The animal component used for the program is adapted from theoretical nutritional requirements prepared by the National Academy of Science (1976). All animal requirement data is converted to animal unit months for a 1000 pound. The computer utilizes calf crop percentages inputted during program use and automatically culls open cows, saves replacement heifers, and weans calves at 7 months. Calves kept longer than 12 months must be re-entered for the computer to assign their requirements. Extra replacement heifers or stocker steers can be added to the cattle herd by including their number, weight, month bought and month sold. The number of bulls are inputted with an estimate of mean weight. The computer calculates the forage requirements for all classes of animals based upon their stage of growth and categorizes them into monthly needs.

Running the Program

Now that we have an idea of how the computer program works, let's discuss what the operator sees as he/she is working on the computer. The computer first asks that the user identify the output with a volume and output number. Once entered the user is now into the farm data input section of the program. The computer first asks

the user to enter "Herd Names". The herd name is an identification of the class of animal present on the farm - cow, bull, steer, heifer. If the user selects "cow", the computer continues with a series of questions necessary to calculate forage requirements. They include the size of the cow herd, month at which birth occurs, percent calving, age sold (months), and extra replacement heifers in case the producer is in a herd building phase of his/her operation. Only two cow herds can be handled at one time so the program works best for producers who synchronize their cows to calve in a 60 day period.

Selection of steers or heifers as the herd name results in a series of questions describing the number, average herd weight (nearest 50 lbs.), the month in which they are started and when they are sold. Bull input information is the number and average weight.

Once the producer/county agent/specialist finish with the animal data, the computer presents the user with a list of forages from which he/she can select species for hay, pasture or silage to build a forage program. Our current list has 23 entries, but could be expanded to any number by changing the dimensions of the data arrays within the program. For each entry selected, the user is asked to rate the field for low, medium or high production and give the acreage within that field. After all forage data is entered the computer asks if changes are necessary which restarts the program from the beginning if an affirmative answer is given.

Upon correct entry of all farm data the user can generate outputs on the screen for viewing or on the printer for hardcopy and study. On either, the computer calculates and presents three spread sheets. The first expresses the monthly feed requirements for each class of animal within each month, gives the total monthly need for each month, and adds all the monthly needs together for a total yearly need (Table 1). The second spread sheet expresses forage production for each forage entry for each month, as well as monthly and yearly totals (Table 2). The final spread sheet gives the user a comparison between monthly needs and production, calculates surplusses and/or deficits for each month and for the year (Table 3). Knowing when surplusses and deficits occur during the year permit the producer to plan for increases or decreases of labor needs for harvesting or feeding conserved forages.

If the user wishes, he/she can study the hard copy and allocate acreages from one forage to another on paper in an attempt to minimize "peaks and valleys" of forage deficits and surplusses. By doing so the user then ascertains an approximation of best land utilization through species allocation to provide better constancy of fresh forage production to meet the livestock operation needs.

Uses and Limitations of Computer Programs

The computer program described in this paper does not account for adjustments to potential productivity through climatic variations or geographic differences. Instead it uses best available information from short and long term studies to predict forage availability for monthly time intervals. Therefore deviations from normal climatic conditions can result in over or underestimations of forage production. As a result, the farmer must be warned not to perceive the program output to be a precise estimation of forage production for any particular year. Undoubtedly the most important tool for this program is to demonstrate how a producer can change the constancy of forage production through allocation of pastures to various forage species. This is especially important in areas of the state where producers, out of tradition, rely too heavily on any one forage species. These are problematic areas because of firm beliefs that their existing forage programs are providing them with adequate and constant nutrition. Once the seed is planted, new ideas are formulated and the "what if" syndrome begins. At this time the specialist has the opportunity to stimulate creative thinking. With the computer, a specialist can more than describe "what if" circumstances to the farmer concerning forage related issues and rather than give an opinion, let the computer do the talking from hard copies of the output. When in groups the farmers may even break up into smaller discussion groups with the computer spread sheets to discuss alternative forage systems. Therefore, by "playing" the farmer learns more about forage species allocation to pastures and their effects on the forage/livestock system.

Not all producers are equally enlighting or rewarding to work with. As with many college students, graduate students and faculty, the majority of farm producers do not understand how computers operate or the limitations of computer programs. There seems to be an automatic distrust for the computer by producers who have no or limited knowledge with their use. They may possibly have a phobia about computers and through fear of becoming dependent upon them resist their acceptance. Under these circumstances it is particularly important to describe, as best possible, the logic by which the computer generates the output. In addition to describing what the computer is going to do, explaining the logic of the computer to the user "humanizes" the machine and promotes confidence in the user. The program is fairly user friendly and by sitting with a new user and "walking through" the program several times, confidence is established and acceptance of the new technology delivery system is gained. However, the specialist must continually remind the user to be cautious of using the generated output as a guarantee of forage production and communicate that its best use is to demonstrate a concept rather than generate accurate production figures.

Table 1. Forage requirements for a livestock operation given by animal class (monthly), total monthly and yearly needs.

Animal Forage Feed Requirements (in aums)

HERD SIZE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
25 COWS*	32.50	32.50	32.50	37.50	45.00	45.00	45.00	21.25	21.25	19.13	19.13	17.00
21 CALVES	2.13	2.13	2.13	6.38	6.38	8.50	10.63	0.00	0.00	0.00	0.00	0.00
11 STEER CALVES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 HEIFER CALVES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9 REP HF CALVES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.56	7.00	7.00	7.44	7.88
9 REP HF YRLGS	8.75	9.63	9.63	9.63	9.63	9.63	9.63	4.13	4.13	3.38	3.00	2.63
15 FDR. STEERS	17.25	18.00	18.75	19.50	19.50	19.50	0.00	0.00	0.00	14.25	15.38	16.50
TOTAL MONTHLY NEED	60.63	62.25	63.00	73.00	80.50	82.63	65.25	31.94	32.38	43.75	44.94	44.00

YEAR TOTAL 684.25

* CALVES ARE WEANED AT 7 MONTHS. COWS AND REPLACEMENT HEIFERS ARE ALSO CULLED AT THIS TIME

85 % CALVING
BORN - JAN SOLD - JUL

Table 2. Forage production for a pasture/hay system given by field (monthly), total monthly and yearly production potential.

Forage Production (in aums)

FORAGE TYPE AND FIELD DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TALL FESCUE/CLOVER (HAY) 65 ACRES AT MED.	8.06	12.09	40.30	100.75	80.60	32.24	16.12	16.12	32.24	40.30	16.12	8.06
BERMUDAGRASS PASTURE 25 ACRES AT MED.	0.00	0.00	0.00	14.40	18.00	27.00	45.00	36.00	27.00	9.00	3.60	0.00
SUMMER ANNUALS (PASTURE) 15 ACRES AT MED.	0.00	0.00	0.00	0.00	2.21	6.30	9.45	7.87	4.73	0.94	0.00	0.00
RYE/CLOVER (PASTURE) 15 ACRES AT MED.	1.80	6.00	18.00	9.60	6.60	0.00	0.00	0.00	0.00	6.00	9.60	2.40
MO. FORG. AVAIL.	9.86	18.09	58.30	124.75	107.41	65.54	70.57	60.00	63.96	56.25	29.32	10.46
YEAR TOTAL	674.50											

The ultimate computer extension tool for forage/livestock systems is one which simulates forage production, utilization by livestock, their resulting performance combined with a report to give the farmer a predicted sale date for maximum economic return. Such models are in the developmental stages but are not likely to be available in the near future. Information from these more basic physiological and mathematical models help us to identify research areas to refine mathematical-logic relationships from which more accurate simulations and predictions can arise (Little 1985). In addition these models are so complex that micro or mini computers can not store enough information in their data banks to run the forage program. Until more simplified and accurate prediction models are developed, more simple and easy to use programs, such as the one here described, must substitute for farm systems planning. Possibly, the most important role these programs will perform is to introduce the producers to computers in preparation of more sophisticated software to come.

Table 3. Review of monthly and yearly totals with surplus/deficit classifications.

MONTH	ANIMAL NEED	AVAILABLE FORAGE	DEFICIT (aum)	SURPLUS (aum)
JAN	60.63	9.86	-50.77	-
FEB	62.25	18.09	-44.16	-
MAR	63.00	58.30	-4.70	-
APR	73.00	124.75	-	51.75
MAY	80.50	107.41	-	26.91
JUN	82.63	65.54	-17.09	-
JUL	65.25	70.57	-	5.32
AUG	31.94	60.00	-	28.06
SEP	32.38	63.96	-	31.59
OCT	43.75	56.25	-	12.49
NOV	44.94	29.32	-15.62	-
DEC	44.00	10.46	-33.54	-
TOTALS	684.25	674.50	-165.87	156.12
TOTAL DEFICIT/SURPLUS --}			-9.75	

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FORAGE CROP VARIETY RELEASE AND AGRICULTURAL EXPERIMENT STATION POLICIES

J. F. Pedersen[1]

The policies governing the release of genetically improved lines from public institutions have created much discussion in recent years. Debates continue over the appropriateness of public institutions releasing finished varieties, and the associated financial rewards that they may generate for public institutions. However, these arguments have usually concerned crops in general. This paper will deal with a much narrower topic, variety release of forage crops in the Southeastern U.S.

First, it is important to examine the involvement of private enterprise in this area. Table 1, adapted from Strosnider (1984), demonstrates that forage crop breeders are scarce in the private sector. Only 34 Ph.D. scientists from a total of 435 employed by the private sector are working in the area of forages. Most of these 34 are involved in alfalfa improvement. Eleven are involved in grass improvement, including turf which is regarded as receiving more emphasis than forage grasses (Zajac, 1984).

Table 1. Number of Ph.D. scientists involved in private plant breeding in 1982.[1]

Crop	Ph.D. Scientists[2]
Corn	155
Veg. & fruits	96
Soybeans	36
Wheat	23
Forage legumes (mainly alfalfa)	23
Grain sorghum	23
Cotton & fiber crops	17
Sunflowers	15
Sugar beets	14
Forage & turf grass	11
Barley, oats, rye tritacales, millet	7
Rice	7
Flowers-ornamentals	5
Safflower	2
Tobacco	1
Total	435

[1] Adapted from Strosnider (1984).
[2] Scientist/year equivalents

It is clear that relatively little effort is being spent by the private sector in the developement of improved forage crop varieties, with the exception of alfalfa. If this contribution is further diluted by dividing the U.S. into geographical regions, it is apparent that the private breeding effort directed specifically towards forage crop improvement in the Southeast is small.

Where then, do the forage varieties utilized by producers in the Southeast come from? Table 2 shows the forage crop variety recommendations for one Southern State, Alabama (Ball, et al, 1985), and their origin (CSSA, 1982) (private or public). Privately developed varieties of alfalfa, most small grains, and red clover are dominant. Although many ryegrass varieties have been made available in recent years, 'Gulf' and 'Marshal', both publicly developed varieties, make up most of Alabama's ryegrass acreage. Most clovers and perennial grasses recommended for use in Alabama originated from publicly supported programs.

Table 2. Auburn University 1985 forage crop variety recommendations and their origin[1].

Species	Variety development	
	Private	Public
Alfalfa	Apollo	Florida 77
	Cimarron	Liberty
	Gladiator	---
	Vanguard	---
	Weevilchek	---
	WL 311	---
Arrowleaf clover	---	Meechee
	---	Yuchi
Bahiagrass	---	Argentine
	---	Pensacola
Ball clover	---	Common
Barley	---	Barsoy
	---	Keowee
Bermudagrass	---	Coastal
	---	Midland
	---	Tifton 44
	---	Tifton 78
Crimson clover	---	Autauga
	---	Chief
	---	Dixie
	---	Talladega
	---	Tibbee
Fescue, tall	---	Kentucky 31
	---	AU Triumph
Lespedeza, serecia	---	Interstate
	---	Interstate 76
	---	Serala
	---	AU Lotan
Oats	Coker 227	---
	Coker 716	---
Orchardgrass	Crown	Boone
	Hallmark	Potomac
	Napier	---
Red clover	Florie	Kenstar
	Redland II	Orbit

[1] Dept. Agronomy and Soils, Auburn University, Ala. Agric. Exp. Sta., Auburn Univ., Ala. 36849

	Redman	---
Rye	AFC 20-20	---
	Forager	---
	Gurley's Grazer 2000	---
	Wintergrazer 70	---
Ryegrass	Penploid 4	Gulf
	Shannon	Marshal
	Tetrablend	---
	Urbana	---
Vetch	---	Cahaba white
	---	Vanguard
	---	Hairy
	---	Nova II
	---	Vantage
Wheat	Coker 68-15	Georgia 1123
	Coker 747	Omega 78
	Coker 762	Caldwell
	NK-McNair 1003	---
White clover	Nolin	Louisiana S-1
	Arcadia	Regal
	---	Tillman

[1] Adapted from Ball et al.(1985); CSSA Registered Field Crop Varieties: 1926-1981; and other sources.

Should public institutions in the Southeast be involved in forage crop variety production? Public Research Advisory Committee (PRAC) Sub-Committee on "Public Research Priorities" Preliminary Report to the American Seed Trade Association (ASTA) Executive Committee (May 1984) states that minimum government involvement includes "continued varietal development on those species that do not attract sufficient private investment for effective product development. This is true for most minor vegetable species and forages with the exception being alfalfa (PRAC, 1984). Based on this, and the information shown in tables 1 & 2, the answer to the above question is a clear yes. To quote Strosnider (1984) "Cultivar improvement must be done by public institutions for some crops, if it is to be done at all."

How then, should these new forage varieties be released? This is indeed a difficult question. The ASTA clearly opposes the general release of varieties on exclusive basis - particularly if royalties are involved (ASTA, 1982). However, they also state that "Exclusive or restricted release of varieties is acceptable in situations and to the extent that a general release will not protect integrity of the variety or ensure the availability of the variety on a continuing basis." Eberhart (1982), states that "Exclusive releases are probably appropriate, however, for a low volume (seed) situation. In these instances, however, it may make a difference between having an improved variety available to farmers on not."

In fact, most southern Agricultural Experiment Stations (AES) do have provisions for the exclusive release of some varieties (Table 3). All have provisions for open, or public, releases (Buchanan, 1984). It is this author's belief that this reflects the desire of most AES breeders and administrators to consider how each newly developed cultivar may best serve the public.

Table 3. Nature of plant variety releases in southern region state agricultural experiment stations[1]

State	Exclusive	Open	Other
Alabama	x	x	x
Arkansas		x	
Florida	x	x	x
Kentucky	x	x	x
Louisiana	x	x	
Mississippi	x	x	
N. Carolina	x[2]	x	x
Oklahoma	x	x	
S. Carolina	x[2]	x	
Tennessee		x	
Virginia		x	
Puerto Rico		x	

[1] Adapted from Buchanan (1984).
[2] Rarely exclusive release.

Two quotations will serve to summarize and conclude this paper. The first is drawn directly from the The Alabama Agricultural Experiment Station variety release policy (1981) and reflects, I'm sure, the general attitude of public breeding institutions: "The purpose of this release policy is to facilitate the orderly and equitable release of new germplasm from the research program of the AES. Improved plant material must be rapidly and widely used if it is to have its greatest impact on (Alabama) agriculture."

The second is drawn from the PRAC Sub-committee on Research Priorities report on a survey of ASTA members. In his report on Pasture, Forage, and Turf Grasses, Zajac (1984) states "The majority response favors Public sector involvement in basic areas of research not competing with industry .... However, all indicate general agreement with existing AES policy which, in the grass area, is varietal development and exclusive release on a royalty basis." Apparently, for forage breeding there is more cooperation than argument between the public and private sectors. Inputs including public variety developement of forages and private seed production and marketing will be needed to best serve our constituency.

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EXCLUSIVE VARIETY RELEASES

Foy Campbell[1]

Thank you very much, Mr. Chairman. I am honored to be invited to speak here on the subject of exclusive variety releases. I will use layman's terms in an attempt to anticipate, and hopefully answer, a wide range of questions about exclusive variety releases.

"Exclusive Variety Releases" conjures up, for some, the vision of a big fat seed company on the way to the bank with a big bag full of money. I'm sure that I don't have to explain to a learned group such as this that such a vision does not represent reality. In fact, a more realistic title for this presentation might be, "All That Glitters Is Not Gold."

I am aware that not everyone fully understands the concept of exclusive variety releases by our land grant universities. As a result of this, the subject is at times controversial. It is debated in different ways, depending on the group discussing the subject. Nevertheless, the concept of exclusive releases is fully supported by a wide range of knowledgeable people.

Others have been quite critical; even the American Seed Trade Association has at times been involved in the controversy, depending, I think, on certain constituency pressures at the time. Exclusive releases have been discussed and praised, as well as severely criticized at the highest levels of academia. The USDA-ARS has been involved, and to some degree, at times, caught in the middle of the debate.

Stating these observations frankly and openly, and knowing that my company is involved in the production and marketing of several exclusive variety releases, makes this a challenging assignment. However, I shall attempt to deal with it factually and objectively.

I hope that my personal comments and references to my company will not be misunderstood. I make these references only to illustrate, and because this is where my experience lies.

INSTITUTIONAL INVOLVEMENT

Some people apparently think institutions with exclusive release policies just crank out varieties and turn them over, pell-mell, to commercial seed companies. Nothing could be further from the truth. Research efforts in our land grant universities, State Agricultural Experiment Stations, and the Agricultural Research Service - USDA are primarily related to generating new scientific information and to developing and integrating new technology for agricultural production systems.

Even the universities having the exclusive release policies release varieties on a very selective basis. Such releases have been largely confined to forage crop varieties and some vegetable varieties of a somewhat specialized nature. Such varieties may be restricted in use due to limited adaptation and/or needs, may be quite difficult to produce, and in many instances, it may be necessary to produce the seed in some distant place other than where the end product is to be used. Exclusive licensing is sometimes necessary as an incentive to call forth the investment to produce and distribute adequate seed and plant materials on a continuing and dependable basis.

U. S. farmers have come to expect a steady flow of improved varieties of all economic crops. These have been significant elements in raising farm productivity, which, in turn, has moderated food price increases. Partly as a result of the enactment of the Plant Variety Protection Act in 1970, private breeders became increasingly engaged in the breeding of self-fertilized crops, where the final products were relatively true breeding varieties. Segments of the public sector are still deeply involved in the development of germ plasm and varieties in many of the major crops. Some of these developments come about as a by-product of other research efforts or, if as a specific objective, they are usually specialized crop varieties, or those with limited use as compared to some of the major crop species.

FUNK SEEDS' INVOLVEMENT

My company is presently involved in the production and marketing of several different crop varieties, which have been released on an exclusive basis. On behalf of Funk Seeds International, I express appreciation for the trust and confidence placed in our firm by the releasing institutions. Some of these varieties were previously released to other firms that were either unable to bring the varieties to commercial production and distribution levels, or for some other reason decided to drop the varieties; or the varieties were withdrawn by the institution and re-released.

PVP OBJECTIVES AND FORAGE VARIETY DEVELOPMENT

One of the stated purposes of the PVP Act was: "To encourage the development of novel varieties of sexually reproduced plants and to make them available to the public, providing protection to those who breed, develop or discover them, and thereby promoting progress in agriculture in the public interest." There is no doubt that the main purpose of PVP is being achieved. However, limited areas of

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adaptation and use of some of our forage species along with recent unfavorable economic conditions have discouraged efforts in this area by private breeders. As evidence, witness some of the recent changes by seed companies in the forage seed area, where programs have been dropped or directions changed. Continuation of some of these programs becomes a matter of limited profitability as compared to the high costs and risks involved.

LIMITED PROFITABILITY

Of this group, only one or two are just now beginning to be marginally profitable, while the others will be carried in our R&D program as long-term investments until they become profitable or we're forced to give up. Without exaggeration, some of these varieties may have several hundred thousand dollars invested in them by our company before a single bag is ever marketed. I suppose the logical question is, "Why in the world would a company in the business of making a profit do a thing like that?" A good question; you may not have even thought of raising the question before.

Number one, we have confidence in ourselves. Number two, we believe that ultimately most of these varieties can be turned into worthwhile ventures. And number three, in so doing, our company can make a significant contribution to southern agriculture.

FUNK SEEDS' RESEARCH COMMITMENT

Our company has major research efforts in hybrid corn, hybrid sorghum, cotton, and soybeans. Despite all of this activity and sizeable research investment, we have not chosen to set up research and breeding programs in the southern forage area, because they would compete with the university varieties, which we are working diligently to get in commercial production and market. This is the sort of philosophy that has evolved as we have become more involved in this exciting program.

OBJECTIVES OF EXCLUSIVE RELEASES

Let's review some of the objectives in considering exclusive releases. I do not propose to speak for the universities who have exclusive release policies nor against those without such policies. Although I've spent many hours discussing this subject with both administrators and scientists at numerous institutions, I do not recall that any have outlined all of their specific objectives. Most institutions require a detailed report by interested companies, including an outline of seed production experience, experience with certified seed production of the same crop species or similar crops, specific seed production plans, acreage anticipated, production anticipated, and so forth.

Usually, an overriding concern is the seed distribution system, marketing experience, and capability of the company making application. Most institutions are also keenly interested in the company's general promotional and dealer/customer service activities, including promotional literature, advertisements and services rendered. The releasing institution, administratively at least, has as a primary goal the best and most efficient use of the tax dollars spent in research and development. To accomplish this objective, it is essential to devise a method or procedure to insure dependable production and orderly marketing of the particular crop specie to the largest number of farmers within the institution's home state.

PUBLIC SECTOR ATTITUDES

As I have talked with administrators and scientists at many land grant universities--even those who do not have exclusive release policies--they have repeatedly told me about many times seeing years and years of research dollars and investment of a lifetime by outstanding plant breeders go "down the drain," because a particular development was not aggressively promoted and marketed. Or it was started and dropped, because of some unfavorable situation. Such experiences are numerous. Many of the administrators and scientists have told me that they wish they had an exclusive release program for such specialty products.

To be perfectly frank and open, in some states, the constituency pressure, which is often more political than realistic, raises a wall of opposition that makes it impossible to set up such a program, although it might be in the best interest of the farmers who would be the beneficiaries. Therefore, many good varieties are often lost.

RISKS FOR SEED COMPANIES

The company awarded an exclusive variety release has considerable risks. There are the usual risks of working out seed production systems and procedures...the best place to produce the particular seed crop, cost factors, commercialization for large-scale field production, storage, distance from the marketplace, etc.

Another very important factor is the releasing institution's position regarding subsequent releases of improved varieties of the same specie and type. For example, a company may spend large sums of money and considerable time in introducing and developing a market for a particular cultivar. Inasmuch as an aggressive research program may often result in improvement of existing cultivars, a new variety better than the original release may be developed. Some particularly virulent disease

may build up that may not have been detected on the original variety release.

Suppose significant improvements are made, significant enough to be called a "new variety." Then, the entire process of releasing would again be opened up and the company who had made a large investment on the original variety would have no guarantee of being awarded the improved variety. This could leave such a company in a financially vulnerable position. It would not seem ethical for the company to make its own genetic improvements, in effect "stealing" the original germ plasm.

These are some hypothetical problems, but they could become a reality.

SOME COMMON PROVISIONS OF AN EXCLUSIVE RELEASE

1. Length of agreement: None of the agreements I know about are permanent. They are subject to annual review and may be cancelled by either party, usually with a year's advance notice.

2. The recipient company is expected to follow an orderly procedure to get high quality, certified seed produced and distributed through the normal market channels within the state.

a. Most exclusive releases are patented varieties under provisions of Plant Variety Protection of the Federal Seed Act. A part of this act provides that seed will be produced as a class of Certified Seed. This is as it should be, and gives added assurance of high quality seed. Nevertheless, the matter of producing Certified seed of some of the forage species is a bit unusual in the seed trade. For example, I have never seen a bag of Certified Hairy vetch seed. It is also rare to find Certified annual ryegrass seed. As a result, in the traditional production areas, in order to get good seed produced and to insure high quality, one must secure clean land to insure a minimum risk of contamination. Thus, it is generally necessary to pay a premium for such production. This increases the costs substantially above the run of the mill production of non-certified similar crop varieties.

b. Also, it is important to remember that in any volume seed production program, we are competing for land use. This means that contracts must promise a return at least equivalent to the best anticipated returns of commercial crops or other seed crops grown in the area.

c. There is an added dimension of responsibility by the recipient company, and that is to protect the integrity of the variety and to challenge or prosecute violators of Plant Variety Protection under the Federal Seed Act. This, too, can add to the costs of the product. Yet, failure to pursue such violations renders the Plant Variety Protection meaningless.

OTHER QUESTIONS OFTEN ASKED

Some other questions often asked regarding exclusive variety releases:

What is the basis for making an award for production and marketing rights to an exclusive release? Is the release made on a bid-basis to the highest bidder, or what determines the recipient company?

Answer: It is my impression that the overall determination in such cases is a qualitative decision rather than a quantitative one. The decision is no doubt based on several factors, such as market capability, sales organization, market coverage, seed production experience, facilities for handling, research experience and capabilities, etc.

As far as a bid-basis is concerned, I know of no institution where this has been used as the basis for making an exclusive release, and wisely so, I believe. On such a basis, the recipient organization would then own the rights, rather than the developing institution, and could keep the variety off the market to avoid competition with one of their own varieties.

What about royalty charges?

Answer: A commonly accepted practice is to charge a royalty on sales to help defray long time research costs. Although a part of the Memorandum of Understanding, this is not something used to determine who gets a particular variety. Some institutions have a strict policy of not charging a royalty, but may request quantities of seed for university farm and research purposes. In agreements where royalty charges are levied, such charges may vary from variety to variety and specie to specie.

SEED PRODUCTION CONTRACTS

There are certain built-in advantages for farmer-contract growers of seed for a company with an exclusive variety release. Traditionally, the seed grower has either had to form some marketing group or has had to serve as his own marketing agent, assuming all the risks in the market place. This is great, as long as the price is going up, but when it heads south, he can also get clobbered.

Under an arrangement with exclusive varieties and under Plant Variety Protection--at least as far as our company is concerned--although prices may fluctuate, the seed crop is sold the day the farmer plants it. Such contracts, even

for long established perennial crops, are rewritten on an annual basis and adjustments made, depending on market outlook. If the seed does not sell, then the company has the obligation of assuming that risk, and suffering the loss.

PRICING OF SEED

The market place pricing of seed, or the end-product pricing, under such arrangements is often misunderstood. Funk, for example, does not establish the price paid by either the farmer or the dealer for the seed. Our general policy has been to establish the price to the distributor or wholesaler, who in turn sets his margins to the dealer. The retail dealer, in turn, establishes the retail prices to the farmer-customer.

Sometimes we, as well as the releasing university, get criticized for high prices of seed, when actually we have nothing to do with that directly. In fact, it would be illegal for us to try to do so. In establishing the one price that we charge to the wholesale distributor, we add a small profit above our actual expenses. This may seem high in some instances, and it may seem quite low in others. In other words, we do not "play the market" like a supply-and-demand situation, attempting to ride a high market for all it´s worth.

Hopefully, this system will eventually stabilize some markets. It will take time. For example, we have all seen the Sericea lespedeza market go from a few cents a pound to almost three dollars a pound in years past. It has been described as a roller coaster or yo-yo market. This left seed producers, seed distributors and dealers at the mercy of a supply-demand situation, with unpredictable, wide swings. Consequently, when the price was cheap and markets scarce, production stopped. When the prices rise again, everybody jumps in and rides it out, until the supply is again glutted, and the price again falls.

CONCLUSION

In closing, exclusive variety releases do not present an all-purpose solution to all problems. Nevertheless, it does seem the best system available for certain types of crop varieties to insure a reasonably stable market and supply of certain crop varieties that are vital to an improved agriculture and a better standard of living for the American consumer.

No doubt, there are many unanswered questions that time will not permit me to cover. If there are questions, I will be glad to try to answer them, either now or later. Thank you, again, for the invitation to speak to this conference.

BREEDERS RIGHTS AND COMPENSATION FOR PLANT BREEDERS FROM PUBLIC INSTITUTIONS

L. R. Nelson[1]

This report will address the patent policy of state experiment stations related to release of germplasm to private or public commercial groups. This is a very complex issue and not surprisingly each institution has a different policy. In past years, the normal arrangement was that any and all germplasm was owned by the state experiment station (Anonymous 1982). Seed was given to a Foundation Seed Association, and they in turn produced seed for an open public release and the funds from this operation supported in part or the total operations of the Foundation Seed Service. New developments have changed, or are changing, these procedures. Presently, in addition to varietal releases there are many new potentially profitable germplasm releases such as exclusive release of vegetables, clovers, forage grasses, breeding lines containing valuable genes, or parents of hybrids. Other avenues might include asexually produced forage or lawn grasses, shrubs, fruits or nuts. The explosion of tissue and cell culture and the resulting new area of germplasm selection technology are again forcing the re-evaluation of germplasm release policies (Anonymous 1984).

In the past, it was assumed by all plant breeders employed by public institutions that since they work for a salary they would never receive any additional revenue from their research efforts. However, this began to change, primarily because of more liberal patent policies enjoyed by colleagues in engineering and chemistry departments. In many of these areas some research scientists did receive revenue from inventions developed as part of their general research assignments. Presently, there are a number of public institutions that do consider patentable germplasm in the same context as patented formulas or inventions. In these public institutions, plant breeders are being financially compensated for profitable germplasm releases.

In 1984, Dr. Gale Buchanan (Buchanan 1984), Dean and Director of the Alabama Agricultural Experiment Station conducted a survey of the Southern Region to determine plant variety release procedures of other states (Table 1). Of 13 states or territories reporting in this report, eight states have released some germplasm through exclusive releases. All states, however, were maintaining the open germplasm release policy on some crops. The distribution of royalties from these states indicated that revenue was shared by the University, Experiment Station and Department; and surprisingly, in six states, individual scientists could be financially rewarded with a percentage of the royalty. This compensation ranged from 15% to a high of 50% in Florida and Louisiana; however these policies were being revised and may have changed since 1984. Since this report (Buchanan 1984) was written, Arkansas has agreed to make some exclusive releases and South Carolina and Virginia are studying their policies.

Two other states with liberal patent policies (this includes plant germplasm) are Wisconsin and Ohio. In Wisconsin, the breeder may receive 20% of the gross income from the release, which is handled by the Wisconsin Alumni Research Foundation (WARF). The scientist's department receives 15% and the remaining 65% goes to the WARF. At Ohio State about 3 years ago, the Experiment Station came under the administrative guidelines of Ohio State University. This resulted in a policy where royalties were split 15, 45, and 40% to the breeder, Experiment Station, and Department of origin, respectively. However, this presently may be changing so that the breeder will receive 50% and the Experiment Station will receive the other 50%.

In the Texas Agricultural Experiment Station (TAES), exclusive releases have been utilized; however, exclusive releases are rare in Texas, and used only when the public interest is better served by limiting the number of participating parties. When royalties are earned, the revenue is returned to the Department or TAES and, at this time, not to the plant breeder. The TAES policy is that plant breeders are employed primarily to produce improved materials and provide publicly-useful varieties and the products are intentional rather than an incidental result. The feeling is that the continued sharing and distribution of plant breeding materials is essential among public workers and specific safeguards must be considered to avoid self-serving interests or personal financial gain to result from their employment or research efforts. The Texas Agricultural Experiment Station Handbook states that royalties from patents or discoveries will be divided in the following manner: The investigator shall receive 50% of net revenues (after 15% overhead is deducted) and the remaining 50% shall accrue to TAES. At the present time, germplasm from plant breeding programs is not considered to be in the same category.

Cooperation among plant breeders whether state, federal or private, and relatively free exchange of germplasm in the United States, have contributed greatly to the success of varietal and hybrid development, to numerous genetic studies and to the overall advancement of plant science. The evolving germplasm release policy may jeopardize some free exchange of germplasm between plant breeders; however, there is no evidence of this presently. The potential financial gain that could be realized by a plant breeder or plant breeding teams may strengthen their efforts and add greatly to germplasm development. Much remains unresolved between the public and private plant breeding programs and how germplasm should be turned over to commercial programs.

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Many questions will be answered in the next decade.

ACKNOWLEDGEMENTS

Appreciation is expressed to the many individuals who responded to the author in gathering information for this paper.

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TABLE 1. Nature of Plant Variety Release and Distribution of Royalties in State Agricultural Experiment Stations in the Southern Region in 1984 (4).

	Nature of Release			Distribution of Royalties			
State	Exclusive	Open	Other	Univ.	Exp. Sta.	Dept.	Ind. Scient.
ALA	Sometime	Sometime	Sometime	-	-	100%	-
ARK	Never	Always	-	X(1)	-	X(1)	X(1)
FLA	Sometime	Sometime	Sometime	50%	-	-	50%
GA	-	-	-	-(2)	-	-	-
KEN	Sometime	Sometime	Sometime	33 1/3%	33 1/3%	-	33 1/3%
LA	Sometime	Sometime	-	-	-	-	50%(3)
MISS	Sometime	Sometime	-	-(2)	-	-	-
N. CAR.	Seldom	Sometime	Sometime	-	100%	-	-
OKLA	Sometime	Sometime	-	-	50%	50%	-
S. CAR.	Rarely	Usually	-	-	50%	-	15%
TENN	-	Always	-	-	5%	-	15%
VIR	-	Always	-	-	-	100%	-
P. RICO	Never	Always	-	-	-	-	-

(1) Amount determined on case by case basis
(2) No royalties received
(3) Where University directly obtains patents there will be a payment of 50% on first 50,000 of net royalties, 33 1/3% thereafter.
(4) This information is from a report by Dr. Gale Buchanan (1984).

REVIEW OF ARS POLICIES FOR RELEASE OF IMPROVED VARIETIES AND GERMPLASM

Wayne W. Hanna[1]

The following review of USDA policies for release of improved varieties and germplasm is a summarization of three letters and personal communications with Dr. Howard Brooks, who is the ARS point of contact for this subject. A large portion of this review is quoted from policy letters in order to maintain accuracy.

A policy letter[2] written by Dr. Mary E. Carter, Acting Administrator stated, "The development of genetically improved plants has been and will continue to be of vital importance in meeting the need for food and fiber of the people in the world. ARS scientists have a key role in the broad spectrum of activities needed to produce genetically superior plants. These activities include the introduction, genetic improvement, and distribution of new germplasm; the development of improved breeding methods; and the creation of new techniques for gene manipulation. The results are more useful germplasm bases and improved varieties. ARS recognizes that strong and highly productive programs must be continued to broaden and enhance germplasm bases and to develop improved plants to meet the need for increased productivity." The above statement indicates that ARS is committed to continued support of research programs that produce both improved germplasm and improved varieties.

Howard Brooks[3] indicated there are about 230 releases per year involving ARS scientists. Of these, 80% are germplasm releases and 20% are variety releases. He said that 98% are joint releases with state and/or industry scientists. Brooks also stated that as general ARS policy, "If it is determined that a national need exists for the development of improved varieties for a given crop and industry and/or states cannot satisfy that need, ARS will attempt to meet this need by continuing with variety development programs."

ARS policy regarding release of improved germplasm and varieties was summarized in a policy letter written by Mary E. Carter[2] as follows:

"1. ARS will encourage continued cooperation among ARS scientists and scientists of State Agricultural Experiment Stations, foundations, international organizations, and private industry conducting plant improvement research.
2. ARS will emphasize the collecting and development of improved plant germplasm.
3. ARS will develop varieties when it has been determined that a need exists and this need may not be met by any cooperative or individual plant breeding program.
4. ARS will use the full array of scientific approaches, emphasizing the use of the most modern techniques of gene preservation and manipulation for the development of plant breeding methods, germplasm enhancement, and release of improved plant germplasm."

The policy statements are clear except for who will determine "that a need exists" to produce varieties as indicated in statement #3 and when that determination will be made. Howard Brooks indicated ARS intends to use the recently formed Crop Advisory Committees of the National Plant Germplasm Committee to help advise on all matters relating to germplasm of specific crops. The committees would advise on the national need for improved varieties, ability of industry and states to satisfy that need, and the level of ARS research needed. It seems that this aspect will require long-range planning because plant breeding programs cannot be expected to be productive "overnight".

In general, industry does not have intensive plant breeding programs for the forages (except alfalfa). Therefore, there appears to be little, if any, duplication of efforts in forages. Another possible duplication of efforts could be with plant breeding efforts of state agricultural experiment stations. In reviewing this latter situation with forages, there appears to be little or no duplication within forage crops. In fact, most state and ARS crop emphases complement each other.

It appears that, with forage crops at least, ARS is still in the plant variety producing business. In another policy letter written by Mary E. Carter[4], it was stated that "varieties are the desired and natural end-product of plant improvement programs. Whereas, ARS scientists emphasize development and release of improved germplasm populations, under certain circumstances it is appropriate and necessary for ARS scientists to develop and release varieties either solely or in cooperation with other institutions. As a general rule, ARS developed varieties will be released on a non-exclusive (public) basis. However, there are instances when ARS developed varieties may receive inadequate distribution unless released on an exclusive basis." The letter further stated that "ARS will consider granting an exclu-

[1]USDA-ARS, and the University of Georgia, College of Agricultural Experiment Stations, Coastal Plain Exp. Station, Agron. Dept., Tifton, GA 31793.

[2]A letter sent on Sept. 9, 1982 by Dr. Mary F. Carter, Acting Administrator to Regional Administrators and D. A. Niffenegger on Release of Plant Varieties.

[3]Personal communication with Dr. Howard J. Brooks, National ARS point of contact for variety and germplasm release.

[4]A letter sent on Sept. 9, 1982 by Dr. Mary E. Carter, Acting Administrator, to Regional Administrators and D. A. Niffenegger on Exclusive Release of ARS Developed Plant Varieties.

sive license when:

1. Adequate supplies of seed or plant materials are not likely to be produced or marketed on a continuing basis under non-exclusive production and distribution; and
2. Exclusive licensing is a reasonable and necessary incentive to encourage the investment of capital and to produce and distribute adequate certified seed or plant material on a continuing basis.

Criteria to justify exclusive release must include:

1. The new variety must have one or more significant advantages over current varieties.
2. The seed or plant market is limited.
3. Special marketing techniques are required as with vegetatively propagated varieties.
4. Specialized production techniques or production areas are required as with many forage legumes and grasses."

Brooks[3] indicated there have been only three exclusive ARS variety releases in the last three years and all three were forage crops.

Release Procedures

The detailed procedures for obtaining approval of ARS developed germplasm and varieties were prepared on April 25, 2984 by the National Program Staff and sent to Area Directors on the same date by Howard J. Brooks. These procedures and guidelines are available from Area Directors and Howard Brooks.

THE ROLE OF STATE FOUNDATION SEED ASSOCIATIONS IN THE RELEASE OF IMPROVED LINES FROM PUBLIC INSTITUTIONS.

J. Earl Elsner[1]

The general authority given to foundation seed projects is the increase and distribution of new or established varieties developed and released by the public plant breeding sector. All production and conditioning leading to foundation quality seed is accomplished within regulations established by AOSCA and local Crop Improvement Associations. The responsibility that comes with this authority is the maintenance of varietal purity and the creation of sufficient seed for adequate distribution to interested seed growers. The authority to receive breeder seed comes from state law or memorandums of agreement between foundation seed organizations and university experiment stations or USDA.

The funding for the foundation seed organizations is primarily from seed sales. However, subsidies from university, department of agriculture or other appropriate budgets in the form of capital expenditures for initial building, salaries and overhead have been common. The majority of the organizations at present operate on a non-profit, self-supporting basis. Several are independent corporations and thus do not have the opportunity to receive state appropriated budgets with current policy. It is not uncommon for foundation seed projects to return a portion of surplus funds to university plant breeding programs or other research projects. In some cases the funds are for designated use, but other times the university administration dictates the distribution of funds.

In the southeast the majority of the foundation seed programs restrict interstate seed sales. Whenever there is a need the seed sales are coordinated through that state's foundation seed office. Breeder seed usually are shared across state lines whenever the need arises. The philosophy is that each state foundation seed organization should have access to all public varieties to grow and distribute to their seed producers. These relationships are not a matter of law or even a firm policy but rather are designed to promote cooperation between states. The goal is to provide the highest quality foundation seed to the largest number of growers in the shortest period of time possible.

The varieties available for foundation seed increase are those from public sector breeding programs. Most states also utilize varieties from neighboring states and varieties released into the public sector by philanthropic organizations. The seed produced is usually limited for sale as foundation seed. While seed can be downgraded to the registered class if it fails to meet standards, this is an exception to normal operating procedures. It is not the purpose of foundation seed organizations to compete with the registered or certified seed trade. Rather, the purpose is to support the commercial seed trade with appropriate quantities of high quality genetically pure foundation seed.

The goal of every plant breeder is to have his/her variety planted on sufficient acreage to justify the plant breeders existence and provide wide exposure to the newly developed line. It is the opinion of many that wide distribution, effective utilization, and even survival of the variety depends upon large-scale promotional efforts available only to commercial plant breeding organizations. These promotional efforts are available to public varieties only if they are released on an exclusive basis to an organization willing to commit production and advertising dollars to the new variety.

While this concept can be used to justify exclusive releases, it should be recognized that other probably more important factors also influence varietal selection by farmers. A partial listing of these factors in no order of importance are; 1. superiority of new variety, 2. previous contribution from breeding program, 3. acreage available to utilize the new variety, 4. incentive for producers to change varieties (related to superiority of new variety and difficulty in changing varieties of perennial crops) and 5. availability and cost of seed or other planting stock (includes entire seed distribution network). Numerous examples can be given to demonstrate that promotion may be needed to introduce a "me too" variety. In contrast, growers will be requesting superior varieties before the breeder is ready for public release.

It is the opinion of this writer that exclusive releases are needed in the public sector for certain crops and specific situations. The difficulty arises in determining when to use the procedure and how to distribute royalty income, if any. A discussion of the five basic types of southern forage crops in regard to seed production, distribution, and utilization may provide an insight into the need for exclusive releases. The types of forage crops in regard to seed production, distribution, and utilization may provide an insight into the need for exclusive releases. The types of forage crops in regard to seed production are:

1. Annual crops with seed production in the southeast; proso millets, vetch, lupine, wheat, and rye.

2. Annual crops with limited seed production in the southeast, but most in drier climates; pearl millets, rye grasses and forage sorghums.

3. Perennial crops with limited seed production in the southeast; clover, lespedeza and fescue.

[1]Division Director, Georgia Seed Development Commission, Ga. Dept. of Agriculture, 2420 South Milledge, Athens, GA. 30605

4. Perennial crops with no seed production in the southeast, alfalfa, birdsfoot trefoil.

5. Vegetatively propagated species; bermudagrass.

1. Annual Crops with Seed Production in the Southeast.

These crops should be produced as public varieties by certified seed growers. Certain crops like vetch are grown on a very limited acreage. As a consequence, interest in seed production will be minimal. The resulting lack of interest will be due to the crop rather than inadequate exposure of the new variety. Of course, if no seed producers are interested in the variety the exclusive production agreement is an option.

2. Annual Crops with Limited Seed Production in the Southeast.

Local producers will want the opportunity to produce these crops for seed. However, inconsistent production and seed quality will probably limit distribution and utilization of newer varieties. The exclusive release will allow local or national companies to develop seed production in the most desirable climatic area and import seed into the southeast or other areas of utilization. It would be difficult for a commercial seed company to finance a production and marketing program for these public varieties if exclusive rights were not offered.

3. Perennial Crops with Limited Seed

These crops are regularly grown for seed in the southeast. Georgia has seedsmen who have demonstrated success in growing each of these crops for seed for several years. However, the trend in adjoining states is to release these varieties on an exclusive basis. The reasons given usually relate to improved marketing and generation of royalty income for the university. The marketing concept may be related to controlling the seed supply and resultant seed prices rather than concern about inadequate supply.

4. Perennial Crops with No Seed Production in the Southeast.

These crops should be released to qualified organizations on an exclusive basis. There should be no complaints from growers and considerable support from dealers for this approach.

5. Vegetatively Propagated Species.

Should be released as public varieties since geographic location should not be a constraint in the production of planting stock.

If a decision has been made to release varieties on an exclusive basis, the normal procedure is to contract with a qualified seed company and they in turn apply for plant variety protection. That contract will normally specify the source of breeder seed, number of generations or seed crops eligible for certification; marketing scheme in terms of early distribution to home state, royalty to be paid, etc. All of these considerations except the royalty are fairly standard and cause little confusion. In most cases, the actual income from royalties will hardly cover bookkeeping costs. There are exceptions, however, where the crop may generate a significant cash flow. In either case both the foundation seed organizations and university want authority over the money. It will be indeed unfortunate if the inability to agree on proper distribution of funds prevents the exclusive release of varieties which have the potential for improving southern agriculture.

In summary there are three points that should be emphasized:

1. Foundation seed organizations were created to have the authority to receive, increase, and distribute seed of new crop varieties and maintain established varieties. These agencies have served southern agriculture well and continue to be the critical link between the public sector plant breeder and grower seedsmen.

2. Exclusive release of forage crops or other speciality crops is a release option that has considerable merit with crops not normally grown for seed in the geographic area covered by the releasing state.

3. Exclusive release should not be used primarily to generate funds for public sector plant breeding programs.

BUSINESS MEETINGS AND RELATED MATTERS

Forty-first Southern Pasture and Forage Crop Improvement Conference
Raleigh, NC 27650
20 May 1985

Minutes of the SPFCIC Executive Committee

Mr. Billy Nelson, Chairman, called the meeting to order at 8:00 p.m. Other officers present were Hagen Lipke, Harold Brown, John Miller, Monte Rouquette, and Wilfred McMurphy. Also present were Jim Rice and Carl Hoveland.

Old Business

1) The minutes of the 40th executive meeting were read and approved.

2) There was a review of the status of the application for non-profit status under Internal Revenue Code 501. It was indicated that the IRS had requested changes in the verbage of our by-laws (approved April 1984) to the effect that reference was directly made to sections 501(c) (3) and 170(e) (2) of Internal Revenue Code. Three changes were made and reviewed. A motion to accept the changes and amend the by-laws of the Southern Pasture and Forage Crop Improvement Conference to include reference to the above mentioned sections in the purposes, activities and dissolution clauses was made by Wilfred McMurphy, seconded by Harold Brown. Passed. The revision contained a signature sheet signed by all officers. This was executed and sent to the Internal Revenue Service.

New Business

1) Carl Hoveland gave a report of the combined meeting between SPFCIC and the American Forage and Grassland Council, April 1986 at Athens, GA. Suggestions for revisions were made and adopted. A copy of the revised tentative program is attached. The following were major points suggested by the Executive Committee:

   1) Maintain southern orientation for the meeting.
   2) Switch tour from Tuesday to Wednesday, and vice versa
   3) Hold executive meeting 7:30 p.m. 14 April 1986.
   4) Hold SPFCIC roll call and business meeting 4:30 p.m. 15 April 1986 (Tuesday).
   5) SPFCIC will publish its proceedings separately.
   6) There will be a separate SPFCIC and AFGC registration.
   7) SPFCIC will include $5.00/registrants for cost of proceedings.
   8) Financial planning and accountability for registration, donations and expenses will be separate for both organizations.
   9) SPFCIC will announce and solicit registrants through their mailing list as is usually done.

2) A letter of invitation from Dr. W. C. Godley inviting the 43rd SPFCIC to meet in South Carolina in 1987 was read by Wilfred McMurphy. A motion to accept was made by Monte Rouquette, seconded by Hagen Lipke. Passed.

3) A motion was made to adjourn by Harold Brown second John Miller. Passed.

Minutes of the 41st Southern Pasture and Forage Crop Improvement Conference
22 May 1985 12:00 noon
Raleigh, North Carolina

Mr. Billy Nelson, Chairman, called the order at 12:00 noon.

Old Business

1) A financial report was made by R. S. Kalmbacher indicating that $1937.00 was in the SPFCIC account in Wauchula, Florida.

2) R. S. Kalmbacher indicated to the group that the executive committee had amended the by-laws adopted in 1984 so that they included reference to IRS code section 501(c) (3) and 170(e) (2) in those statements dealing with SPFCIC: purpose, activities, and dissolution clause. There were changes requested by the IRS.

3) A report of the S-45 committee was made by Dr. Joe Burns (N. Carolina) indicating that work was still in progress toward publication and completion.

New Business

1) Dr. C. Hoveland presented the tentative plans for the joint AFGC/SPFCIC meeting (14 April to 18 April 1986) at Athens, Georgia.

2) A letter was read from Dr. W. C. Godley, Associate Dean and Director of the South Carolina Experiment Station, inviting the 43rd SPFCIC to meet in South Carolina in 1987. A motion to accept the invitation was made by D. Chamblee, second by W. McMurphy. Passed.

3) A report was made by the nominating committee, (composed of Harlan White, Joe Burns [North Carolina], and Harold Brown). They placed the name of Dr. Don Ball, Alabama, in nomination for president elect-elect. A motion to accept the name was made by Lee Mason seconded by Bill Ocumpaugh. Passed. A motion to elect Dr. Ball by acclamation was made by J. D. Burns seconded by H. Brown. Passed.

4) A report was made by Dr. Lee Mason for the resolutions committee which was composed of

Lee Mason and J. D. Burns (Tennessee). Resolutions were made with instructions to the secretary to send copies to wives of deceased and/or retired.

1) Deceased: Dr. G. O. Mott 26 November 1984
2) Deceased: Dr. E. N. Fergus 3 January 1985
3) Deceased: Dr. C. R. Montgomery 29 December 1984
4) Retired: Dr. E. C. Holt

A motion to accept the resolutions as read was made by B. Ocumpaugh, seconded by D. Chamblee. Passed. A fifth resolution recognizing the work and effort of the North Carolina forage workers and the appreciation of the registrants of the 41st conference was read by Dr. Mason. (Copy on records). A motion to accept the resolution as read was made by Dr. H. Fribourg, seconded by Dr. K. Quesenberry. Passed.

5) With no further business for the 41st meeting, the gavel was passed from Mr. Billy Nelson to Wilfred McMurphy, Chairman of the 42nd conference. Dr. McMurphy presented Mr. B. Nelson with a plaque expressing appreciation of SPFCIC for this effort as past chairman.

The meeting was adjourned.

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