Agroforestry in the Southern United States: 33rd Annual Forestry Symposium, 1984

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AGROFORESTRY IN THE SOUTHERN UNITED STATES

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FOREWORD

Historically, the South has been considered as having an ample supply of undeveloped land. But the uses of rural land -- forestry, crop agriculture, cattle grazing, and residential and industrial development -- are growing faster in the South than elsewhere in the country. So ways need to be devised for increasing the multiple uses of single tracts of land, especially through agroforestry: the combined production of timber and crops or livestock on the same acreage.

Recently, the agroforestry approach to land management has been identified as an area of high technology with potentials for Louisiana. Our Symposium is the first formal exploration of this concept in the United States. The concept has been identified as having potential throughout the southeastern U.S. as well as in other regions of the nation. To many persons the idea is new; it is not new in other parts of the world. The International Council for Research in Agroforestry, headquartered in Nairobi, Kenya (P.O. Box 30677), has identified specific combinations of species managed under the agroforestry concept worldwide.

Producing livestock on native forage growing under forests has been practiced in the U.S. since the first Europeans settled here. The practice has become known as forest range grazing and the management science associated with this system has been developed over the last 30 or more years. Interestingly, management recommendations for combining southern pines and livestock have changed little since the 1950's. Under the agroforestry concept, forest range grazing may be termed a silvopastoral system. But, a silvopastoral system connotes a greater intensity of management than mere forest range grazing.

For this Symposium, we attempted to assemble those scientists and managers who have considerable experience in forest range management in the southeastern United States as well as those who have intensified their management efforts and extended into the agroforestry concept. We have contrasted operations using tame vs native forages and have
included a few with novel configurations of tree spacing. We concentrated on grazing management and conflicts on southern pine forests because the land base (about 200 million acres) and the conflicts seem greatest with this combination, which is presently the most used agroforestry system in the southeastern United States.

We also must mention that there are a variety of other agroforestry operations in practice, being developed, or that have at least been attempted in the Southeast. Among these are production of forage crops under pecan plantations, production of crawfish under cypress, production of potatoes in pine plantations, and cropping of cotton or soybeans between rows of soft hardwoods.

Agroforestry systems and potentials have mostly come by way of landowner and land manager invention. They are the product of innovation and management skills. Most important is the fact that the agroforestry concept has the potential to greatly increase land productivity and profitability in the United States. Agroforestry is a technology that has not been fully developed.

Norwin E. Linnartz

Mark K. Johnson
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Dr. Robert H. Mills, Associate Specialist (Forestry), Louisiana Cooperative Extension Service, was co-chairman of the program committee, and his assistance is appreciated.

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Ungrazed mat of subterranean clover growing under slash pines at the Palustris Experimental Forest near Glenmora, La. Photo by Lee Davis; see article, p. 89-104.
Cattle in young (top) and 12-year-old slash pines (bottom) in Spicer Field, Conecuh National Forest, Alabama. Photos by Joe Brown; see article, p. 152-158.
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SESSION I

THE RESOURCES

Moderator:

Evert K. Byington
Winrock International Livestock Research
and Training Center
Morrilton, Arkansas
WHAT IS AGROFORESTRY?

Wayne D. Mosher
Professor Emeritus
Oregon Cooperative Extension Service
Roseburg, Oregon

Just what is agroforestry? The term is of recent vintage and first came to my attention in the early 1970's. It is broadly defined as growing an agricultural crop and a forest crop on the same land at the same time. I usually think of agroforestry as a combination of trees and grass for animal grazing, but it also often involves growing grain, hay or other crops under forest trees.

I think we are most interested here in grazing animals among trees, so I will confine my remarks to that subject.

I first learned of the concept of agroforestry from a New Zealand publication in 1973, "Trees and Grass -- An Opportunity for the Hill Country Farmer." Since then, numerous publications on the subject have come from both New Zealand and Australia.

In New Zealand and Australia most of the current work in agroforestry is in planting trees in pasture. The recommended practice is to have land in a good grass-legume pasture for at least two years prior to planting trees. Grazing is restricted the first two years after trees are planted to allow the trees to grow high enough to lessen livestock damage.

The Monterey pine (Pinus radiata D. Don) from California is the dominant tree used in New Zealand and Australia. Studies have examined tree density, planting patterns and animal stocking rates. Rapid pruning is practiced to keep the tree bole clear over a 4-inch center. This also allows light to reach the pasture growing under the trees. While overall forage production is reduced 20-25%, projections of net income favor the combination of trees, grass and animals (Knowles and Percival 1983,
Percival and Knowles 1983). Final tree stocking of 100 trees per hectare (40 trees per acre) was most profitable in their model simulations. Most of these data are based on an expected harvest of trees at 25 to 35 years of age.

As for agroforestry in the United States, I would like to discuss two concepts of mixed forestry and grazing: 1) the grazing of animals in already established trees, and 2) the planting of trees in livestock pastures. The most common "agroforestry" today is grazing animals in already established forests. Domestic stock has been grazed in public and private forests since early in the settlement of the United States. In the West, many ranchers are dependent on forest grazing on public land to keep their livestock operations viable. Forest grazing allotments are part of the value of many ranches.

In the South and East, some 36 million acres of forest land are currently being grazed (Byington 1982). Byington indicated that 310 million acres produce forage which could be grazed and could support nearly 20 million cow-calf units each year.

While recent studies show well managed animal grazing can be beneficial to trees, much of the grazing in the forest in the past has often been unmanaged. Unmanaged or poorly managed grazing can result in tree damage and soil damage which are unacceptable to many land managers.

So how do we manage the animals to reduce damage to trees and soil? Several recent studies may give us some clues. In Western Oregon and Washington, studies have been underway showing the use of sheep to harvest forage in young growing trees in the National Forests. We have, in my area of Oregon, three to four bands of sheep grazing clearcuts in the forest. The idea is to use the forage which is in competition with young trees and hopefully to browse enough of the brush species to reduce the need for chemical sprays. How has it worked? The results are promising.
Sharrow and Leiniger (1983) have reported that grazing has been beneficial to the trees by increasing diameter growth of small trees 8–14%. We have learned that we do not want sheep in small trees at bud burst because the trees are more palatable then. We have learned not to unload hungry sheep in a stand of small trees because they eat almost anything they can find. Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco] are not very high on the list of preferred eating by sheep and a thousand sheep on a 40- to 100-acre clearcut can stay for about three days before any damage to the trees occurs.

The Weyerhauser Company, as reported in the Oregon Farmer–Stockman (Monfore 1983), believes cattle grazing in new plantations is desirable if certain criteria are met: 1) get the cattle on the range early, 2) move them directly to plantations and keep animals distributed, 3) control the herd with riders to keep animals distributed, 4) have adequate animal numbers, and 5) do not use animals with a diet preference for pine needles. A few years ago Weyerhauser did not want cattle in tree plantations. Today they want them there.

I imagine most people attending this conference will be interested in grazing under trees that are established. You should consider the possibilities of planting pasture under the trees, particularly when the trees are thinned at 12–15 years of age. Other speakers here will give you details of how forage may be successfully planted under pine trees and what species may be adapted. Keep in mind that legumes under trees do fix nitrogen which helps make both the grass and the trees grow better. I will discuss that further in the next section.

The original idea in New Zealand was to plant trees in pasture. They recommended that pasture should be planted and grazed for at least two years before planting trees. The New Zealand grazing system is based on the use of legumes to provide the nitrogen in the pasture and no nitrogen fertilizer is applied. They feel having the pasture in and grazed for a couple of years will raise the fertility level enough to help the trees grow.
They restrict the grazing or cut hay or silage from between the rows the first two years to reduce animal damage. By the third year the young Monterey pines are above the sheep and the only damage is some bark chewing. Cattle are also grazed among trees but must wait an extra year to get in. The New Zealand studies also are looking at tree-planting patterns. One interesting pattern under study is two rows about 12 ft apart and then 80 ft to the next two rows. Within the row the trees are 4½ ft apart. These are then thinned to 40 trees per acre at 5 years with a final spacing of 80 ft by 16 ft. The objective is to grow a sawlog in 25 to 30 years that is mostly clear lumber for the first 30 ft.

To me the idea of agroforestry was intriguing -- to think that I could run almost as many animals on my farm and still be growing a crop of trees to harvest in 20 to 30 years when I got old and needed retirement income. I was also interested in harvesting more of the nitrogen cycling in the system.

I am using a cross of the Monterey pine from California for its very rapid juvenile growth and the knobcone pine (\textit{P. attenuata} Lemm.) from higher elevations for better winter hardiness. This cross, commonly known as the KMX, has a very good growth rate. I expect the trees under good fertility to reach a dbh of 15 to 20 inches by 20-25 years. I will prune the first 32 ft to maintain quality for two 16-ft logs. A 20-year-old planting of KMX planted on 12-ft centers is currently 65 ft tall and averages about 12 inches dbh. The trees have been interfering with each other for several years. Properly thinned and pruned, they should make 15 to 20 inches dbh in 20 to 25 years.

Pruning is essential to make the wood of higher quality and to let more light in to keep the forage growing. I prune to keep the knotty core of the trees at 5 inches or less in diameter. This will produce mostly clear wood which should be more valuable. I planted the trees in a pasture that had been established for 15 years and had a high level of fertility. We sprayed around the trees for the first two years to reduce moisture competition to the trees. (We have
a summer dry period of two months or more which can be critical for tree survival). We also had to limit grazing because of tree damage. The trees were above the sheep in the third year and now we graze regularly and quite hard. We are starting now to thin the trees to reduce competition and maintain enough light for the subclover and grass. At five years we had trees 15 to 17 ft tall and 3 to 5 inches in diameter at 3 ft above the ground.

Obviously there are both advantages and disadvantages to growing trees and livestock together, so let us try to list them. First, the multiple use of land offers potentially more income per acre of land. It can also give you more control in stabilizing your income. You can sell logs if cattle prices are low. When cattle prices are high, the logs can be left to grow larger, thus providing you with more marketing options.

There are ecological benefits. A legume forage can add nitrogen to the system. This will facilitate greater tree and forage growth which could mean more livestock. It will make a more nutritious and highly digestible forage base. A good pasture will reduce soil erosion by tying down the soil with a network of roots.

The livestock can convert grasses, legumes, brush and weeds into a saleable product - meat! At the same time we reduce the fire hazard and help to dictate the understory vegetation. Proper grazing can determine what forage species will survive and what will be eliminated. Sheep can eliminate many undesirable shrubs and keep pastures in grasses and clovers.

The animals serve the purpose of making the nutrients in the system more available. When the animal eats the forage and distributes dung and urine on the soil, it increases the availability of nitrogen to the plants about ten times and the phosphorus about three times. This should result in better tree growth and better pasture growth.

With the use of a legume in this system, you can reduce your fertilizer bills. No nitrogen should be needed. You
must supply phosphorus and sulfur to make the legumes grow, but these cycle in the system. Selling the animals carries off a very small amount of purchased fertilizer. The animal body consists mostly of nitrogen, carbon, hydrogen and oxygen, all of which are abundant in the air and water. Only about 1% of the animal body sold is phosphorus and sulfur.

Agroforestry has disadvantages and requires a higher level of management than livestock alone or trees alone. There is an increased investment in the new component added, be it trees or forage planted. Adding forage to trees or trees to pasture will result in less forage produced as the canopy closes due to light restriction. For us, planting trees in pasture means we must restrict grazing until the trees get big enough so animals will not damage them. A period of two to three years may be required. Some work with cattle and pines seem to indicate that restricted grazing is not a problem if care is taken in grazing management. The biggest disadvantage I believe is the need for better management skills. The livestock, grass and trees must be considered in the management decisions.

Now, what about agroforestry in the South? From what I have seen, I feel a great deal of optimism. Mark Johnson and Lee Davis at Louisiana State University have shown that subclover (Trifolium subterraneum) will grow under pine trees thinned for timber production. Studies at Mississippi State University indicate subclover is more shade tolerant than other species, making it an ideal legume for this purpose. If you can grow this much forage under the trees, it certainly should make for ideal livestock pasture. It may also lengthen the pasture season because it grows in the winter and early spring. It also should be beneficial for deer and some game birds.

The nitrogen fixed by the clover should help provide high fertility for the grasses growing in the forest. The animals grazing that forage should grow better because of better quality forage which the legumes provide. The animals will convert the forage they do not need for growth
into highly available nitrogen to make the trees and grass grow faster. This should make a bigger tree to harvest.

There are about 200 million acres in the South which offer an absolutely fantastic potential for increasing production of trees, livestock and game, and at the same time tying down the soil and reducing erosion. The animals' grazing should reduce brush encroachment, leaving the forest more open for management. This gives you the opportunity to sell forage and brush growing under the trees for a profit as meat and provide a source of income while the trees are growing.

It is exciting to think that the animals sold carry off very little of the mineral elements needed to fertilize plants. Ninety-seven percent of the animal body is carbon, hydrogen, oxygen and nitrogen which are all abundant in the system. Only 3% is mineral and only about 1% or less needs to be purchased in a fertilizer bag.

Other studies indicate that well spaced trees grow faster than crowded trees. Trees thinned at about 15 years of age in most forestry operations in the South allow enough light to reach the forest floor so forage will grow underneath.

In addition to providing nitrogen through fixation, subclover may fit in well in the region to provide winter and early spring forage and so help fill in the year-long nutritional needs of the livestock used to graze the forest.

This can be a boon to cattlemen and foresters alike by providing income from the land while waiting for the timber harvest.

Agroforestry could be a valuable multiple-use program for the forester and the cattlemen, helping both to a more sound and economic growth program.
Literature Cited


Discussion

Question: You showed a photograph of a grazed vs. ungrazed Douglas-fir plantation that was 3 years old. On the grazed site there was nothing on the soil. You said that about 2000 head of cattle used the area. What about soil compaction and erosion?

Mr. Mosher: I was talking about work by Weyerhauser Company. All they were doing was using the
forage available without hurting its regrowth or the trees. We have not seen compaction damage on the soils which are mostly in relatively dry situations. On the same sites only 250 cow-calf pairs were run before; now 2000 pairs can be run because of this change in management.

Question: Please explain how the combined grazing with different types of livestock works?

Mr. Mosher: In general, cattle, sheep and goats have different dietary preferences. So we are not talking about increasing production from monocultural pastures. Sheep do not eat plants that are as coarse as those cattle will eat. Sheep browse more than cattle, and goats browse more than sheep.

Question: What kind of pasture mix do you have?

Mr. Mosher: Most of our grazing is on subclover and grass, but there are native weeds and brush that invade. In most pastures there are a variety of plants available. We can include wildlife as another type of grazer. Each grazer uses only a portion of the plant species available unless the pasture is over-stocked.

Mr. Nation: Most people think about television movies and range wars when we talk about grazing cattle and sheep together. That happened in a dry climate and the resource was limited so that people fought over it. In the Southeast our problem is keeping up with growth because of the high rainfall. In most pastures, there are more than enough weeds to support sheep.
Gifford Pinchot, statesman and leader of our forestry beginnings, said in 1933: "We find that almost every one of the forty-eight states is headed toward forest bankruptcy in timber of merchantable size."

Maybe he was close to right at the time, but the good Lord and a determined lot of individuals have proved him wrong in the last 50 years.

We have a marvelous inheritance in our timber and timberland. Much of the forest was given to us by the forces of nature, with our guidance and protection. Another large portion we grew ourselves from seed. The entire forest is a unique asset and our southern states are uniquely situated with soils and climate to take full advantage of this inheritance.

What does the future look like for this southern forest, and what must we do to enhance its prospects?

It will sharpen our forward look if we first segregate all timberlands into three broad categories.

First are those timberland owners who have forest products plants or pulp mills dependent on the timber cut from these lands. They have their own internal plans for developing the timber crop so that it will best furnish their long-term needs, and they have plans to make the economics of timber-growing balance out with the economics and profitability of the whole company, both short-range and long-range.

In this first category are the pulp and paper companies which are found to dominate the list of the ten largest landowners in each southern state.
They have invested tremendous sums in the improvement of trees and the improvement of forest management. They continue to develop trees which are genetically superior in growth or quality or pest resistance. They constantly improve their planting methods, their thinning regimes and the machinery and equipment needed in timberland management.

All other timberland owners benefit from this broad base of research and development provided by the large companies.

At the other end of the scale, the second category includes nearly one and one-half million timberland owners who, in their forests, are letting nature take its course. These owners cover the whole spectrum of economic status and of resident versus non-resident or absentee, and all have different objectives for their lands. Their forests cover the whole spectrum of pine and other species, of poor to excellent fertility, and of stocking which is excellent down to cull trees and brush. The composite problem of trying to get these owners to do more with their timberlands has been the subject of hundreds of meetings and seminars and a whole library of articles and books.

There is a third broad category of timberland owner which fits in between the first two. This is the non-industrial owner who has a timber-growing objective and wants to take advantage of the current forest management know-how, to make his timberlands yield the highest possible return. Usually these owners have more acres than the average and they number perhaps 10,000 across the South. They include investors in large tracts, families who have managed their lands well for years, and even some of the woodlot owners who have graduated from the second category by their acquired interest in scientific forestry.

In the future, we may have an important fourth category which is coming on the scene right now. These owners will be financial interests such as pension funds who are interested in the timberland investment as a long-term, productive portion of their portfolios. These investors will eventually own a portion of the present industry lands,
perhaps contracting the timber production back to the industry, and thus relieving the companies of some of the capital burden of holding land.

Except for this interesting possibility, I do not see much change in the basic pattern of ownership and management of timberland. Pulp and paper companies will continue to be aggressive in forest research, development and management. The million-plus small tracts will not improve on the average, and most will continue to produce forest products only by happenstance, and at a diminishing rate. Some of these small tracts will be purchased by companies, but the change in ownership will be very gradual.

The South now has hundreds of consultants, company foresters, state foresters, federal foresters and professors working to assist timberland owners and working on forest improvement. The future will bring major improvements in natural regeneration methods, the wider use of prescribed fire, logging methods better suited to modern forestry, and effective herbicides which will be the ideal method for controlling weed species.

The future certainly promises us genetically superior trees, much better ways to plant them and to manipulate their development into high value products. But planting coupled with site preparation is very costly, and private owners may seek the other avenues of natural regeneration to keep their lands productive. Even the promises of 100% more growth and yield from plantings made with superior trees may not persuade owners to invest that extra $200 per acre on the front end.

To summarize so far: The broad ownership pattern will not change much for decades to come. Even the new timberland buyers from foreign shores and from the financial institutions will not absorb much of the 185,000,000 acres of commercial forest land. Companies will improve their timber production significantly, other large landowners will improve production commendably, but the matrix of small owners will improve very little, it at all.
There are other major trends which point to a diminishing timber supply in the South.

1) Millions of acres of commercial forest land are lost each decade to other uses. In the 1970-1977 period it was 4.5 million acres, or about 650,000 acres per year. Timberland is the "wild country" which is preempted for everything else man seems to need, including cropland and pasture. It need not be cleared to be retired from commercial forest status, as for example the many residential developments.

2) Millions of acres of productive pine land are harvested and degraded to a poor oak-pine or upland hardwood type. In the 1965-1975 period, the loss of pine type amounted to over 7 million acres. This is the net result of the lack of forest management by small owners.

3) A majority of our present natural pine forest is the result of successful seeding on old fields and pastures and on seedbeds prepared by successive wildfires. These millions of acres of natural seedbeds are no longer present, hardwood species predominate in the absence of fire, and the recent surveys show a significant decline in numbers of 2" and 4" pine trees. The 1 million acres planted to pines each year have helped to prevent this situation from becoming a real disaster.

Enough on the supply side - what about demand?

Straightening out what the experts say about our future timber demand falls in the same category as questions about future interest rates, federal budget deficits, and the strength of the dollar.

I have reviewed several recent demand projections (U.S. Forest Service 1984, U.S. Dept. of Commerce 1983) and will give you conclusions based on them, adjusted by my own experience and judgement.

The future demand for southern forest products will hinge on many diverse influences.
Domestically, our demand will be affected by the state of the economy, especially the rate of residential construction and the use of shipping cartons. A major projection is the greatly expanded use of wood for fuel.

Internationally, our southern timber production area is one of the world's finest, but can other countries afford to buy our products? The amount we can export will depend on a complicated mix of our wage rates and other costs and the relative strength of the dollar. Certainly, there are many areas of the world needing great amounts of wood - and there are also a few areas where abundant softwood for export will compete with ours. These are the plantations in Chile, Brazil, Australia, New Zealand and South Africa and the extensive forests of Canada. The net expectation for exports of southern pine shows no significant increase until world economics and trade change considerably. It should be noted, however, that forest products are high on the list of exports which can improve our balance of trade.

The U.S. Forest Service (1984) predicts a very gradual increase in our national use of lumber and plywood. It predicts that pulpwood use will continue to grow at 3% per year. And it shows fuelwood use growing at a very rapid rate, at least until year 2020.

If we look at the year 2020, which is one good pine rotation from 1980 - 40 years, the Forest Service predicts that U.S. demand for softwood will have increased from 10.7 billion cubic feet in 1980 to 15.0 in 2020, a jump of 40%; and hardwood demand during the same period will increase 106% from a 1980 base of 5 billion cubic feet.

A small part of this increased demand is offset by net imports, but overall it presents a picture of a positive pressure and a steady or rising price level for timber growers. Softwood timber harvests in the South are projected to rise from about 4.1 billion cubic feet in 1980 to 7.3 billion in 2030 - a 70% rise in 50 years.
Data Resources, Inc., (1983) studies timber supply and demand in minute detail. A few of their conclusions have a place in this paper.

DRI shows that the South was overcutting its timber by as much as 10% in the early 70's but dropped back to a cut of more nearly 86% of growth in 1982-83. From here forward, the projection of this ratio trends upward, in five-year up and down cycles, crosses the 100% of growth line in 1993 and 110% of growth 5 years later, in 1998.

DRI shows southern pine stumpage prices following this same trend line, reaching about $330 per thousand board feet Scribner scale in 1994, and $400 per thousand in 1998. The trend of the "real" stumpage price is shown as almost level, and the "real" prices in 1994 and 1998, based on 1972 dollars, were the same as in 1973, or about $65 per thousand. I cannot agree with DRI that there will be no "real" price increase in stumpage in the next 15 years if demand climbs from 85% of supply to 110% of supply.

What do these forecasts and projections say to the timberland owner who would like to consider his forest as a profitable business?

If he is already an owner, he is locked in to the markets in his region, with the hope that some new industry will build there. However, pulp mills on new sites will be rare in the future. The new Great Northern mill at New Augusta, Mississippi, will cost more than $500 million. The outlook for new plywood plants is also a dim one. DRI predicts that between 1985 and 1995 waferboard and oriented strand board will take 14% of the panel market away from plywood. These boards, in turn, use a lower grade and lower priced part of our forest production.

New state-of-the-art sawmills may be our best hope for a continuation of the stumpage price differential between logs for solid wood products and those used for chips or fiber.
A prospective timberland buyer should certainly choose a region which has strong industry demand, even a supply deficit. The stumpage grower is in a strong position in a region where cut exceeds growth.

Forest practices have a brilliant future. There are already more techniques available than we can use, and research under way will do much more to increase forest productivity and reduce costs. The forest owner must be an analytical businessman to be sure that he is growing the right products and keeping his forest productive at the least cost to meet his objectives.

A profit from the forest depends on this cost control and also, of course, on the original purchase price. On the income side, I predict that stumpage prices will keep pace with inflation, perhaps exceed inflation by a few percentage points. There will be cycles, and we seem always to take a dim view during down cycles. A forest owner has the advantage that his timber volumes are growing 6% to 7% at least through these ups and downs, and his timber values even more, because of product mix. He has a pool of capital which he can draw upon in any year, or even liquidate in an emergency, and he pays only a capital gain tax on this income.

There is no way to predict what an average owner will make on his forest tract. Each case has its own set of circumstances, not the least of which is the owner's own objective.

But we are sure that we will get volume growth, and we are sure that our trees will grow larger and into better products. And we can predict that stumpage prices will keep pace with inflation and perhaps increase a little above inflation. We can only conclude that the future for a managed forest in the South is bright.

Literature Cited

Discussion

Question: Why are wafer boards cheaper than plywood?

Dr. White: The raw materials are much cheaper. The stuff that could be called junk from the woods is what is being used. As time goes on, better fibers will probably be desired, but now this is the main difference in expense between plywood and fiberboard.
The Southeastern part of the United States currently supports a cow herd of around 16.5 million head, the largest cow inventory of any region in the United States. The USDA estimates that our region could carry another 10 million cows by better utilization of existing forage resources. They further estimate that an increase in the southern cow herd will become evident by the latter part of this decade. This increase will not come due to a rise in cattle prices, but due to deflationary pressures to increase the utilization of existing resources and to better amortize existing fixed costs.

There are currently a quarter of a billion acres of grazing resources in the South. Grass is still and will always be our largest crop. Grass is also one of the most underutilized resources of our region.

Is there any money in grass? The USDA Economic Analysis Unit has recently pointed out that the large grass-based farming unit is the most profitable farming group in the United States, if looked at in the amount of net profit it can generate per dollar of input. The grass farmer has been able to insulate himself from inflationary pressures better than any other farmer. This has not been fully expressed in our university research, because much of our research did not adapt to the rise in fertilizer prices as rapidly as the cattlemen adapted. Probably most of the cowmen in the South are currently running a native pasture operation even though they may use tame pasture grasses.

To a great many producers with outside income, the primary attraction to cows and timber are that they are
viewed as low management enterprises requiring minimal daily input or management. Efforts to shift many of these producers to a higher management input have been fruitless for years. For these producers, higher calving percentages and weaning weights, balanced against higher inputs of cash and management time, are not considered worth the investment.

The great majority of the cattle in the South are being produced the way the owners want to produce them. These producers are primarily interested in least-cost production methods -- a field we have sorely neglected in our research. In fact, we have often seemingly tried to devise most-cost production methods with the mistaken idea that increasing cash inputs would increase cash returns at the same ratio.

As Dr. E.R. Beaty of the University of Georgia has frequently pointed out, cattle production is usually most profitable in its simplest form.

As we gear toward least-cost systems, a lot of what we have learned and taught over the last two decades will have to be discarded in order to better utilize our resources. This is assuming a continued decline in beef prices as our herds increase. Many of our improved grass species, especially the tropical grasses, may not be better than native forage. Most of these grasses were bred to react to nitrogen inputs, inputs which have now priced themselves out of practical reach with the exception of hay and some stocker-growing methods.

One of the brightest hopes on our horizon is controlled grazing. Controlled grazing offers to double our current stocking rate, whatever our production system. For $4-an-acre-worth of wire, we can do what $100 worth of fertilizer can do. Under controlled grazing we may find that our slow-maturing native grasses are actually superior to improved grasses for brood cows.

Another bright hope is the new strain of fungus-free fescue which promises to revolutionize cattle production and performance in much of the upper South.
Legume-based grazing systems are lowering costs and improving performance in all areas of the South. As we learn to manage the natural fertilizer recycling of grazing animals, our non-nitrogen fertilizer inputs will also fall dramatically.

Multiple species grazing of cattle, sheep, and goats also promises to return more profit from the same input expense as harvesting efficiency increases.

As we better utilize our resources to grow our calves heavier and heavier, the economics of shipping cattle to the grain versus shipping grain to the cattle reverses. The cattle business will eventually have to come to grips with what every other industry is facing in these times of deregulation. Trucks are cost efficient only on hauls of 200 to 300 miles. Currently our industry is based upon hauling most of our cattle some 1,500 miles during their lifetime. In fact, the cost of trucking, shrink, and death loss from this system usually exceeds the profit in the cattle.

As cattle prices decline, our present system of three to four owners of each steer will also have to decline. The margin just won't be there to support this many people. We are seeing the start of this now with large cow outfits integrating forward at least through the stocker phase, and the stocker operator increasingly having to accept the responsibility of feeding his grazing cattle.

All of our research should be aimed at maximizing the grass in our cattle and minimizing the grain, as this reflects the best use of both the South's resources and a ruminant animal. We can no longer support research aimed at perpetuating the current split of cow-calf, stocker, and feeder. All of us need to realize that every calf that hits the ground ends up somewhere as meat on the table. Calves do not sell for $200. They sell for $700 -- at slaughter. This is the only price we need to be talking about.

The true worth of a cow will only be recognized this way. The true worth of breeding and management will only be
recognized this way. The man who owns the cow can control the cattle business. He can always take all the marbles in the game if he wants to. If he chooses not to do this, it is his decision; but we cannot continue to waste the taxpayers' money, and good farmers' time, trying to invent a better Band-Aid to keep our present system going a few more years. It costs no more to build something new than it does to perpetuate the past. The present system doesn't work today and certainly won't work in the future with cheaper beef prices.

There are those defenders of the present system who are saying we need to cut the herd again to get the prices up. The problem with this thinking is that grass has no value without ruminants. Let's let the chicken and pork guys cut back. Haven't we learned in the last few years that any decrease in beef supply will be filled almost overnight with pork and chicken?

We in the South have always been willing to bend to the wishes of the grain-based national industry. In 1975, when they said we had too many cattle, we decimated our herds while the rest of the country stood pat and barely reduced theirs at all. Today with our hillsides washed away and our bankruptcy courts full of rowcrop farmers, they are asking us to do it again. I say it is time to tell them to shove it!

Since 1974, cattle feeders have lost money 74% of the time. No amount of cutting back will change this percentage. As cattle feeder Bill Brown of Atmore, Alabama, continually points out, "All the money in cattle is made with grass." Probably the only consistent profit we can expect from cattle feeding is in what we save in freight, shrink, and sales commissions, but on an 850-lb steer this is a considerable amount of money.

If America eventually joins the rest of the world in eating grass-fed beef, it will not invalidate any of the grazing research we are currently doing. The 1,000-lb plus slaughter weight is a result of our grain-based grading system. No grass-based slaughter system uses this heavy a
weight, but slaughters cattle at what we currently consider feeder-cattle weight. This is the most efficient weight to grow grass cattle to, as research here at LSU has confirmed.

Research at the University of Tennessee has shown that we can come up with a consistently acceptable piece of meat using fully grown grass feeder cattle with approximately 60 days on whole-shelled corn. It is this consistent acceptability that should be the grade standard we in the South are concerned with, especially at the university level.

I guarantee you, if the current 120- to 150-day feeding standard becomes 100% unprofitable over a number of years, the South will not be alone in asking for a grading change. We need to spend all of our time working on the future, not complaining about the inequities of the present system.

All of these changes are just not in Al's crystal ball. They are happening out there in the South, even as I speak. The better cattlemen are full of new ideas and a desire for change. By the end of this decade, all of this ferment and thought will suddenly become apparent, seemingly springing full-grown to people who can't see the struggling gestation of it today.

I believe the future of beef never looked brighter, at least as far as the South is concerned, and that is my and your main concern.

To tie these remarks into the main theme of this conference which is agroforestry, I want to give all of you in the present-day forestry industry a word of warning. This cattle industry I have outlined is not here today, but it's coming. Today, agroforestry is looked upon primarily as an accommodation to cattlemen. We have to prove ourselves to you. Ten years from now, the shoe may be on the other foot. You may, as the New Zealand forest industry is having to do, prove that timber will not detract from grazing production. One only has to go to Missouri and look at the thousands of acres of chemically deadened timber to
see what happens when you force cattlemen to make a choice between cattle or timber.

We who support and promote agroforestry do not want to have to force that choice. We believe that cattle and timber are the best use of the resource and that they are compatible, complementary enterprises. We sincerely hope the forestry industry will join us in promoting total resource farming in the South.

**Discussion**

**Question:** To understand what might happen in forestry in the future, we need to know the ownership mix. Do you have comparable figures for cattle ownership?

**Mr. Nation:** In the lower Coastal Plain of the southeastern United States, the average farm is 289 acres and 50% is in timber production. If you ask the owner if he is a timber producer, he answers, "No, half the farm is just trees".

My wife's family was in "just trees" and "just cattle" and the cattle just happened to get in the trees all the time. There was nothing planned about it. The real potential of the combination comes with planning.

The problem we have with cattle, the same problem as you have with timber, is the heavy front-end cost and long pay-out situation. With the current rate of interest, there is a heavy front-end cost to get into the cattle business.

**Question:** What size is an efficient herd?
Mr. Nation: You should have enough cows for 1 bull to service, so about 35 head would be an efficient herd. However, 65-70% of all cattlemen in the U.S. own fewer than 35 head. The other 30-35% of cattlemen are looking for a better way. About 0.01% of the cattlemen in the U.S. own as many cattle as 85% of all cattlemen. After weaning, about 75% of the calves produced in the Southeast get bunched into herds of 200 or more.

One of the biggest problems is the land cost. We hope timber producers will see that forest grazing could benefit timber operations.

Mr. Mosher: There are timber people in Oregon who are looking for bands of sheep and willing to pay to have sheep graze their pine plantations for brush control.

Mr. Nation: It's interesting that the New Zealand people analyzed the economics of combining livestock and timber operations, and the timber people ran out and did it first. They needed a greater return from their land.

Question: Who at the University of Tennessee is looking at combining sheep and cattle?

Mr. Nation: That is Dr. Bill Backus. There will be an article about his work in the May issue of The Stockman. He breaks out the budget and explains the system.

Question: Can you explain what you meant by suggesting that it would be cheaper to ship grain to cattle than cattle to grain?
Mr. Nation: The cost for shipping an 800-lb steer from Jackson, Miss., to a feed lot in the high plains of Texas is $32. During shipping there will be 10% shrink; on a 60¢ market that's worth $48. So, it costs $80 to get the steer to market. It takes 1800 lb of corn to finish the steer and the corn can be shipped from southern Illinois to Jackson for $8, so the savings would be $72. Similarly, we figured that in our present system of 3 ownership changes, the cost of shipping, sale commissions, and shrink and death loss for shipping a calf from Florida to Mississippi and then to the High Plains costs about $150. This represents an extra $150 that the cattle producer could make simply by retaining ownership and operating forward through all phases of beef production.
Progressive beef cattle programs are aimed at reducing break-even cost and creating a potential for profit. Whether the land base is owned or leased, the objective has been difficult to achieve because cow costs (the cost of maintaining a cow) have been high relative to calf prices.

Annual cow costs will vary with such factors as area of the U.S., soil type, primary feeds available, operating costs, and the amount of fixed overhead charged to the cow herd. A sample budget suitable for our purposes is shown in Table 1. Although all of the assumptions are not provided here, the budget is similar to a Louisiana budget for that year and thought by the authors to be representative of average conditions across the U.S.

The difference between cash costs and total costs in Table 1 amounts to a contrast of a one-year budget to a budget which would sustain a cow herd over several years. The effect of fixed overhead increases if the goal is to sustain an operation over several years. Notice, however, that any management practice that would decrease pasture cost and fixed overhead would decrease cow costs and lower calf break-even prices. Low land base costs per cow is an important consideration when examining the potential for profit.

Another approach to establishing the importance of annual maintenance cost is provided by studying the composition of a production unit of 100 brood cows. Assume a calving percentage of 86%, a calf mortality rate of 2% and a cow replacement rate of 15%.
Table 1. Economics of cow-calf operation, 1981 U.S. costs per cow unit\(^1\)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cash Costs</th>
<th></th>
<th>Total Costs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Cow</td>
<td>% of Total</td>
<td>Per Cow</td>
<td>% of Total</td>
</tr>
<tr>
<td>Feed:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture</td>
<td>$100</td>
<td>35</td>
<td>$100</td>
<td>24</td>
</tr>
<tr>
<td>Other Feed and Supplement</td>
<td>$50</td>
<td>17</td>
<td>$50</td>
<td>12</td>
</tr>
<tr>
<td>Total Feed</td>
<td>$150</td>
<td>52</td>
<td>$150</td>
<td>36</td>
</tr>
<tr>
<td>Other Operating Costs:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hired Labor</td>
<td>$25</td>
<td>9</td>
<td>$25</td>
<td>6</td>
</tr>
<tr>
<td>Vet/Supplies/Other Variables</td>
<td>40</td>
<td>14</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Operating Interest</td>
<td>14</td>
<td>5</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Total Other Operating Costs</td>
<td>$79</td>
<td>28</td>
<td>$93</td>
<td>22</td>
</tr>
<tr>
<td>Fixed Overhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machines/Buildings/Fences</td>
<td>$7</td>
<td>2</td>
<td>$32</td>
<td>8</td>
</tr>
<tr>
<td>Livestock</td>
<td>50</td>
<td>18</td>
<td>93</td>
<td>22</td>
</tr>
<tr>
<td>Management</td>
<td>--</td>
<td>--</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Total Fixed Overhead</td>
<td>$57</td>
<td>20</td>
<td>$175</td>
<td>42</td>
</tr>
<tr>
<td>Total Cost/Cow</td>
<td>$286</td>
<td>100</td>
<td>$418</td>
<td>100</td>
</tr>
<tr>
<td>Calf Break-even ($/Cwt)</td>
<td>$78.38</td>
<td></td>
<td>$122.06</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Adapted from Thorpe and Beall (1982).
29

100 Cows
3 Bulls
42 Male Calves
42 Heifer Calves
15 Replacement Heifers

Of the total 202 animals, 15 cows, 42 male calves and 27 female calves are available for sale - a total of 84 animals or approximately 42% of the herd. On the average, about 2 animals must be maintained in the herd for each animal sold. If the use of forest ranges can reduce costs sufficiently, this should be considered where available.

Table 2 shows the production characteristics that are important in the commercial cow-calf industry. Weaned calf-crop percentage, the most important, is a function of fertility, livability and herd health. High reproductive performance is the most economically important characteristic in commercial beef production.

Of the factors affecting reproductive performance, level of nutrition is the most important. When considering forest ranges for cow-calf production, adequate forage production and range carrying capacity must be considered.

Weaning weight is another important consideration. Although other contrasts between the value of reproductive performance and weights (Willham 1978) for returning income to the farm have shown reproductive performance to be relatively more important than indicated in Table 2, weaning weight must be considered. Since weaning weight is a function of the genotype of the calf and milk production of the dam, the importance of adequate quality forage is again apparent. Realistically, however, the negative relationship between weaning weight and price per pound would offset some of the importance of high weights and emphasize again the importance of high reproductive performance.

If forest rangelands are considered as a base for a stocker operation, considerations other than production characteristics of the cattle are important. From Table 3, it is obvious that the most important factors are selling
Table 2. Impact of 5% change in key factors in a cow-calf operation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Change</th>
<th>Decrease in Break-even Price ($/Cwt.)</th>
<th>Increase in Net Profit ($/Cow Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaned Calf Crop</td>
<td>+5%</td>
<td>$ 4.00</td>
<td>$11.00</td>
</tr>
<tr>
<td>Weaning Weight</td>
<td>+5%</td>
<td>3.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Calf Price</td>
<td>+5%</td>
<td>0</td>
<td>10.00</td>
</tr>
<tr>
<td>Feed Cost</td>
<td>-5%</td>
<td>3.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Interest Cost</td>
<td>-5%</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Cull Cow Weight</td>
<td>+5%</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Cull Cow Price</td>
<td>+5%</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>ALL COMBINED</td>
<td>5%</td>
<td>$16.68</td>
<td>$62.00</td>
</tr>
</tbody>
</table>

1 Adapted from Thorpe and Beall (1982).
Table 3. Impact of a 10% change in key factors in a stocker operation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Change</th>
<th>Decrease in Break-even Price ($/Cwt.)</th>
<th>Increase in Net Profit ($/Cow Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Price</td>
<td>+10%</td>
<td>-0</td>
<td>$40.96</td>
</tr>
<tr>
<td>Purchase Price</td>
<td>-10%</td>
<td>$4.87</td>
<td>29.70</td>
</tr>
<tr>
<td>Average Daily Gain</td>
<td>+10%</td>
<td>1.97</td>
<td>12.80</td>
</tr>
<tr>
<td>Average Daily Gain (Shorter season)</td>
<td>+10%</td>
<td>1.35</td>
<td>8.62</td>
</tr>
<tr>
<td>Pasture Cost</td>
<td>-10%</td>
<td>0.97</td>
<td>7.00</td>
</tr>
<tr>
<td>Interest Cost</td>
<td>-10%</td>
<td>0.38</td>
<td>2.43</td>
</tr>
<tr>
<td>Death Loss</td>
<td>-10%</td>
<td>0.14</td>
<td>0.92</td>
</tr>
<tr>
<td>ALL COMBINED</td>
<td>10%</td>
<td>$8.33</td>
<td>$84.40</td>
</tr>
</tbody>
</table>

1 Adapted from Thorpe and Beall (1982).
price and purchasing price. High average daily gains are important also, but not to the extent of the buying and selling prices. Forest ranges, which probably would not be tilled to produce high quality seasonal forages, might be entirely satisfactory for a stocker operation base.

Several cattle types and varieties would probably fit forest grazing schemes, but two cautions should be exercised. First, avoid females of the extremely large, late-maturing breeds and types. Maintenance requirements increase as mature size increases. Long et al. (1975) suggested that larger mature types are more suited for intensive management and feed regimes. Second, in any long-term operation, reproductive performance must be monitored to indicate level of adaptability. If 85% or more of the mature cows are producing calves each year within a 365-day period, adaptability is probably sufficient and some intensification of management would probably elevate reproductive performance to a more profitable level.

The Brahman F\textsubscript{1} female has proven to be adaptable, fertile, ample in milk production, and long lived under a variety of environmental conditions. Her greatest shortfall is that she does not replace herself in most breeding schemes recommended. This deficiency can be overcome by purchasing other F\textsubscript{1} females of the same type as needed and partially overcome by using F\textsubscript{1} bulls of the same type to produce F\textsubscript{2} calves or by using bulls of the American breeds to retain some of the Brahman base in the female replacements.

For the most part, other proven effective beef management practices can also be applied to animals using forest ranges. My opinion is that a lack of understanding of the relative importance of factors affecting profits or losses is probably much more limiting than the forest ranges themselves.
Literature Cited


Discussion

Question: Could you describe the tax benefits from buying and depreciating replacement cows?

Dr. Chapman: I can't do it adequately, but there are tax benefits.

Question: Regarding lighter calves being worth more than the heavier calves, what happens if the operation is run forward through the stocker phase?

Dr. Chapman: If people listen to us and produce heavy calves, they probably would not have a local outlet for them. It would probably be more profitable to retain ownership from that point. Whether ownership is retained on a forage-based system or a grain-based system is the question. The 550- to 600-lb calf can be obtained at weaning, but the question is whether you have a system to keep them rolling forward from that point. In total dollars, the heavier calf will bring more,
but the price may be 7-8¢/lb less, so the profitability of producing a heavier calf might be lower than for a lighter calf.

**Question:** On woodland range many calves wean at 400 lb. We have seen that these stressed calves have a compensating pop; they gain faster than calves right off the tit. Do you agree with that statement?

**Dr. Chapman:** Yes, there are compensatory gains on hardier calves providing they have a little age on them.

**Question:** Would Dr. Pat Bagley comment on the weaning weights of calves from forest range compared to those produced from improved pastures at the Rosepine Research Station in western Louisiana?

**Dr. Bagley:** Calves from the forest range are much heavier. They are Brahman-cross cattle. When we first started the program, calves weaned at about 350 lb. We added some creep grazing on improved pastures and now the calves wean at 550-585 lb.

**Dr. Chapman:** My concern is that calves from the forest range might have to come off at an earlier age. The additional weight might not pay for the supplemental feed. That is a question that each cattleman will have to answer for himself.

**Question:** How many people who run cattle on forest range have supplemental pasture available?

**Dr. Bagley:** If you don't own the forest, obviously your management options are limited. We have two 5-acre creep pastures, 25 cow-calf pairs and 350 acres of forested range. We also have about 7 acres of firelanes producing clover.
and bermuda which are over-seeded with ryegrass for winter grazing. These areas are also used for hay production in summer.

Dr. Linnartz: I think you can work with forest industry to obtain chain-wide cleared firebreaks. These areas can be treated with basic slag and seeded with a forage such as lespedeza or clover. So you can have improved pasture and a permanent firebreak. This system can also greatly reduce soil erosion which often occurs with annually plowed or disced firebreaks.

Dr. Chapman: My point is that it is good to get high calf weights, but you also have to have good reproductive performance in a cost-effective system before we can claim to do well in the cow business.
About 100 million acres of forest land in the Southeast have the potential to produce forage for livestock. Seven million acres of that land is in Louisiana (Shiflet 1980). Though timber production is considered the primary land use, substantial numbers of range livestock graze the forage that grows under the trees. Cattle herds commonly graze yearlong and are typically under small herd ownership. Cattle numbers are closely related to the availability of private nonforested grazing land and cropland used for hay (Byington et al. 1983). Some producers graze livestock entirely on a woodland range and, in many cases, depend on absentee owners or industrial timberlands and National Forest grazing allotments for their forage. Research and practical experience have provided some alternatives and recommendations regarding management and economics of cattle production on native forest ranges in the South. The research results are from continuing work done at the Palustris Experimental Forest in central Louisiana, and practical experience has been obtained from cattlemen, not only in Louisiana but throughout the South. Specifics pertain mainly to the longleaf-slash pine forest type, but they also apply generally to the bordering loblolly-shortleaf pine and oak-pine types (Figure 1).
Figure 1. Forest range types of the South (Byrd 1980).
Multiple-Use Management

Because of the potential changing markets and national needs, diversity in management is important when woodland is used for grazing. Management flexibility helps livestock producers survive poor markets as well as supply the needed food and fiber commodities for the nation.

When developing a woodland grazing operation, the livestock operator should be aware of the total multiple-use management concept. The primary land use is for the production of wood. Consequently, timber, livestock, and wildlife management should operate in harmony.

Cattle damage to young pine plantations is a major concern of foresters, while dense tree canopies that shade out the forage is a primary concern to cattlemen. Tree and forage relationships are the most important influence in determining forest grazing potentials. Any forest management practice that alters the overstory will change forage potentials. Forage yields decrease as timber canopies increase (Gaines et al. 1954, Halls and Schuster 1965).

Where an active effort is being made to grow timber on range, coordination of cattle and forest management is essential. With planning, some practices can serve both interests. For instance, correctly timed prescribed burns can aid the timber grower in controlling undesirable hardwoods, reducing hazard from wildfire, preparing seedbeds for pine regeneration, and controlling the brownspot needle blight of longleaf pine (Pinus palustris Mill.) seedlings (Halls et al. 1964, Grelen 1975), as well as improving forage quality for cattle.

The key to success in forest grazing and pine regeneration is maintaining a balance between forage and animals. Management guidelines developed to reduce cattle damage to slash pine (P. elliottii Engelm.) regeneration include prescribed winter rotational burning and control of grazing intensity (Duvall and Whitaker 1964, Pearson et al. 1971). Only heavy grazing (60% utilization)
significantly reduced pine survival (about 20%) in planted slash pine stands. Avoiding late winter and spring grazing during establishment in the first year alleviated most damage problems, even with high stocking rates. These guidelines appear equally applicable to longleaf pine regeneration (Pearson 1980). Furthermore, pines are highly resistant to grazing damage. In an attempt to simulate grazing damage to pines in Georgia, several types of injury were inflicted on slash pine seedlings, including the removal of needles, removal of the growing shoot, bending of the stem parallel to the ground, and stem girdling (Lewis 1973, 1980a,b,c). These injuries, inflicted in varying degrees and combinations to seedlings 6, 18, and 30 months after planting, showed that mortality was negligible except after complete girdling. Slash pines, and possibly other pines, recover quickly from most of these injuries. Shortleaf (P. echinata Mill.) and loblolly (P. taeda L.) pines browsed within an inch or two of the ground by rabbits survived and grew as well as unbrowsed trees (Wakeley 1970).

Cattle stocking rates are dependent on the kind and amount of forage, which in turn varies with the size and spacing of trees. Forage is most plentiful when the trees are small. It declines as the pines grow and close their crowns, but a useful amount remains if rotation burns are made and the timber stands are thinned periodically (Pearson 1982).

**Grazing Systems**

Prescribed burning reduces plant competition and provides for emergence of early green foliage in the spring, which attracts grazing animals. Burning just before initiation of spring forage growth is recommended for livestock production. Burns improve forage availability by removing accumulated old plant material and stimulate succulent new growth high in protein (Campbell et al. 1954). Burning should be incorporated into the grazing and timber management plans to be most effective. Six to eight acres of newly burned area per cow are recommended for pine-bluestem ranges. The use of fire as a management tool in developing grazing systems is one method of obtaining
livestock distribution. An excellent one-pasture grazing system developed for the forest range is the rotational burning system (Duvall and Whitaker 1964). This yearlong, continuous-grazing program uses a three-year burning rotation and has shown good livestock production while sustaining forage production. This system presents a good baseline for initiation of a grazing program in the forest range situation. It markedly effects utilization of herbage. When the overall utilization is between 30% and 45% of the annual forage produced, the average forage use by livestock will be 70% to 80% during the first year following the burn, 30% to 36% the second year, and 15% to 20% the third year (Duvall and Whitaker 1964, Pearson and Whitaker 1974).

Multi-pasture grazing systems provide greater potential for the livestock operation. More intensive systems provide better rotation for resting and improving the forage resource and help increase the grazing capacity. Livestock distribution problems can also be worked out easier with multi-pasture systems. Electric fences have improved the efficiency and economics of subdividing grazing units. These fences are dependable, low in cost, and relatively maintenance free. One strand of electric cross-fencing is adequate to control cattle after a brief initiation period. Electric fences offer distinct advantages over conventional barbwire fences in a forest range operation, in that smooth wire and suspension type spans can be put up or taken down with relative ease. This is especially helpful during times of timber harvest or other cultural manipulations. In addition to forest range grazing systems, supplemental improved pastures and crop aftermath can also be incorporated into a complete grazing system. These additional forage resources are especially important if grazing on forest range is limited during certain seasons of the year. In all cases, the combined forage resources should be interwoven into a grazing management plan.

In some operations, native forages supplement improved forage operations in critical times of the year. Other operations use improved forages to supplement the native forage resources.
Livestock Management

Livestock supplementation is of major importance when planning a grazing operation using native forages. Native forages in the South are deficient in some nutrients for livestock, especially during the winter. Without supplements, calf crops and weaning weights are low (Campbell and Cassady 1951). Though crude protein in forages reaches 13% in the spring when young green growth is abundant, it drops to 5% during the winter (Pearson et al. 1982). Both digestible energy and crude protein are insufficient for animal maintenance and growth from late fall through winter. Phosphorus is deficient yearlong. A planned supplementation program can materially reduce these deficiencies.

There are several supplemental feeding alternatives for forest range. They include hand feeding of cottonseed meal, cake, or cubes; liquid supplements containing urea and molasses; and fertilized winter pasture. Any one of these alternatives or combination of alternatives may be appropriate for a particular operation (Figure 2).

The supplemental feeding regime to be selected will depend on several factors, including cost of supplements and available labor. Another factor to consider when winter pasture is to be used is the weather. For instance, ryegrass (Lolium perenne) pasture supplementation is unpredictable at best because of the weather. When September or October drought exists, the pasture is not ready for grazing until late winter, if at all; however, when rainfall is adequate, this may be the most economical method of livestock supplementation (Pearson 1982). Subterannean clover (Trifolium subterraneum) is another supplemental pasture alternative (Davis et al. 1983).

If labor is available, hand feeding of about 400 lb of cottonseed cake per head during late fall, winter and early spring may be the preferred method. Feeding on alternate days or three days per week saves labor and benefits livestock as much as daily feeding (Duvall 1969, Pearson and Whitaker 1972).
Figure 2. Relationships between forage and cattle managed for maximum returns on southern pine ranges (USDA Soil Conservation Service 1965).
Each cow needs about 300 lb of hay each winter for cold, rainy days. When wintering open heifers, about 150 lb of cottonseed cubes and 200 lb of hay are adequate. A high phosphorus mineral supplement, such as steamed bonemeal (10% phosphorus) or a commercial high phosphorus mineral mix, should be maintained in a free-choice feeding system year-round.

A controlled or regulated breeding system is also needed when developing a grazing program using native forages in the South. The breeding season should be limited to 3 or 4 months during the late winter and spring. Calves dropped in December through March are old enough to utilize all the milk the cows produce when the native grasses begin to grow during the spring. If the calves are marketed in August, cows will have adequate recovery time prior to winter (Figure 2).

Breeding should be limited to the period from mid-March to mid-June in order to have calves dropped from mid-December through mid-March. Calves born later than March 15 will be light in weight in August; however, in some cases smaller calves may have a decided price advantage. Cows should be kept as long as their calving rate is high and they consistently wean heavy calves. Cows with serious defects and those that fail to calve should be culled. Several criteria of importance in culling are: (1) disposition—problem cows; (2) fertility—all open females more than 5 years of age and all females 2 to 5 years of age that are open more than once; (3) weaning weight—all cows more than 12 years of age with adjusted calf weaning weights more than 5% below that produced the previous years; (4) hardiness—ability to rustle food, produce a calf, retain vigor and body weight, and resist disease; and (5) structural defects—feet, teeth, eyes, udders, etc. These criteria for culling should be used unless abnormal circumstances occur beyond the ability of the cow to produce a weaned calf, such as sterile bulls, calves killed by outside sources, weather, etc. Well nourished range cows should remain highly productive for 10 to 12 years. Heifers equal to about 10% of the breeding herd should be sufficient
to replace cows culled from the herd. If chosen from the herd, heifers should be from cows of known production. Heifers should be at least 27 months old when they have their first calf. Good purebred bulls should sire the herds at a rate of one bull to 20-30 cows. Bulls should be fertility tested before being placed with a cow herd. Crossbred cows which include some Brahman have been among the more efficient producers on the southern forest range.

Last but not least of the livestock management programs is that of herd health. Cattle should be treated three to four times per year for the control of external parasites. Impregnated eartags are beneficial for fly control for about two years, after which a rotation of spraying or dusting and the use of eartags should be practiced. When cattle are concentrated for any length of time, such as in a winter feeding program, internal parasite control in the spring may be beneficial.

Calves should be vaccinated for blackleg. Heifers to be held for replacement should receive vaccination for leptospirosis and vibriosis and be calfhood vaccinated for brucellosis. Bull calves should be castrated at no more than three months of age.

**Economics**

Results from 20 years of research on cattle grazing, slash pine regeneration and growth, and economics at the Palustris Experimental Forest were recently reported (Pearson 1982). Fence cost was estimated to be $2,000 per mile. This value includes labor, equipment and materials to build the fence. This cost, along with corral, water, feeding facility, animal, and transportation costs, were estimated to be an investment of about $850 per cow-unit.

In forest grazing, much of the labor is part-time. Occasionally, several people are needed, but on many days no work is required. Off-season and spare-time labor can be used efficiently, as well as neighbors helping neighbors. On the average, about one-half person would be sufficient to maintain 25 to 30 cows per year.
Range supplementation costs were the largest single operational expense, averaging about $100 per cow annually. Prescribed burning, veterinarian supplies and marketing costs, along with bull and cow replacement, averaged about $50 per cow-unit. Annual cost for depreciation on facilities and equipment was $24 per cow-unit. Annual returns during the first 10 years from cattle grazing were estimated to be a gross of $219 per cow. This was with a $60-per-CWT selling price, 85% calf crop, and 430-lb calves.

The net return per cow was about $48 or 5.6% interest on the investment. This was based on approximately 500 acres of forest range per bull-unit. During the 20-year period, the stocking rate varied from a high of 18 acres per cow in clearcuts and early forest regeneration to a low of 48 acres per cow just prior to initial commercial tree thinning (Pearson 1982).

Forage increased after thinning, as did the stocking rates. Net annual returns varied from a rate of 5.6% during the first 10 years to 2.9% just before thinning. The 20-year average rate of return from livestock was 4.7%. Expanding the livestock information to a 3,000-acre forest range, four timber management alternatives, including a 30-year rotation without thinning and a 60-year rotation with periodic thinnings, were assessed (Lundgren et al. 1983).

The rates of return varied from 0.5% for the 30 years with no thinning to 4.5% for the 40 years with periodic thinnings. Apparently, timber management practices significantly affect annual returns. Similarly, supplemental feeding alternatives also affect returns. Under the three supplemental feeding regimes in the 20-year study, the rate of return varied from 4.9% to 8.5% (Pearson 1982). The most economical supplemental feeding practice was a winter ryegrass pasture. Even this alternative increased in efficiency with strip grazing (Pearson and Rollings 1984). Multi-pasture grazing systems provide the greatest potential for increasing net returns because of an increase in the number of cows on the same land (Lundgren et al. 1984).
Conclusions

Forest grazing presents some new challenges over single-use management, but planning is more difficult. However, the benefits may be worth the additional time and expense.

Land managers must understand tree and forage relationships to achieve proper and efficient use of the forest lands. Successful pine regeneration along with cattle grazing requires deferment of stocking or lighter initial stocking. Effective distribution of livestock may be obtained by burning, feeding, or other means. Early thinning of young pine stands enhances the livestock program. The type and amount of supplemental pastures that might be available can also accrue benefits, both to the pastures and the woodland forage operation. Economic returns are probably greater from multiple products such as timber, cattle, and wildlife, and flexibility in land management aids in surviving poor markets for any one of these forest land commodities.

Literature Cited


Discussion

Question: You said that spring burns are best for livestock in timber. Most foresters try to burn during colder weather. On wiregrass range in central Florida, our cattlemen want to burn in October or November to have green grass for winter. How does that relate to your comment?

Mr. Cutshall: In southwest Louisiana spring burns are best. Could you comment on that, Henry?

Dr. Pearson: Spring burning being best is related to longleaf pine height growth. For livestock we recommend burning in February or March, just prior to spring green-up. If you burn during fall, there is no forage left for cattle to eat. Cliff Lewis should comment about burning in Florida.
In the wiregrass type, we have a different situation. We can burn in September, October, or November and get immediate green-up which will continue through winter. So, in this special case, fall burning is permissible. In Louisiana some fall burning might be all right, but I wouldn't burn all the range.

Question: Does the burning hurt tree growth?

Mr. Lewis: A cool backfire used correctly, even in young pines, doesn't affect growth appreciably.

Dr. Pearson: I want to emphasize that spring burning was designed to consider the nutritional value of the forage. We also found that height growth of longleaf pine was stimulated by burning during May compared to burning in February or March. Longleaf pine might otherwise stay in the grass stage for 5 to 20 years.

Mr. Cutshall: Fall burning would remove forage needed during winter and create a potentially serious erosion problem because of the removal of ground cover.

Question: You mentioned a net gain of $2.50/acre. Is that based on a calf per 6-8 acres?

Dr. Pearson: Those values were based on about 18-20 acres per cow. So, as the tree canopy closes in, more acres are needed and the net profit per acre declines. The average break-even cost of our operation is 47¢ per lb of calf live weight. This is with a winter feed cost of $90 per cow. We have been able to reduce this cost to $65-70 with ryegrass pasture. Obviously, this won't work every year, so there must be some other feed to fall back
on. We are not advocating selling weaned calves but are only set up to study that part of the system and our objective has been to reduce the cost of operation.

Dr. Chapman: The contrast between my figures and yours illustrates the point I was trying to make. If it's profitable and you can calculate what will make a profit, then it's probably the thing to do.

Mr. Nation: The University of Florida did a survey and found that if all producers did what the University of Florida said, we'd have a winter grazing industry and nobody would be able to sell all their calves. However, they also discovered that there were real producers who were spending $100 more than the University per cow.

It's almost an individual thing, but it goes back to what Hollis said. If you ain't got it, I don't think you will go out today and buy it at today's profit. We need to use what we have and make more out of it.

Mr. Cutshall: We need to look at the use of the forest on an individual basis. You might have a wildlife lease or/and a grazing lease. The burning has to fit into each situation.

I would like to point out the problem with a per-acre lease. For the first 10 years following regeneration of timber, the livestock producer is in good shape. However, when the forest canopy closes in, he needs more acres or fewer cows. So, leases should be developed on the basis of the amount of forage available, or what we call an animal-unit basis.
Question: You showed a slide where there was little forage under a dense stand of timber and another where timber was so thin that the area was mostly pasture. Are you trying to maximize the two together? Can you graze through the whole timber rotation?

Mr. Cutshall: You can graze through the whole rotation, but the cattle producer needs to plan for periods when forage production will be low. These resources can be managed compatibly, but they do need to be managed. That's the bottom line.
Farmers of the southcentral United States have many opportunities to integrate forestry and livestock production through agroforestry. Farmers own or rent 78 million acres of land in the region's 360 counties located in Alabama, Arkansas, Oklahoma, Tennessee, Missouri, Kentucky, Louisiana, Mississippi, and Texas (Figure 1). Fourteen million acres of this farmland are forested. Sixty-six percent of the farms sell cattle and calves. As a result of this juxtaposition of woodlands and livestock, grazing on forested lands is common. An analysis of data in the 1978 Census of Agriculture (Bureau of Census 1981) reveals that 7.5 million acres of the region's farm woodlands were grazed by livestock.

Agroforestry is defined as a sustainable land management system to increase overall yields from the land by combining the production of forest plants and crops and/or animals, simultaneously or sequentially, on a unit of land by applying management practices compatible with local cultural practices (King 1979). Livestock grazing on forest land is very common in the South but much of it does not qualify as agroforestry under this definition. All too often forest grazing is opportunistic and even exploitive to the point that overall resource yields are reduced and the resource base is damaged. This low level of management need not exist. Researchers and land managers have developed basic principles of resource management which can enable agroforestry production to be efficient and sustainable, particularly in the Southcentral Region's pine forests (Child and Byington 1980).
1. Texas Blackland Prairie
2. Texas Claypan Area
3. Arkansas Valley and Ridges
4. Ouachita Mountains
5. Southern Mississippi Valley Aluvium
6. Southern Coastal Plain
7. Western Coastal Plain
8. Southern Mississippi Valley Silty Uplands
9. Alabama, Mississippi, and Arkansas Blackland Prairie
10. Gulf Coast Prairie
11. East Gulf Coast Flatwoods
12. West Gulf Coast Flatwoods

Figure 1. The land-resource areas within the study (from Austin 1972).
The challenge before us today is to encourage landowners to implement the management principles discussed during this symposium. In this paper we will concentrate on farmers, since they have major forest holdings and own most of the region's livestock. Unfortunately, this challenge of improving forest grazing will not be easily met. The basic management principles and their associated technologies must be integrated into an overall farm strategy which considers economic factors as well as animal agriculture and forestry. Those in the public and private sectors seeking to provide agroforestry technical assistance to farmers need an understanding of the socioeconomic environment in which farmers operate. Unfortunately, this environment is not constant across the region. A first step in understanding these local variations is to see how such factors as land use and ownership vary across the region's major ecological divisions.

The information presented in the following discussion of land-use and ownership characteristics relevant to agroforestry was developed from data in the 1969, 1974, and 1978 Censuses of Agriculture, using data-processing methods described in Byington et al. (1983). Information is summarized for the region's major land-resource areas (Fig. 1) as they are defined by the USDA Soil Conservation Service (Austin 1972). All information is based on 1978 census data unless otherwise indicated.

**Farm-Forest Characteristics**

Variations in forest density over the Southcentral Region are reflected in the relative importance of forested land on farms in the 12 land-resource areas. Although an average 18% of the region's farmland is forested, the percentage varies from 7% in the Gulf Coast Prairie to over 38% in the Southern Coastal Plain (Table 1). Many ecological and land-use factors contribute to this variation. The most westerly land-resource areas are on the transition between grasslands and forests; two of the areas house the major urban centers of Houston and Dallas-Ft. Worth. The Southern Mississippi Valley Alluvium and the Southern Mississippi Valley Silty Uplands are among the
Table 1. Forested farmland in the Southcentral Region in 1978.

<table>
<thead>
<tr>
<th>Land Resource Area</th>
<th>Percent of Farmland Forested</th>
<th>Percent Reduction in Forested Farmland Since 1969</th>
<th>Average Size of Woodland per Farm; Acres (St. Dev.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Blackland Prairie</td>
<td>7.9</td>
<td>21.7</td>
<td>99 (48)</td>
</tr>
<tr>
<td>Texas Claypan Area</td>
<td>15.8</td>
<td>27.6</td>
<td>135 (27)</td>
</tr>
<tr>
<td>Arkansas Valley and Ridges</td>
<td>21.5</td>
<td>14.4</td>
<td>106 (38)</td>
</tr>
<tr>
<td>Ouachita Mountains</td>
<td>24.7</td>
<td>20.7</td>
<td>103 (49)</td>
</tr>
<tr>
<td>So. Miss. Valley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alluvium</td>
<td>7.3</td>
<td>29.5</td>
<td>149 (99)</td>
</tr>
<tr>
<td>Southern Coastal Plain</td>
<td>36.8</td>
<td>29.6</td>
<td>134 (71)</td>
</tr>
<tr>
<td>Western Coastal Plain</td>
<td>26.0</td>
<td>22.5</td>
<td>125 (72)</td>
</tr>
<tr>
<td>So. Miss. Valley Silty Uplands</td>
<td>17.5</td>
<td>28.0</td>
<td>126 (97)</td>
</tr>
<tr>
<td>Ala., Miss., &amp; Ark.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blackland Prairie</td>
<td>26.6</td>
<td>27.5</td>
<td>189 (90)</td>
</tr>
<tr>
<td>Gulf Coast Prairie</td>
<td>6.9</td>
<td>23.3</td>
<td>186 (77)</td>
</tr>
<tr>
<td>East Gulf Coast Flatwoods</td>
<td>31.7</td>
<td>25.5</td>
<td>101 (17)</td>
</tr>
<tr>
<td>West Gulf Coast Flatwoods</td>
<td>30.3</td>
<td>35.5</td>
<td>245 (192)</td>
</tr>
<tr>
<td>Average for Region</td>
<td>18.1</td>
<td>25.8</td>
<td>134 (82)</td>
</tr>
</tbody>
</table>

The nation's most productive lands and much of the forest has been cleared for intensive row cropping. However, most of the region is extensively forested and will continue to be because of the presence of a large forest industry and soil limitations which restrict more intensive types of land use.
Farmers as a major landowner class have traditionally owned a sizable portion of forested land in the South. In fact, in the early 1950s, farmers owned half of the forested land in the South; however, by 1976, this ownership had dropped to less than one-quarter of the total (Byington 1980). Data in Table 1 indicate that farm-forest acreage has continued to decline substantially in all the land-resource areas in the Southcentral Region. In many cases, the better soil sites have been converted to row crops while poorer sites are sold, converted to pasture or left as forests. As a group, farmers receive low economic returns from forestry (Byington et al. 1983). Two reasons for this failure to develop the economic potential of farm forests is the small size of many of the holdings and the failure to optimize forest-product marketing (Byington and Abruzzese 1983). Although the average farm forest or woodlot is 134 acres, the large standard deviation indicates that many farms have much smaller holdings (Table 1). Such small acreages may not appear to justify the effort needed to manage the farm forest. On the other hand, many farms have forest holdings much larger than 134 acres. For example, a number of farms in the West Gulf Coast Flatwoods have forest holdings of over 435 acres, and those farms along the Gulf Coast that do market forest products make substantial earnings (Byington et al. 1983).

Pasture and Cattle Characteristics

The agriculture census data indicate that the majority of farms in the Southcentral Region have beef cattle. In five of the land-resource areas, over 80% of the farms have beef cattle and only in one area, the Mississippi Valley Alluvium, does the percentage drop below 50. The data also indicate considerable variation in beef-cattle herd size, both between and within the land-resource areas. However, the majority of herds are under 50 animals and nearly all are less than 100, particularly in the more forested areas. Thus, the beef cattle enterprise is seldom large enough to be the sole source of income to support the farm. Cattle farmers must seek ways to expand herd size to achieve an economically sustainable unit or rely on other
land-management activities or off-farm employment for additional income.

On the average, the region's farms have 186 acres of all types of grazing lands. This acreage includes grazed forestland, improved pasture, cropland used only for pasture, and unimproved pasture and range (Table 2). About half the region's farmers who own or rent forested land graze livestock on it. However, the data for the land-resource areas in the region and the large deviations in Table 2 indicate that there is considerable variation in grazing land availability and the willingness to graze forested land.

Table 2. Total pasturage and grazed woodland per farm in Southcentral Region in 1978, acres (st. dev.)

<table>
<thead>
<tr>
<th>Land Resource Area</th>
<th>All Types of Pasture</th>
<th>Woodland Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Blackland Prairie</td>
<td>229 (70)</td>
<td>79 (13.0)</td>
</tr>
<tr>
<td>Texas Claypan Area</td>
<td>283 (59)</td>
<td>88 (4.5)</td>
</tr>
<tr>
<td>Arkansas Valley and Ridges</td>
<td>197 (80)</td>
<td>66 (12.3)</td>
</tr>
<tr>
<td>Ouachita Mountains</td>
<td>176 (106)</td>
<td>59 (14.9)</td>
</tr>
<tr>
<td>Southern Mississippi Valley Alluvium</td>
<td>143 (101)</td>
<td>28 (16.5)</td>
</tr>
<tr>
<td>Southern Coastal Plain</td>
<td>125 (50)</td>
<td>40 (9.7)</td>
</tr>
<tr>
<td>Western Coastal Plain</td>
<td>184 (86)</td>
<td>59 (16.8)</td>
</tr>
<tr>
<td>Southern Mississippi Valley Silty Uplands</td>
<td>142 (85)</td>
<td>40 (16.0)</td>
</tr>
<tr>
<td>Alabama, Mississippi, and Arkansas Blackland Prairie</td>
<td>260 (114)</td>
<td>44 (5.8)</td>
</tr>
<tr>
<td>Gulf Coast Prairie</td>
<td>521 (486)</td>
<td>72 (23.6)</td>
</tr>
<tr>
<td>East Gulf Coast Flatwoods</td>
<td>92 (45)</td>
<td>49 (26.8)</td>
</tr>
<tr>
<td>West Gulf Coast Flatwoods</td>
<td>254 (195)</td>
<td>65 (8.7)</td>
</tr>
<tr>
<td>Average for Region</td>
<td>186 (168)</td>
<td>50 (21.8)</td>
</tr>
</tbody>
</table>
There are opportunities to increase cow herd size in the region through more intensive management of the forage resource. During 1978, about 15% of the pastureland in the region was fertilized. Research and field experience have demonstrated that forage production can be more than doubled through a combination of improved forage varieties and fertilization. Also, much of the grazing of livestock on forested land is opportunistic with little management input and, as a result, much of the productive potential for forage and wood products is lost. Research and experience have demonstrated that forest forage production can be dramatically increased, with benefits also to wood production (Child and Byington 1980).

In summary, the majority of farmers in the Southcentral Region have pasture and forested lands with a high biological potential to produce forage for livestock grazing and forest products. Although technologies are available to develop much of this potential, many of these technologies are not being fully utilized and production is often substantially below its potential. Obviously, many factors in addition to the availability of land, livestock, and technology affect farmers' decisions to implement such intensive management strategies as agroforestry. Prices paid for farm inputs and products are important factors affecting such decisions. But as the data thus far presented indicate, other important socioeconomic factors such as production-unit size also need to be considered in designing programs to promote agroforestry in the region.

**Farmlands and Farmer Characteristics**

Patterns and trends in farm ownership will affect the region's development of its agroforestry potential. The total amount of land under farm management has continued to decline in recent years (Table 3). An analysis of 1969, 1974, and 1978 census data indicates that farmland loss was substantially greater between 1969 and 1974 than between 1974 and 1978, so farmland loss may be leveling off (Byington et al. 1983). Part of the loss of farmland is due to an expanding urban population resulting from a southward migration to the Sunbelt. Some farmers are finding it more
Table 3. Total acres of farmland, number of farms, and farm size in 1969 and 1978

<table>
<thead>
<tr>
<th>Land Resource Area</th>
<th>Total Acres of Farmland per County</th>
<th>Number of Farms per County</th>
<th>Average Farm Size (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX Blackland Prairie</td>
<td>447,844</td>
<td>404,066</td>
<td>- 9.8</td>
</tr>
<tr>
<td>TX Claypan Area</td>
<td>401,655</td>
<td>360,142</td>
<td>-10.3</td>
</tr>
<tr>
<td>AR Valley and Ridges</td>
<td>288,284</td>
<td>262,709</td>
<td>- 8.9</td>
</tr>
<tr>
<td>Ouachita Mountains</td>
<td>167,804</td>
<td>158,887</td>
<td>- 5.3</td>
</tr>
<tr>
<td>Southern Miss. Valley Alluvium</td>
<td>247,498</td>
<td>243,478</td>
<td>- 1.6</td>
</tr>
<tr>
<td>Southern Coastal Plain</td>
<td>174,376</td>
<td>136,903</td>
<td>-21.5</td>
</tr>
<tr>
<td>Western Coastal Plain</td>
<td>178,826</td>
<td>156,523</td>
<td>-12.5</td>
</tr>
<tr>
<td>Southern Miss. Valley Silty Uplands</td>
<td>241,502</td>
<td>214,375</td>
<td>-11.2</td>
</tr>
<tr>
<td>Alabama, Miss., and Arkansas Blackland Prairie</td>
<td>281,417</td>
<td>240,742</td>
<td>-14.5</td>
</tr>
<tr>
<td>Gulf Coast Prairie</td>
<td>431,262</td>
<td>428,406</td>
<td>- .7</td>
</tr>
<tr>
<td>East Gulf Coast Flatwoods</td>
<td>53,139</td>
<td>48,742</td>
<td>- 6.5</td>
</tr>
<tr>
<td>West Gulf Coast Flatwoods</td>
<td>133,671</td>
<td>122,038</td>
<td>- 8.7</td>
</tr>
<tr>
<td>Average for Region</td>
<td>241,257</td>
<td>217,032</td>
<td>-10.0</td>
</tr>
</tbody>
</table>
profitable to sell their land than to farm it. Although the area in farms has declined and reduced the area available for agroforestry, the number of farming units has declined at an even faster rate (Table 3). Many farmers appear to be selling their land to other farmers. As a result farm size on the average is getting larger (Table 3). The trend towards larger farms should improve opportunities for agroforestry since larger acreages permit more efficient commercial forestry. However, owners of smaller farms may still participate in agroforestry by cooperating with neighboring farms to develop joint forest-management plans.

A farmer's age, view of farming as an occupation, and type of farm ownership have a strong influence on which land management options will be considered. The average age of the region's farmers was 52 in 1978. This high average age could be a detrimental factor in a farmer's consideration of a production strategy that requires forest establishment or young-stand management. The farmer may see little appeal in a 30-year forestry investment or in learning new production methods to integrate forestry with existing livestock or crop activities. The advanced age of the farming population makes the issue of land transfer following retirement an increasingly important factor.

Farm ownership is still dominated by various types of family organizations. Families controlled 89% of the region's farms and 77% of the farmland acreage. Non-family ownership is highest in the Mississippi Valley and the Gulf Coast Prairie. These two land-resource areas also have the lowest percentage of forested farmland (Table 1) and a relatively low number of beef cattle (Byington et al. 1983). In contrast, the areas with high beef cattle numbers and large percentages of forested farmland are also the areas with the highest percentage of land under family organizations. Thus, farms under family management appear to be the major farm-ownership type with the opportunity to practice agroforestry. The advanced age of many farmers, combined with family ownership, make the intentions of younger family members toward the farm an important factor affecting farmers' decisions to manage their forest lands more intensively. Even older farmers could be interested in
implementing a new, long-term agroforestry strategy if they expect younger family members to take over the management of the farm. But if it seems likely that the farm will be sold or rented outside the family, there would be much less incentive to invest in a new agroforestry strategy.

Many factors affect whether or not younger family members will take over the management of the farm. One of these factors is the economic viability of the farm and how farming compares to other income opportunities. Only 43% of the region's farmers consider themselves principally as farmers. The majority of farmers, except in the Mississippi Valley, consider farming a secondary activity and have other sources of income. The farm may be held for economic objectives such as an investment, tax shelter, or supplementary source of income. Or it may be held for recreation (such as hunting), as a second home, or for sentimental reasons. Some of these objectives are clearly not compatible with intensive agroforestry management systems focusing on livestock and wood products. Even if additional income is the objective, farmers may not wish to invest the time and resources into mastering agroforestry, particularly when the return on investment may be long-term.

Summary

The biological potential for agroforestry is high in the Southcentral Region, but many socioeconomic factors affect farm-management decisions to develop this potential. Some of these factors can be characterized from the agricultural census and aid specialists in research, technology transfer, and land management to develop and promote agroforestry. An analysis of selected socioeconomic factors indicates that many farmers may be discouraged from considering agroforestry as a management alternative because of constraints resulting from off-farm employment; limited land area available to simultaneously produce marketable quantities of wood products and livestock; and ages of family members and uncertainty of future ownership. However, a substantial number of farmers do not have these constraints. The challenge is to find farmers with larger landholdings and a long-term commitment to agriculture,
particularly those who currently have ruminant livestock and managed forest resources. Chances of successful agroforestry would be higher with such farmers, and their operations could serve as demonstrations for others who have the resource potential but are less willing to risk adopting new production methods.

Literature Cited


SESSION II

FORAGES IN PINE FORESTS

Moderator:

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Limited land resources, the associated high cost of land, increasing property taxes, and increased production costs are forcing land managers to consider new methods for increasing net returns from their land. Agroforestry appears to be an attractive alternative. A silvopastoral approach to agroforestry is the growing of trees and forages together for the production of wood and red meat. In the southeastern USA, this approach usually entails the planting of non-native improved pasture species under planted pines.

Understory forage produced on about half of the 200 million acres of forestland in the South is generally grazable by cattle. However, beef production is limited due to low nutrient and energy content of the native forages. Although pines grow rapidly, landowners receive no income from the trees during the early years of pine plantations. Therefore, the grazing of cattle on forages under these pines could provide some annual income while the trees are maturing. Since pines are relatively unpalatable to cattle (Adams 1975, Williston 1974) and will respond favorably to fertilization (Hughes and Jackson 1962, Hughes et al. 1971, Lewis 1977), it seems reasonable to assume that combining pines and pastures could be made a profitable enterprise. In this paper, I examine several techniques for accomplishing this purpose and discuss some special considerations, such as cattle damage to planted pines.

Introducing Pasture Forage Species Under Pines

The substitution of high-quality introduced forage species for low-quality native forages has been tested in south Georgia. Beginning in 1946, 23 grasses and 14 legumes
were tested over an 8-year period for their adaptability to southern forested range by studying (1) the introduction of grasses and legumes without site preparation, (2) the introduction of grasses and legumes with site preparation and fertilization, (3) the effect of various densities of pine canopies on grass/legume mixtures, and (4) the establishment of pastures on harvested forestland where 3 to 8 seed-trees/acre were retained.

In summarizing results from these studies, Burton (1973) found that establishment was generally poor without mechanical site disturbance and that fertilization was needed to establish and maintain good stands of forage plants. A heavy tree canopy reduced yields of forages and limited their persistence. Best results were achieved with common carpetgrass (*Axonopus affinis* Chase), Pensacola bahiagrass (*Paspalum notatum* Flugge), annual lespedeza (*Lespedeza striata* (Thunberg) H. & A.), and white clover (*Trifolium repens* L.). Pensacola bahia was the most shade tolerant of the warm-season grasses.

In another study, three common pasture grasses were planted under 5-year-old slash pine (*Pinus elliottii* Engelm.). Pensacola bahiagrass, coastal bermudagrass (*Cynodon dactylon* (L.) Persoon.), and dallisgrass (*Paspalum dilatatum* Poir.) were planted under pines spaced 10 x 10 ft and were fertilized annually with nitrogen at 50, 100, 200, 300, and 400 lb/ac (Hart et al. 1970). The grasses became well established during the first year. Forage yields during the second year were 4600, 6000, and 3600 lb/ac for Pensacola bahia, coastal bermuda, and dallis grasses, respectively. By plantation age 10, canopy closure was complete and grass yields dropped to 940, 460, and 660 lb/ac, respectively. Thinning this plantation increased forage yields (especially by Pensacola bahia) for a few years but the canopy soon closed again and forage yields again dropped.

**Combining Pines, Pastures, and Cattle**

The integration of pines, pastures, and cattle was studied for 20 years on the Alapaha Experimental Range in
Berrien County, Georgia (Lewis et al. 1983). Slash pine was planted at 12 x 12 and 20 x 20 ft and kept weed-free by mechanical cultivation for 3 years. Slash pine was also planted at these spacings in native vegetation and was neither cultivated nor fertilized. Coastal bermuda, Pensacola bahia, and dallis grasses were planted the fourth year, and grazing by yearling cattle began the fifth year. Improved pastures were fertilized annually with 100-22-42 lb/ac of elemental N-P-K. All trees had been pruned twice by age 10, at which time the 12 x 12-ft plantations were thinned.

Initial survival of the planted pines was good. However, in the third year a severe infestation by southern pine coneworms (Dioryctria amatella Hulst.) and southern fusiform rust [Cronartium quercum (Berk.) Miyabe ex Shirai f. sp. fusiforme (Bursdall and Snow)] occurred on the fast-growing slash pines. These attacks continued for several years and resulted in 40% mortality in the pasture-grown trees while only 15% of the trees planted in native vegetation died. Little tree damage resulted from grazing because the trees were 4 years old before cattle were placed in the plantations.

After 20 years, the slash pines grown in fertilized pastures were taller (59.0 vs. 52.0 ft) and larger in diameter (12.5 vs. 8.4 inches) than the trees planted in native vegetation. Even with much lower survival, the pasture-grown trees produced about 30% more wood (21.6 vs. 16.6 cd/ac). Wood yields (merchantable volume) were 28.8 and 14.4 cd/ac for the 12 x 12 and 20 x 20 ft spacings, respectively, in pasture plantations as compared to 23.1 and 10.1 cd/ac, respectively, for the native plantations.

Liveweight beef gains during the 15 years of grazing were directly affected by the increasing tree canopy which reduced both gains and stocking rates. Total gain during the study period from treeless pastures was 3500 lb/ac while gains in the 20 x 20-ft and 12 x 12-ft pastures yielded 2100 and 1400 lb/ac, respectively. Pensacola bahiagrass produced slightly greater live-weight gains (2700 lb/ac) than dallisgrass (2400 lb/ac) and both produced significantly
more than coastal bermudagrass (1900 lb/ac). Pensacola bahiagrass was the most shade tolerant throughout the study while coastal bermudagrass was the least and disappeared earlier under both tree spacings.

In the previous study, forage production was sacrificed during the first 4 years to protect the trees. Many landowners, especially the small, nonindustrial owners, cannot afford to forego this annual income. Therefore, another study investigated planting pines and pasture simultaneously but with the trees in widely spaced rows to allow harvesting hay until trees were large enough to permit grazing (Lewis et al. 1983). Slash pine was planted at 91 trees/ac in configurations of 10 x 48 ft and 16 x 30 ft along with coastal bermudagrass or Pensacola bahiagrass. Pastures were harvested for hay the first 3 years, then grazed for 3 years. Fertilizer was applied annually at 200-44-82 lb/ac of elemental N-P-K for hay production and at 100-22-41 lb/ac for grazing.

The tree rows and machinery turning-areas removed 5-8% of the land from hay production. However, after the grasses became well established hay yields were about 7.5 T/ac which is near normal for coastal bermuda and Pensacola bahia in this locale. Machinery operation among the pines was easy and only a few trees were killed by the haying operations.

Slash pine in these pastures grew rapidly, as in the previous study. After 6 years, they averaged 21.5 ft in height and 5.2 inches in diameter. Being of merchantable size, the trees were clearcut and sold for pulpwood.

It should be noted that, in these two studies and in one other (Lewis et al. 1972), heavy infestations of southern pine coneworm and southern fusiform rust occurred in fast-growing slash pine. In other areas where pines and improved forage have been grown together, this has seldom been a problem. Therefore, in areas where these pests are prevalent, this type of management may be troublesome until effective disease and insect control measures are available.
Several landowners across the South have succeeded with a variety of agroforestry practices (Byington et al. 1984, McKathen 1980, Peebles 1980). Container Corporation of America's Woodland Division manages a 150-head, commercial cow-calf herd on its Heather Island tract east of Ocala, Florida. The tract is fenced into five pastures plus an 80-ac bull pasture. Approximately 90 ac of open bahiagrass pasture, 200 ac of bahiagrass planted to pines, 350 ac of planted pines on cutover native land, and 1200 ac of uncut pine-hardwood forest are grazed. Cows are kept in a single herd and rotated among four of the pastures during the growing season. The remaining pasture is rested to allow an accumulation of forage that is used during the winter when cattle have access to all pastures and a 32% molasses-based supplement. Cattle-related tree damage has been minimal and the commercial cow-calf operation has been profitable.

A demonstration area was established in 1977 on the Withlacoochee State Forest near Brooksville, Florida, to examine the opportunity for combining pines, pastures, and cattle in central Florida. Slash pine was planted at 8 x 12 ft on an 80-ac pasture that had been double-disked in the spring to kill the old grasses and then seeded with Pensacola bahiagrass. Cattle were first placed on the area in July 1979. They graze the pine pasture from mid-March to October when they are placed on native forested range supplemented with about 25 ac of annual ryegrass. This management scheme supports about 120 head, the pasture remains very productive, and the trees are about 14 ft tall after five growing seasons.

Unusual Pine Spacing Configurations

Production of improved forage always decreases when canopies close (Hart et al. 1970, Lewis et al. 1983). Planting fewer trees at wide spacings or with wide rows delays the time when forage yields decrease (Lewis et al. 1983) and increases overall forage yields. Unusual patterns of tree planting may also be beneficial. For example, instead of planting at more conventional spacings of 6 x 8 ft with 908 trees/ac, or 8 x 12 ft with 454 trees/ac, using some wide-row spacings of 4 x 15 ft with 726 trees/ac, 4 x
20 ft with 544 trees/ac, or 5 x 18 ft with 484 trees/ac provides adequate stocking of trees while maintaining an open canopy for a longer period of time. Another approach would be to plant strips of double and triple rows of trees with even wider spacings between strips of trees.

In south Georgia improved selections of slash pine and loblolly pine (Pinus taeda L.) were planted in double-row configurations with paired rows at 6 x 6 ft and 18 ft between rows, denoted as a (6 x 6)18-ft configuration, resulting in 605 trees/ac. At age 13 tree heights were 34.7 and 32.3 ft while diameters were 4.7 and 4.6 inches for slash and loblolly pines, respectively. Comparing these trees with adjacent slash pine planted at 6 x 12 ft with 605 trees/ac whose heights and diameters were 30.9 ft and 4.4 inches at the same age, the double-row plantings were growing as good or better.

In central Florida, slash pine has been planted at 454 trees/ac in single rows of 8 x 12, 4 x 24, and 2 x 48 ft along with double rows at (6 x 8)24, (4 x 8)40, and (2 x 8)88 ft. At age 13, all spacings averaged 34 ft and 8.2 inches in diameter. In south Florida, slash pine was planted at 8 x 12 ft and compared with plantings in double rows of (4 x 8)40 and (2 x 8)88 ft. At age 13, these plantings averaged 31 ft in height and 4.6 inches in diameter.

Through age 13, therefore, there has been little difference in tree growth at these unusual configurations. However, there appears to be some effect on tree growth where trees were planted very close (2 ft) within rows. Responses through age 20 should show the full potential of these configurations on tree growth. The real value of these plantings is an open canopy to promote growth of forage plants throughout a rotation. Although these configurations have not been tested with improved pasture species, the results should be good for both forage and tree growth. Another interesting possibility is to plant more trees in the open area between rows some 5 to 10 years before the end of a rotation. These trees would become the crop for the next rotation, and the frequency of final harvests would be increased.
Cattle occasionally damage pine by browsing and trampling (Cassady et al. 1955, Pearson 1976, Williston 1974). During summer cattle occasionally break small trees by riding them to remove insects from their stomachs. The primary reason for severe damage and loss of plantings is having too many animals where there is too little forage or by placing minerals, water, and/or supplemental feed stations within young pine plantations. Young plantations suffer little damage if cattle numbers are kept in balance with the forage supply (Adams 1975, Hilmon et al. 1963, Pearson et al. 1971, Wahlenberg et al. 1939).

Various approaches are available for preventing injury by grazing animals. The most obvious is to fully exclude grazing. Equally successful is deferring grazing during the first growing season or up to 18 months after planting pines (Byrd and Lewis 1983). When grazing is initiated within 2 years of planting, cattle stocking should be kept low; begin with about one cow/calf to 3 ac for a 7- to 9-month period. After the trees are 3 to 5 ft tall, little damage generally occurs and stocking can be increased. Animals accustomed to pines and woodland grazing usually ignore pines while feeding.

Accepting some injury is important because not all injury is damaging to tree survival or growth. Studies in south Georgia have shown that injury must be severe to greatly affect planted pines (Lewis 1980a, 1980b, 1980c). Known levels of injury were hand-inflicted on slash pine at 6, 18, and 30 months after planting. Lewis (1980c) removed foliage at 0, 25, 50, 75, and 100 percent of the needle material. Survival was not affected by defoliation and, after 6 years, little height growth was lost. Lewis (1980b) examined defoliation, browsing on shoots, and stem bending, where 18 combinations of treatments went from the least to the maximum possible. Stem bending had little effect. The highest levels of combined defoliation and shoot removal reduced survival, especially on recently planted seedlings. However, when less than 100% of the needles were removed, there was little impact on survival and older trees
experienced minimal mortality. Height growth was reduced by high levels of combined foliage and shoot removal, especially at 6 months after planting. Six years after treatment these trees were about half as tall as the lesser combinations of injury; older trees were not greatly affected. Anything less than a full girdle had little affect on survival or growth (Lewis 1980a). These studies indicate that slash pine is able to sustain the usual injuries inflicted by grazing animals. However, repeated injury over an extended period can be very harmful to planted pines. Frequent monitoring of young stands is necessary to avoid undue injury which reduces wood production.

Rates and Season of Use

Cattle stocking rates should be established according to the amount of forage being produced, the size of the trees, the species of grass, and the length of the grazing season. As mentioned earlier, grazing should be light until after the trees are about 5 ft tall. After that, stock according to forage production and the desired level of utilization. If the pastures are fertilized annually and shading has not reduced forage yields, stocking can be similar to open pastures of the locale. When shading begins to reduce yields, stocking rates should be reduced accordingly. When trees are planted at 10 x 10 ft or 8 x 12 ft, forage yields will be greatly reduced by age 9 or 10. However, wide-row or double-row spacings should lengthen the time of high forage yields. Thinning and pruning will help maintain forage yields and higher stocking rates (Byrd and Lewis 1983).

The season of use will depend on the landowner's total grazing program and other available forages. However, it is wise to use pastures when they are most productive and nutritious, especially if fertilizer is being applied. Warm-season grasses, such as bermuda, bahia, carpet (Axonopus spp.) and pangola (Digitaria spp.), should be grazed during the spring and summer. Cool-season plants, such as fescue (Festuca spp.) and legumes, should be grazed during the fall, winter, or early spring. Some forage may
be left ungrazed and held for emergency use, but the quality of forage usually declines rapidly as it ages. It is often best to harvest the excess forage as hay.

Conclusions

Combining pines and pastures is growing in popularity around the world. This permits producing substantial liveweight beef gains and rapid growth of planted pines. Special attention must be given to assure a good stand of trees since improper grazing can destroy young pine plantations. Tree density and spacing configurations strongly influence forage yields.

Tree density should be kept relatively low and spacing configuration should allow adequate sunlight to reach the forest floor. Thinning and pruning may be needed to maintain forage production throughout a timber rotation. Insects and disease can be troublesome in fast-growing, fertilized pines. The landowner needs to be attentive to these pests.

The forage species should be relatively shade tolerant for use under pines. Pensacola bahiagrass is more shade tolerant than coastal bermuda, dallis, and common carpet grasses. Bahia offers additional features, such as tolerance of mild flooding or drought and persistence without fertilization. Its ability to thrive under heavy utilization is also an advantage. These characteristics make it very useful for agroforestry in the South.

With careful management, the combined production of pines, pastures, and cattle offers opportunities for multiple-product yields. Landowners should consider these alternatives in their land-use planning.

Literature Cited


Discussion

Question: Is natural pruning affected by the silvicultural burns?

Mr. Lewis: Possibly, but we have burned all our areas. The loblolly and slash pine were not burned for 10 years and natural pruning was taking place anyway. The slide of the loblolly plantation taken in October followed a summer wildfire; because we had been grazing the plantation, the trees were not devastated. Part of the pruning in this case could have been from the burning. We recommend burning even in improved pastures to remove needle cast and control spindle bugs and army worms. Fire is an integral part of our management program.

Question: In our investigations of planting pines in pastures, our people think that the response to fertilizer is linear. Do you feel this is true, and in a planting of trees spaced at 4' x 8' x 40', could you concentrate the fertilizer where there is full sunlight and get the same cattle stocking as if the fertilizer were spread over the whole area?

Mr. Lewis: I don't know how bahiagrass responds to high rates of fertilizer. However, when we put high rates on coastal bermuda, the grass just keeps growing. This would also help keep cows out of the double rows of trees. Our research in tree fertilization suggests that the minimum amount of fertilizer we might use will meet the needs of the trees.

Question: Did you supplement the livestock and what was the season of use?

Mr. Lewis: We grazed our pine-pasture in spring and summer when grasses were lush. We did
supply a salt-phosphorus mixture but utilization of it was low. The fertilized forages provided sufficient minerals during this period.

Question: Could you guess as to the percentage cattle stocking rate that you could use during pine establishment years?

Mr. Lewis: On one area that was in bahiagrass, watermelons were produced one year, then slash pines were planted and the bahiagrass seeded back naturally. We began grazing the second year at about 30 cow-calf units per 90 acres. Within 4-5 years we were stocking at 1 cow-calf per acre. I think, if you are planning to graze within 12-18 months after planting pines, that cattle stocking should be 50% or less of the level you would normally stock.
Multiple use of the southern forest range for wood, livestock, wildlife, and other amenities is becoming popular because of current and future demands on land resources. Southern forests have the climate, soils, water, and light necessary to produce good forage and timber simultaneously (Duvall 1973).

Potential forage biomass production is higher in the South than in other range areas of the United States (Grelen 1978). However, native range production is declining rapidly due to accelerated pine regeneration and the establishment of fast-growing pine species which results in drastically reduced herbage production in a few years. Historically, yearlong grazing of native vegetation on southern forest ranges produces 45% to 50% calf crops with calves weighing 200 to 300 lb at weaning (Campbell and Cassady 1951, Lewis 1980). Studies on pine-wiregrass and pine-bluestem ranges were initiated some 30 to 40 years ago
in Georgia, Mississippi, and Louisiana (Southwell and Halls 1955, Smith et al. 1958, Campbell and Cassady 1951). Subsequently, calf crops and weaning weights have improved with supplements. Supplemental feeds, including cottonseed meal, citrus pulp, pasture grasses, crop aftermath and hay, were fed in different seasons of the years, in various combinations, or in rotation (Shepherd et al. 1953, Southwell and Halls 1955, Southwell and Hughes 1965). The most critical forage need for improving beef yields is during winter; quality hay fed free-choice, cottonseed meal, liquid supplements, or winter pasture help meet this need (Pearson 1982). Lewis and McCormick (1971) found that supplying 0.6 acre of improved pasture per cow along with 10 acres of burned and 10 acres of unburned range during the spring and summer would boost beef yields. Calves weighed over 450 lb at weaning and cows maintained good condition from year to year with good fall-winter maintenance.

One approach to improving the forage resource has been the introduction of improved pasture species into native vegetation. Beginning in 1946, 23 grasses and 14 legumes were tested over 8 years for their adaptability for planting on southern forested range. In a summary of these studies, Burton (1973) reported that establishment was generally poor without site disturbance and that fertilization was very important for obtaining good stands. Tree canopy greatly influenced the establishment and persistence of exotic plants. Species that showed the greatest success were carpetgrass (*Axonopus affinis*), Pensacola bahiagrass (*Paspalum notatum*), annual lespedeza (*Lespedeza striata*), and white clover (*Trifolium repens*). Pensacola bahiagrass proved to be the most shade tolerant of the warm-season grasses. Pearson (1975) identified Kentucky 31 and Kenwell tall fescue (varieties of *Festuca arundinacea*) as cool-season grasses with potential for introduction under southern pines to extend the grazing season.

Our research approach to improving the southern forest range was to evaluate the relative performance of several species and varieties of cool-season grasses and legumes in artificial shade chambers. The chambers were constructed from lumite vinyl shade cloth designed to provide 50% and
25% of natural illumination. The shade cloth was mounted on metal frames with legs to maintain it at 30 cm above the soil surface.

Species were screened initially in a single harvest system for dry matter yield, percent dry matter, height, root and nodule weights, and mineral composition. Some species from the initial screening trials were evaluated further under multiple harvest systems.

Effects of shade on 16 cool-season forages are presented in this paper. The level of shade had relatively little effect on the number of seedlings that germinated (Table 1). Exceptions were Yuchi and Meechee arrowleaf clover and berseem clover which had more seedlings present as level of shade increased. Chief crimson clover had fewer seedlings with shade.

Dry matter yields varied considerably among species and shade levels (Table 1). In general, yields across shade levels were highest for ryegrass followed by the subterranean and crimson clovers. Most yields decreased by 40% or more under 50% shade and by 75% or more under 75% shade. Exceptions were Nangeela subclover and berseem clover, where production was decreased 8 and 12%, respectively, by 50% shade.

In contrast, root yields and the percent of root weight represented by nodules were not affected by shade (data not shown). Root weights ranged from 1.9 to 2.4 gm of dry matter per plant and nodules made up 12 to 15% of the root weight.

There were wide variations in height among species, and shade generally reduced the height of the upright type of species (Table 1). Decumbent species such as the subclovers showed less variation in height among the levels of shade. There was a trend for percent dry matter to be lower in all species as level of shade increased. Plant maturity was delayed 5 to 10 days by shade.
Table 1. Seedling counts, yield, height, and percent dry matter of 16 forages grown under three levels of shade.

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<td>Plant Height (cm)</td>
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<td>18</td>
<td>16</td>
<td>18</td>
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<td>24</td>
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<td>60</td>
<td>54</td>
<td>60</td>
<td>6279</td>
<td>51</td>
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<td>21</td>
<td>15</td>
<td>17</td>
<td>17</td>
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</tr>
</tbody>
</table>

1/ Planted on 10/20/78 and counted on 1/20/79.

2/ Harvested 5/14/79.
Total nitrogen content was not affected by shade but values obtained for the legumes were higher than for the grasses (Table 2). In contrast, potassium content of the grasses was generally higher than for the legumes, and there was a trend for potassium levels of all species to increase as level of shade increased. Phosphorus content increased in all species grown under 50% shade, but values did not change as shade was increased to 75%. There were no trends related to species or shade for sulfur, magnesium, calcium, manganese or boron content. Likewise, no definite trends were observed in iron and aluminum content.

Under a multiple harvest regime, dry matter yields decreased for each species as level of shade increased (Table 3). However, performance of the four species was satisfactory under 50% shade; acceptable yields were produced, and all of the species yielded sufficient seed to re-establish themselves the next growing season. Establishment of a good stand the first year and regulation of late spring grazing to permit seed production are critical to continued persistence.

Our studies emphasized cool-season grasses and legumes because it is during the winter months that adequate forage and browse are least available in the southern pine forest. Legumes such as subclover were evaluated because they are used extensively in forest environments in Australia, they persist under heavy grazing and tolerate abuse, have nitrogen fixation capabilities, are adaptive to harsh environments, grow throughout the winter and spring in the southeastern United States, and are prolific reseeders. Other researchers (Haines et al. 1978, Sawyer 1978) confirm that subclover, crimson clover and tall fescue would be excellent choices for use in forested settings in the South. We feel that benefits would accrue primarily through the following: (1) habitat improvement for wildlife, (2) increased capacity for cattle grazing, (3) fixed nitrogen made available to summer grasses and trees, (4) erosion control during winter and spring, and (5) increased soil organic matter and fertility levels.
Table 2. Average nitrogen, potassium, and phosphorus content of grass and legume species and cultivars grown under three levels of shade

<table>
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<th>Species or Variety</th>
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<th>75</th>
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<td></td>
<td>Total Nitrogen (%)</td>
<td>Potassium (%)</td>
<td>Phosphorus (%)</td>
<td></td>
<td></td>
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<td>2.3</td>
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<td>2.4</td>
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<td>.17</td>
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<td>Tallarook Subclover</td>
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<td>2.4</td>
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<td>.16</td>
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<td>Mt. Barker Subclover</td>
<td>1.7</td>
<td>2.3</td>
<td>2.6</td>
<td>1.3</td>
<td>1.4</td>
<td>1.6</td>
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<td>1.9</td>
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<td>1.1</td>
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<td>2.9</td>
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Table 3. Dry matter yield (lb/ac) of ryegrass, tall fescue, subterranean clover, and crimson clover under three levels of shade

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<td>2/80</td>
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<tr>
<td>Ryegrass</td>
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Literature Cited


**Discussion**

**Question:** In the shade-tolerance screening study, you did not use Mt. Barker variety of subclover, but in the pasture study you compared Mt. Barker with ryegrass. Why did you use Mt. Barker and how does it compare with other varieties of subclover?

**Dr. Pearson:** Mt. Barker was used in the screening study; it didn't produce as well as Oregon Nangeela. However, we used Mt. Barker in the pasture because Nangeela seed was not available to us at that time.

**Question:** Have you attempted to study the affects of root competition between trees and subclover as well as shade?
Dr. Pearson: No; studies are needed regarding the effects of root competition from trees and other plants as well as fertilization rates. We have not progressed that far yet.

Question: You said that to keep subclover in you need to graze it heavily. Should the pine trees be established before the clover or the clover before the trees?

Dr. Pearson: In a pasture, I think it best to establish the clover and then plant trees. For an established stand of timber, go ahead and establish clover. In young trees you would have to defer grazing or use it only lightly in the first and second year. We planted loblolly into clover in March and the cattle were there at that time and remained until May. The cattle did not eat the trees. Longleaf does not seem to handle this very well. We think that over-topping rows of longleaf with electric fencing will solve this problem. If you run out of forage, the cattle will eat the trees. If plenty of forage is available, they prefer not to eat the trees.
During the last 30 years, the pattern of land use in Louisiana has changed substantially. A typical 500-acre farm in 1950 consisted of about 300 acres of row crops, 175 acres of bottomland hardwoods, 15 acres in roads and fences, and 10 acres in the farmstead. Today the hardwood area has been cleared for soybean production, the fences and roads have been eliminated, and the homestead area has been reduced to 1 acre. The same 500-acre farm now consists of 495 acres of cropland and only 5 acres of nonprofit uses.

A similar trend has begun on upland acreage. Most pine timber producers view hardwood trees as weeds. Old fields and logging roads are also being planted to pines. These new land-use practices leave few acres for secondary land resources such as wildlife or livestock production. Resource scientists and managers interested in production of wildlife and livestock must find new and innovative management techniques that are compatible with sound silvicultural practices. A common livestock and wildlife management practice that is not compatible with intensive timber production is maintaining openings to produce winter forage for cattle or wildlife. Landowners must sacrifice from $3500 to $5000 in timber revenues over a 50-year rotation for every acre of land set aside to produce winter forage.
A viable alternative to traditional winter pasture and wildlife food plots is to establish a shade-tolerant forage under pine timber. Watson et al. (1980) tested shade tolerance of 20 cool-season forages currently used for livestock grazing in the Southeast and found that the Nangeela variety of subterranean clover \( (\text{Trifolium subterraneum}) \) produced 92% of its potential under 50% shade and performed well under 75% shade.

Past research has shown that, in addition to its shade tolerance, subclover (1) is well adapted to droughty and acidic soils commonly found on the Gulf Coastal Plain, (2) does not require nitrogen fertilizer, (3) is highly nutritious, and (4) with proper management will volunteer indefinitely (Knight 1978). In addition, bloat is generally not a serious problem with subclover (Rossiter 1978).

A cooperative research effort was made by the Louisiana Agricultural Experiment Station and the USDA Forest Service Southern Forest Experiment Station to determine what silvicultural and agronomic practices could be combined for successful establishment and maintenance of subclover in Louisiana pine forests.

**Methods**

We established 44 study plots on the Palustris Experimental Forest near Glenmora, 24 on the Idlewild Research Station near Clinton and 24 on the Lee Memorial Forest near Sheridan, Louisiana. Pines were thinned to goals of 0, 40, 80, and 120 ft\(^2\)/acre of basal area. An equal number of plots at Glenmora were established in loblolly, slash and longleaf pine plantations. Plots at Clinton and Sheridan were established in stands of loblolly/shortleaf and loblolly/slash/longleaf pine, respectively. Pines at all locations ranged from 20 to 30 years old.

During summer 1981, hardwood trees were removed and the plots were prescribed burned during early September. Oregon Nangeela variety of subterranean clover seed was broadcast at 10 lb/ac during mid-September. Half of the plots at
Glenmora were fertilized with 200 lb/ac of 8-24-24. The remaining 22 plots were not fertilized. Half the plots at the other 2 study areas received 200 lb/ac of 8-24-24, while the remaining plots received 400 lb/ac of 8-24-24 fertilizer. Only 2 plots at Glenmora were fertilized the second year (fall 1982). Plots at the other 2 study areas that had been treated with the high rate of fertilizer in 1981 were fertilized with 200 lb/ac of 8-24-24 in 1982. Those plots receiving the low rate of fertilizer in 1981 were not treated with fertilizer in 1982. Plots were mown in August 1982.

A spherical densiometer was used to measure pine canopy cover. All plots were clipped during May, and samples were oven-dried and weighed.

Results

Clover established well on 5 of 44 plots at Glenmora, 23 of 24 plots at Clinton and none of the 24 plots at Sheridan. Clover on plots that did not establish were chlorotic and ineffectively nodulated. Lack of sufficient rain after seeding the plots at Glenmora and Sheridan was suspected as the reason for Rhizobium mortality. Toms (1958), Morley (1961), and Date (1970) emphasized that Rhizobium survival is highly dependent on incidence of rain after sowing, especially if seed is broadcast. Plots were reseeded at Sheridan during November 1981 and at Glenmora during November 1982. All plots established well after the November reseeding.

Volunteer clover was evaluated during fall 1983. All plots receiving fertilizer both years volunteered well, most plots that had been fertilized at least the first year volunteered well, but unfertilized plots volunteered poorly (Table 1). Plots at Clinton and Sheridan that had been fertilized only the first year volunteered well but seedling density appeared much lower than on plots fertilized both years.

Spring clover yields varied considerably among plots but were similar among the 2 years. May production on
Table 1. Proportion (percent) of Nangeela subterranean plots that volunteered successfully during fall 1983 in 3 Louisiana pine forests

<table>
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<th>Pine type</th>
<th>Fertilized</th>
<th>Unfertilized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glenmora</td>
<td>Clinton</td>
</tr>
<tr>
<td></td>
<td>N = 22</td>
<td>24</td>
</tr>
<tr>
<td>Slash</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>Longleaf</td>
<td>84</td>
<td>---</td>
</tr>
<tr>
<td>Loblolly</td>
<td>86</td>
<td>100</td>
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</tbody>
</table>

1 Plots at Clinton and Sheridan were fertilized in fall 1981 and 1982, while plots at Glenmora were fertilized only in fall 1981 with 8-24-24 at 200 lb/acre.

successful plots ranged from about 1000 to 4000 lb/ac. We don't know how much clover was used by all wildlife, but use by deer was heavy. Successfully established plots under slash pine at Glenmora produced the most forage with plots at Clinton and Sheridan following in order (Table 2). Fertilization rate did not significantly affect clover production the first year, but clover production was about 50% greater on fertilized plots the second year. Lack of difference the first year was probably due to release of nutrients following site disturbance from hardwood removal, logging and burning. Clover production with the 400-lb-per-acre rate of 8-24-24 was no greater than production with 200 lb per acre.

Clover yields were highly associated with site, fertilization, and canopy cover ($r^2 = 0.80$, Figure 1). The
Figure 1. Relationships between pine timber canopy and clover yield from fertilized and unfertilized plots.
Table 2. Average production (lb/ac of oven-dry forage) for fertilized subterranean clover. Production values do not include clover used by deer or other wildlife; deer grazed study plots heavily from early to late winter.

<table>
<thead>
<tr>
<th></th>
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<tbody>
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<td>*</td>
<td>*</td>
<td>542</td>
<td>2935</td>
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<td>*</td>
<td>2060</td>
<td>1545</td>
<td>1399</td>
<td>1261</td>
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</tbody>
</table>

* Clover failed to become established.

relationship between clover yield and canopy cover was less associated for unfertilized plots ($r^2 = 0.50$).

Field Tests

Using information obtained from the first 2 years of the study, we established a 10-acre forested pasture to be used for winter grazing on the Palustris Experimental Forest. In summer 1983, we choose a site with a well drained soil and pine timber basal area of 70-80 ft²/acre. Slash pines were about 23 years old. The site was prescribed burned during late September. We fertilized portions of the site with either 200 or 400 lb/ac of 0-24-24 or 100 lb/ac of 0-46-0, in an attempt to determine whether potash fertilizer is really needed.
Rates of phosphorus and potassium fertilization were varied because, unlike previous study plots, the 10-acre forested pasture will be grazed by cattle. The phosphorus need for regrowth after grazing might be greater than the 48 lb per acre of $P_2O_5$ that seemed adequate for ungrazed study plots. We are trying to determine whether the general recommendations of 90-120 lb of $P_2O_5$ and 90 lb of $K_2O$ (Peevy 1972) for grazed clover pastures is too high. This recommendation was made for clover in general when soil extractable phosphorus levels are very low (<10 ppm). The soils our studies were conducted on contain about 5 ppm extractable phosphorus. Obviously, a more refined recommendation for fertilizing subclover on upland pine sites might substantially reduce production costs. Although we have not studied split dressings of fertilizer, applications split between fall and late winter will probably increase clover yields because we have a long growing season in the Gulf Coastal Plain where peak production of clover is split between fall and late winter-spring. Upland soils tend to fix phosphorus, rendering that applied in fall less available by spring (Tisdale 1975:204).

General recommendations for clover also include liming to get soil pH to about 6. Because of costs, we did not lime subclover on our study areas. Subclover will probably respond to lime, but we don't expect the response to be economically significant in forested pastures. Because lime costs about $40 per ton, we believe it would be less expensive to plant more acres of subclover than to lime.

We also subdivided the site so there would be 3 subclover varieties seeded at 15 lb/acre (Oregon Nangeela, Mt. Barker, Woogenellup). To insure effective nodulation, we waited until there was rain (the first week in November) to seed. Establishment was excellent on all treatments. Although Oregon Nangeela subclover tested to be the most shade tolerant, Mt. Barker and Woogenellup might produce as well under pines and seed for these varieties is more available. Cattle began grazing the forested pasture ad libitum during the first week of April. On April 13 exclosures (1.0 m$^2$) were placed on the pasture and forage was clipped on May 17, oven-dried and weighed.
We also established 4 study plots (0.25 acre each) at Idlewild Research Station near Clinton to compare Oregon Nangeela, Mt. Barker, Woogenellup and Meteora varieties of subclover. Each plot was seeded at 20 lb/acre during the first week of November 1983 following mowing and light discing. We used 2 fertilization rates so that each plot was split into 2 treatments: 200 lb/acre 0-24-24 or 100 lb/acre 0-46-0. Each treatment was again split by topdressing half of each plot with 0-0-60 at 100 lb/acre during the first week of April. Timber basal area was about 80-95 ft$^2$ of 35- to 45-year-old loblolly pine. Forage was clipped, oven-dried and weighed during the third week of May.

At both study sites, Oregon Nangeela subclover generally produced the most forage under timber (Table 3). Woogenellup produced slightly more forage than Oregon Nangeela in 2 treatments. However, in each of these at least 1 plot appeared to have less canopy cover than average and clover yields were well above normal compared to plots affected by more pine canopy. In addition, Oregon Nangeela remained green 2-4 weeks longer than the other varieties. Application of both phosphorus and potassium increased yields compared to application of phosphorus alone; 400 lb/acre of 0-24-24 increased yield by about 50% compared to 200 lb/acre of 0-24-24 whether it was all applied in the fall or split with fall and spring applications, and spring application of additional potassium did not increase yields compared to fall application of 0-24-24 at 200 lb/acre.

These results suggest that the most forage can be produced by applying about 200 lb/acre of 0-24-24 plus 100 lb/acre of 0-46-0 in the fall. Oregon Nangeela appears to be the best variety of subterranean clover for use under pines but Woogenellup is acceptable. Woogenellup seed is also easier to obtain at the present time.
Table 3. Effects of subterranean clover variety and fertilization strategy on May forage yields for establishment year from 2 forest study sites in Louisiana. Data are means from 3 clipped plots.

<table>
<thead>
<tr>
<th>Variety of Subclover</th>
<th>Palustris</th>
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<th>Idlewild</th>
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<tbody>
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<td>1207</td>
<td>1766</td>
<td>1743</td>
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<tr>
<td>Mt. Barker</td>
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<td>566</td>
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</tr>
<tr>
<td>Woogenellup</td>
<td>--</td>
<td>1337</td>
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<tr>
<td>Meteora</td>
<td>--</td>
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</tbody>
</table>

1/ 100 lb/acre 0-46-0; fall.
2/ 200 lb/acre 0-24-24; fall.
3/ 400 lb/acre 0-24-24; fall.
4/ 200 lbs/acre 0-24-24; fall plus spring.
5/ 200 lbs/acre 0-24-24; fall: 100 lbs/acre 0-0-60 spring.

Management Recommendations

Some management recommendations have been developed from our studies. Subclover varieties available in the Southeast will not tolerate prolonged wet soil conditions. Ideal soils should have good surface and internal drainage.
Survival of Rhizobium is critical to successful establishment. A seedbed can be prepared by prescribed burning prior to planting. Seed should be inoculated with Rhizobium bacteria developed specifically for subclover. Inoculation should not be done until just prior to planting. Seed should be planted into moist soil within a few hours after inoculation. Prior to use, inoculum should be stored in a cooler or refrigerator. Inoculum stored on a hot shelf in the farmer's cooperative may be dead; inoculum lying on the hot seat of a pick-up for a few hours will also probably die. Broadcast 10-20 pounds of subclover seed per acre (September 1 to November 15). If a September seeding is followed by wet weather, a good stand of subclover can be expected by December. However, if a dry period follows a September seeding, mortality of Rhizobium bacteria is likely and reseeding will be required in late October or early November. Seed should not be sown if freezing temperatures are expected within 2-3 weeks. We recommend a late October to mid-November seeding to reduce the chance of failure. Our preference is to broadcast seed when it is raining.

Lime was not used in our studies. Subclover produced well on plots ranging in pH from 4.9 to 5.3; however, fertilizer is essential for good production of forage and seed. Subclover should be fertilized with at least 50-60 lb/acre of P$_2$O$_5$ and K$_2$O annually. Apply at least 200 lb per acre of 0-20-20, 8-24-24, or 0-24-24. However, Coats and Johnson (1959) reported that the amount of K$_2$O needed was only about half the amount of P$_2$O$_5$. Mixing seed and fertilizer will kill Rhizobium and must be avoided.

Subclover is a prolific seed producer. Because more than 1000 pounds per acre of hard seed should be produced every spring, an excellent sward of subclover can be produced annually. However, annual management and fertilization are required. It is essential to reduce or remove competing vegetation in late August. This can be accomplished by mowing very close to the soil surface, intensive grazing, light discing, or applying a herbicide to kill the grass. Prescribed burning in August or September may be an alternative to mechanical methods, heavy grazing
or herbicides; we are not certain as to whether this method will work. Too much seed may be damaged by the fire.

Based on a seeding rate of 20 lb/acre at a cost of $1.25/lb for seed and a fertilizer rate of 200 lb/acre of 0-24-24 at a cost of $20.00, out-of-pocket costs for a subclover pasture under pines would be about $45.00 per acre for the initial year. Following the establishment year, maintenance fertilization would cost about $20.00 per acre. If a herbicide is used to remove competing grass, we estimate its cost to be about $9.00-$20.00 per acre. We estimate alternative cultural treatments for control of grass competition in late summer, such as mowing or discing, to range from about $10.00 to $15.00 per acre. Therefore, heavy cattle grazing is probably the most economical way to reduce grass competition under pines. Goats might be needed for removal of brush. Prescribed burning during late August is an alternative that may be used when there is sufficient dry fuel to carry a fire. Burning during late afternoon or evening reduces the chance of damaging timber.

We do not know whether any treatment will yield grazable clover during late fall or early winter under pines. Tree competition for water might be too severe, even in a wet year. However, we expect spring production in an average year to range from 2000 to 4000 lb/acre of dry forage with most growth in the Gulf Coastal Plain occurring during March, April and May. We also expect rotational grazing to extend the grazing season well into June and total clover yields to be about twice as high as that we measured on ungrazed study plots.

Subclover can be grazed as soon as full-sized leaves develop. Pull off grazing when the soil surface and horizontal stems are readily visible. Subclover can be grazed even during flowering and seed set. For optimum production, the rest period following grazing should be about 3 weeks (Rossiter 1978).
Outline of Management Recommendations

1. Select a well drained site.
2. Thin pines to 60-80 ft\(^2\) of basal area.
3. Remove hardwoods.
4. Prescribe-burn in late August or September.
5. Fertilize with 50-60 lb/acre of \(P_2O_5\) and 50-60 lb/acre of \(K_2O\) annually in fall. Top dress in spring with 50-60 lb/acre of \(P_2O_5\) if more forage is needed.
6. Broadcast inoculated seed in late October or early November.
7. Do not mix seed with fertilizer.
8. Remove competing vegetation every August.
9. Graze with cattle or sheep (use it or lose it).

Literature Cited


Discussion

Question: How will prescribed burning fit into your subterranean clover system?

Mr. Davis: We like to prescribe-burn in August or early September. I don't know how many talented people you have, but we haven't had any problems burning during late summer under 25- to 30-year-old pines.

Question: When do you do your annual fertilization?

Lee Davis: We applied fertilizer at the time of seeding. However, we also have top dressed in spring with 0-24-24 and have gotten good responses. The problem is that our soil pH is 4.8 to 5.2. The fall applied fertilizer gets tied-up by spring. So, I suggest a split application of fertilizer. This will probably produce more yield than a single application of the same amount of fertilizer.

Question: It looks like you can grow subclover very well biologically. However, it seems expensive. Have you looked at the costs?
Mr. Davis: Initial cost for seed and fertilizer is about $50 per acre. So, if you choose a pine stand with few hardwoods and thinned to about 80 ft^2 of pine basal area, you can establish the subclover. Then you won't have a seed cost in later years and only need to spend $12-20 per acre for fertilizer. Your labor and burning costs are extra.

Question: Do you have any idea as to what the value is to cattle production?

Mr. Davis: No; we are just getting into the grazing studies. However, after the initial year we are producing 2 tons of dry forage, high quality forage, for $10-$20. Economically this seems very strong.

Question: Do you feel that phosphorus has to be added every year?

Mr. Davis: We are working on unlimed soils and because of low pH the soil ties up the phosphorus. Eventually, the phosphorus will probably build up. However, we have only done this for 3 years. It may be several years before your question can be answered.

Mr. Nation: They are not talking about grazing a cow per 6-20 acres of subclover. They are talking about a cow and a half, or 3 yearlings. It's intensive use. You wouldn't put your whole woods into subclover; you'd use it as a winter pasture. If you could put 3 yearlings per acre on it from February until May, you'd put on 200 lbs of beef per yearling, for 600 lbs per acre total. So, that would be worth about $360 for $15-$20. That's a very economical system.
Question: How does that compare with what's done now; is it cheaper?

Mr. Nation: Subclover is such high quality forage that it's a shame to waste it on a cow. It would be used best in a yearling or sheep production system. However, if you could cut your winter supplementation to 6 weeks per year rather than 3 or 4 months, a lot of cow-calf people would view it as very economical. Considering reproduction, the quality of forage is what makes the cow cycle. It's worth a lot for that alone. One of the things we need to look at is that clover is very tolerant to very high stocking rates. We need to learn to use what we grow, and the harder you graze it the faster it grows.

Question: Do you have information on nutritional quality of subclover?

Mr. Davis: Roughly, crude protein is about 25%. Dr. Johnson, help.

Dr. Johnson: Quality varies through the season. Crude protein content of leaves can be as high as 40%. Consistently, the plant is above 20%. Phosphorus varies from 0.2–0.3% and calcium varies from about 1.1 to 2.2%.

I want to stress several points covered by Lee Davis. You do not go to the farmer's coop and get inoculant -- you get subterranean clover inoculant. Many people buy the wrong stuff. It should be stored in a cooler; not on a hot shelf. Don't lay it on the dash of a pick-up. Take it home and put it in the refrigerator. Don't inoculate the seed until you are ready to plant. Absolutely, do not mix inoculated seed with fertilizer. A lot of people mix grass seed
with fertilizer and spread it in one operation. Don't try this with clover or any legume. We must seed onto or into moist soil. Rainfall is essential when seeding on top of the ground. We like to have rain before and after seeding. We prefer to seed during rainfall. We have never had a failure when doing this. The \textit{Rhizobium} survival is critical. The $1-$10 spent for \textit{Rhizobium} compared to the hundreds spent for the rest of the operation is the most important.

**Question:**
Could we use rock phosphate to supply phosphorus to subclover for many years rather than having to fertilize every year? This question is for Gene Shoulders or Cliff Lewis.

**Dr. Shoulders:**
I really don't know, but you need enough phosphorus available in sufficient quantity at the proper time.

**Mr. Lewis:**
We followed the response of native forage to ground rock phosphate for 5 years and looked at tree response for about 15 and saw a continued increase in nutrient content and production. In the corn belt, they were still getting responses for 20-25 years. We should look at this for subclover.

**Dr. Shoulders:**
I would add that recent work has indicated that advantages of ground rock phosphate seem not to be so important now. Also, I would consider using a rapidly available form for the first year or two.

**Mr. Lewis:**
I also think that the ground rock would be more useful in a situation where it would be incorporated into the soil.
RESPONSE OF PINES AND NATIVE FORAGE TO FERTILIZER

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and

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Introduction

Other papers in these proceedings emphasize opportunities for increasing forage production of southern forest ranges by applying the principles of agroforestry to their management. Since most of these lands will continue to be managed primarily for pine timber production, it is important to evaluate what impact practices applied to increase forage yields will have on timber production. It is also important to understand how timber management practices such as fertilization, thinning, and vegetation control affect forage production.

In this paper we address three important aspects of these relationships: (1) the potential for increasing pine timber production through intensive management practices—especially fertilization, (2) the effects of these treatments on production of native forage, and (3) the probable influence on growth of planted pines of annual applications of fertilizers to increase forage yields.

Fertilization of Pine Plantations

Precise estimates are lacking of how many of the more than 70 million acres of southern pine forests will respond enough to fertilization to make the practice profitable. Soils of much of the entire area are infertile, and fertilizers would increase pine growth on many of them.
Even with current practices and prices, scientists of the North Carolina State Forest Fertilization Cooperative (Allen and Ballard 1983) estimated that at least one-half of the existing loblolly pine plantations would yield economical returns from fertilizer applications at some time during the rotation. Other reports (Pritchett and Smith 1972, Fisher and Garbett 1980, Pritchett and Comerford 1983) indicate that fertilization significantly increased growth of slash pine in about two-thirds of the University of Florida Forest Fertilization Cooperative's tests with this species. Research in Louisiana (Shoulders and Tiarks 1980, Tiarks 1983) has shown that fertilizers can increase pine growth enough to return a profit on productive as well as on obviously nutrient deficient sites.

Although the potential has been demonstrated for increased returns from fertilization on a variety of sites, routine application of fertilizers to all or even half the pine sites in the South is not apt to occur in the foreseeable future. From the mid-60's through 1980, about 1 million acres were fertilized operationally in the Southeast (Prichett and Comerford 1983). The total is expected to increase by about 250 thousand acres annually through the next decade (Bengtson 1979). Hence, a realistic projection may be that about 5% of southern pine forests will have received one or more applications of fertilizer by 1990.

Unlike agronomic crops where annual fertilization is normal practice, pine plantations may need to be fertilized only once during a 30- to 40-year rotation. Certainly, no more than 2 or 3 applications during the rotation can be justified from cost-benefit analyses of currently available data. This is especially true of nutrients such as phosphorus and potassium that are retained by the ecosystem. However, even the more mobile nitrogen may increase growth for 7 to 9 years after application to an established plantation (Pritchett and Comerford 1983).

Fertilizer trials across the South have identified nitrogen and phosphorus as the major nutrients to which pines respond (Allen and Ballard 1983, Pritchett and
Commerford 1983). Though laboratory tests often show very low levels of potassium in Coastal Plain soils, pines are apparently able to satisfy their needs for this nutrient by efficient internal and external cycling of the quantities that are available (Pritchett 1979, Ballard 1980). However, responses to potassium may occur after nitrogen and phosphorus deficiencies are corrected.

Presently, the only sites that are operationally fertilized at stand establishment are on soils that are so phosphorus deficient that acceptable growth is not expected without added phosphorus. Current recommendations for these soils call for the application of 40 to 80 lb per acre of phosphorus, -i.e., 280 to 560 lb per acre of ground rock phosphate or 200 to 400 lb per acre of either concentrated superphosphate or diammonium phosphate. This amount of diammonium phosphate would also supply 36 to 72 lb per acre of nitrogen, which could stimulate the herbaceous competition. Therefore, this material should only be applied where herbaceous vegetation is to be controlled or is not expected to be a problem.

Recommendations for fertilization of established stands call for applications of 100 to 150 lb of nitrogen per acre and 40 to 80 lb of phosphorus, if soil tests or foliar analyses indicate the latter is needed. Plantations that are fertilized at the time of establishment may not require additional phosphorus later in the rotation. Ammonium nitrate (33.5% N), diammonium phosphate (18% N, 20% P), or urea (46% N) are equally suitable materials for supplying nitrogen, so selection can be based on availability and price.

**Timing Fertilizer Application to Maximize Response of Pines and Forage**

Newly planted and well established pine plantations are dramatically different environments. A basic understanding of these environments is necessary in order to develop a fertilization regime to maximize both pine and forage production. The amount of response that can be expected
from fertilization depends in part upon the degree of competition from the alternate crop (Fig. 1).

Research seems to indicate that pines respond best to fertilization at (1) stand establishment, (2) immediately following thinnings in stands managed in longer rotations, and (3) about midway through a pulpwood rotation if the trees are to be grown to harvest age without thinning. Newly established and recently thinned stands offer the greatest opportunity for forage plants to respond to fertilizers.

**Fertilization of Newly Established Plantations.** — In newly established plantations, forage dominates the site. Additions of small amounts of nutrients will increase the growth of both forage and trees. However, competition from the forage rather than nutrient deficiencies soon becomes the factor limiting tree growth. Additional increments of fertilizer will not increase tree growth unless some of the competition is removed.

In one central Louisiana study (Tiarks and Haywood 1981), first-year growth of slash pine in a native bluestem rough was unaffected by fertilization with nitrogen, phosphorus, and potassium at rates of 100, 87, and 58 lb per acre applied at planting. When herbaceous growth was eliminated mechanically by hoeing a strip 5 ft wide on both sides of the row of trees, the fertilizer produced a 5-fold increase in total aboveground biomass of the pines (Fig. 2). In the experiment, competition was removed from a wedge-shaped area that increased in width from 0 to 10 ft over a distance of 150 ft. Response to the fertilizer was proportional to the width of the hoed strip. By age 4, the fertilized uncultivated pines had overtopped the herbaceous vegetation and were equal in total ovendry weight to the unfertilized trees that were given complete release from herbaceous competition (Fig. 2). But trees that were fertilized and completely released weighed 163 percent more than either the unfertilized-released trees or the unreleased-fertilized trees. Total heights after four years averaged 8.5 ft with no fertilization or competition control, 9.2 ft with competition control alone, 10.5 ft with
Figure 1. Idealized response to increasing rates of fertilization of two crops growing together.
Figure 2. Effect of fertilization and cultivation on aboveground biomass of young slash pine (from Tiarks and Haywood 1981).
fertilization alone, and 14.4 ft with both fertilization and control of herbaceous vegetation.

Delayed response of pines to fertilization at planting is not unusual on sites occupied by herbaceous plants. In another study, response to a preplanting application of 88 lb per acre of phosphorus was delayed three years, until pines began to dominate the site (Tiarks 1983). The response that followed was still evident at age 13 (Fig. 3). No measurements were made of response of herbaceous vegetation to fertilization in these experiments.

In another study on a recently harvested site in the pine-bluestem type of Louisiana, all vegetation was destroyed by root raking prior to planting. A fertilization treatment of 100, 44, and 83 lb per acre of nitrogen, phosphorus, and potassium was applied at the time of planting. Another treatment was complete herbaceous control on 60% of the area around each tree, leaving a buffer strip of herbaceous plants for erosion control. The herbaceous competition control increased tree height significantly during the entire measurement period (Haywood and Tiarks 1981). Fertilizer significantly increased tree height in the early years but by age 5 the difference in height was not significant (Fig. 4). Fertilization also increased herbage production on this site by a significant amount in the first 4 years but by age 6 the herbaceous production was unaffected by fertilizer (Fig. 5).

Two other points from this study are of particular interest for range utilization. First, brush control did not increase herbage production until the sixth year (Fig. 5). Second, the mechanical removal of all vegetation from 60% of the area around the pine trees reduced second-year herbage production on fertilized plots by only 16% (Haywood and Tiarks 1981). Evidently the remaining herbaceous material also responded to the competition control.

These results are consistent with others from the pine-wiregrass type of north Florida which showed no difference after 5 years in total herbage yields due to fertilization at time of planting (White 1977). The main
Figure 3. Effect of a preplanting application of 88 lb per acre of phosphorus on average heights of slash pine through age 13 years (from Tiarks 1983).
Figure 4. Effects of fertilization with and without competition control on height of loblolly pine on a root-raked site.
Figure 5. Annual herbage production for six years after fertilization, with and without annual brush control.
reason for presenting these results is to illustrate that in plantations with 500 to 800 surviving trees per acre (i.e., within the range of planting densities commonly used in southern pine plantations), pines do not seriously compete with forage plants for light and nutrients until they are about 5 years old (see also Grelen 1976).

In another Florida study, fertilization with 1 or 2 tons per acre of ground rock phosphate (17% phosphorus, 34% calcium) increased first-year yields of native forage by about 4000 and 5000 lb per acre (Lewis 1970). Because the site was heavily overgrazed, gains from fertilization averaged less than 500 lb of forage per acre annually in the second through the fifth year.

Phosphorus fertilization at rates currently recommended for newly established loblolly pine plantations was tested in another site preparation-fertilization study in the pine-bluestem type in Louisiana. Mature pine stands with a substantial hardwood understory were harvested and the sites were mechanically prepared for planting by various combinations of chopping, shearing, diskng, and burning (Haywood et al 1981). Five groups of closely related soil series were represented, which ranged in subsoil texture from loam to clay and in permeability from moderate to very slow. One half the plots were fertilized at time of planting with 65 lb per acre of phosphorus (325 lb per acre of triple superphosphate). Total herbage production was measured annually for three years.

Averaged across soils and site treatments, fertilized plots produced 429 lb per acre more total herbage than unfertilized plots in the first year, 352 lb per acre more in the second year, and 230 lb per acre in the third year (Fig. 6). Herbage production on unfertilized plots averaged 1704 lb per acre per year, which compares favorably with expected annual yields of about 1 ton per acre for open cutover ranges in the pine-bluestem type (Grelen 1976).

Mid- and Late-Rotation Fertilization.— In older plantations, trees are the dominant species, and response of forage plants to fertilization is limited by the extent to
Figure 6. Effect of 65 lb per acre of phosphorus applied at planting on herbage production on recently harvested and prepared sites (unpublished data provided by R.E. Thill).
which trees occupy the site (Fig. 1 and 7). Response of crop trees to fertilization in established stands may be enhanced by thinning (Fig. 8), and herbaceous plants will also benefit from the reduction of pine basal area stocking and canopy cover (Clary 1979, Grelen and Enghardt 1973, Grelen and Lohrey 1979, Grelen et al. 1972, Hart et al. 1970, Wolters 1973).

Our search of the literature produced only three examples of response of forage plants in thinned plantations to fertilization at rates that are currently recommended to promote growth of pines (Duvall and Grelen 1967, Hughes et al 1971). Each example included applications of 100 and 200 lb per acre of nitrogen with and without 44 to 87 lb per acre of phosphorus. Pine basal area stocking averaged 71 and 85 ft$^2$ per acre, which is within the range of densities recommended to maintain reasonable diameter growth on crop trees in stands managed for multiple products. Stands ranged in age from 21 to 30 years when the fertilizer was applied.

The plantations were widely separated geographically with two in central Louisiana and one in northern Florida. Moreover, the Louisiana plantations were on cutover sites that had never been tilled or fertilized, whereas the Florida plantation was on an old field site that had probably received phosphorus applications. Soil tests of the Florida site revealed that pine would probably not respond to additional phosphorus.

Without fertilization, total herbage yields ranged from about 400 to 900 lb per acre annually, depending on the availability of moisture during the growing season. On the Florida site, applications of 100 lb per acre of nitrogen plus 44 lb of phosphorus or 200 lb of nitrogen alone produced an additional 1,900 lb of ovendry herbage. On the Louisiana sites, 200 lb of nitrogen and 87 pounds of phosphorus were required to consistently increase herbage growth. First-year gains amounted to 1,046 and 1,239 pounds of ovendry herbage per acre. The residual phosphorus on the Florida site is probably the reason for the different phosphorus fertilizer requirements in the two states.
Figure 7. Influence of pine basal area stocking on annual production of coastal bermudagrass at high and low levels of fertilization (adapted from Hart et al. 1970).
Figure 8. Average diameter growth response of 12 loblolly pine stands to thinning and fertilization with 150 lb per acre of nitrogen (adapted from Allen and Ballard 1983).
Herbage production was monitored for four years in the Florida study. The application of 200 lb per acre of nitrogen plus 44 lb of phosphorus almost doubled herbage production (1500 vs 900 lb per acre) in the second year, but had no significant effect in the third and fourth year. No other treatment increased herbage production more than one year.

**Pines in Improved Pastures**

So far, only the increases in native forage production that can be expected as a by-product of fertilizing pine plantations to increase timber yields have been considered. The increased growth of pines from fertilization applied to promote the growth of forage plants in integrated cattle-timber operations must also be examined.

Typically, these integrated operations involve growing of pines at relatively wide spacings in tame-grass pastures that are fertilized annually with 100 to 125 lb per acre of nitrogen, 4 to 20 lb per acre of phosphorus, and 32 to 62 lb per acre of potassium (Lewis 1980, McKathen 1980, Peebles 1980, Hills and Suman 1954, Hart et al. 1970). Nitrogen may be supplied indirectly by including clovers or other fixers of atmospheric nitrogen in the pasture mixture (Hagedorn et al. 1980, Jorgensen and Craig 1983, Burton 1973). In any case, nutrient inputs during a 30- to 40-year rotation will greatly exceed the 100 to 400 lb per acre of nitrogen and 40 to 80 lb per acre of phosphorus currently recommended for culture of pines.

Pines have grown well under these circumstances (Lewis 1980, Peebles 1980, Burton 1973), but probably no better than if fertilizer regimes and other management practices had been tailored to their needs rather than those of the forage plants. Certainly, early competition for light, moisture, and nutrients was no less severe between pines and improved pasture species than between pines and native herbaceous plants in the experiments already described. The need to avoid this competition was recognized in at least one experiment where pines were clean-cultivated for two years to accelerate tree growth and "cow-proof" the stand.
before the improved pasture grasses were introduced (Burton 1973, Lewis 1980). With annual fertilization, trees in the improved pasture were about 4 inches larger in dbh and 5 to 9 ft taller at 20 years than those planted in an adjacent undisturbed wiregrass rough (Lewis 1980). Apparently, pines that had begun to dominate the site were able to compete successfully with the improved grasses.

In another experiment, improved grasses were introduced into a 5-year-old slash pine plantation that had been cultivated and fertilized annually until trees were 2 years old (Hart et al. 1970). After the grasses were established, pines on plots that were fertilized annually with 50 lb per acre of nitrogen, 11 lb of phosphorus, and 21 lb of potassium grew as rapidly as those that were fertilized annually with 100 to 400 lb per acre of nitrogen and corresponding greater amounts of phosphorus and potassium. All plots received some fertilization, so the study did not establish if pines benefited from low rates of fertilization, but it did demonstrate that greater amounts were superfluous to their needs.

One positive aspect of integrating timber production into a cattle operation is that annual fertilization of forage plants will more than satisfy the modest needs of pines for additional nutrients. Another is that annual applications ensure a more even supply of nutrients than less frequent applications; this should be equally advantageous to pines and forage plants if nutrition is the only factor limiting growth. Severe competition between pines and forage plants for light, moisture, and nutrients can be minimized by planting pines at wide spacings and delaying establishment of grasses until pines are well established.

**Summary and Conclusions**

Approximately 1 million acres of southern pine forests have been fertilized with nitrogen and/or phosphorus since forest fertilization became operational in the South in the mid-1960's. The fertilized area should increase by about 1/4 million acres annually during the next decade.
General recommendations for fertilizing pine plantations call for application of 40 to 80 lb of phosphorus per acre and 100 to 400 lb of nitrogen during a 30- to 40-year rotation. Preferred times for applying fertilizers are (1) at time of planting, (2) about midway through a pulpwood rotation if trees are to be grown to harvest age without thinnings, and (3) immediately following thinnings in stands managed on longer rotation for high-value products.

Fertilization at time of plantation establishment has increased yields of native forage by 300 to 5000 lb per acre annually for up to 5 years. More modest gains of 300 to 1000 lb per acre have been obtained from fertilization of recently harvested and mechanically prepared sites. After age 5, actual forage yields and forage response to fertilizer decline as the pines occupy the site more completely. Fertilizers applied at the time of thinning may increase forage yields by 600 to 1900 lb per acre for 1 or 2 years after they are applied.

Annual applications of fertilizers to increase growth of forage plants supply far greater amounts of nutrients than are required for optimum growth of pines. Costs in excess of those normally incurred in fertilizing pine plantations must be justified on the basis of increased production of forage.

**Literature Cited**


TIMBER-PASTURES IN LOBLOLLY PINE STANDS

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Introduction

Forage resources of the southeastern United States encompass 350 million acres. Land use data indicate the approximate resource allocations are 130 million nonforested acres and 220 million forestland acres. Forestlands have a forest climax plant community and are classified as native pasture, pine, mixed pine-hardwood, and hardwood timber types. Since hardwood forests managed for timber should not be considered as a forage resource (Shiflet 1980), actual forest range totals 110 million acres. Loblolly-shortleaf pine-hardwood forests found on the Upper Coastal Plain account for 50% of the forest range resource but grazing levels are considerably less than in other forest range types.

Properly managed loblolly-shortleaf pine-hardwood forests can support an expanded livestock industry and maintain a high level of timber productivity. Thirty-four years of research at the Hill Farm Research Station, Homer, Louisiana, have shown that soils typical of the Upper Coastal Plain region can grow excellent grass and timber. Intensively managed coastal bermudagrass pastures have consistently produced annual animal weight gains in excess of 1000 kg/ha. Pine thinning studies have shown that high quality sawtimber can be produced at stocking rates of 250
trees/ha (TPH) with 30-year volume yields comparable to 750 TPH. These two management systems were integrated into a timber-pasture concept by sprigging coastal bermudagrass in a 30-year-old pine stand. Forage management practiced on this tract has supported 7 months of grazing for 3.7 animal units/ha (AUH) and produced 4.46 m³/ha of sawtimber annually for the past 16 years.

This timber-pasture example demonstrates the biological feasibility of establishing, growing, and intensively grazing improved forage in commercially productive loblolly and shortleaf pine stands. Economic viability of the system depends on optimizing timber and forage yields on a single site at a cost less than required to maximize yields on separate sites. Studies have been established at the Hill Farm Research Station to determine the effect of intensive forage management and utilization on the growth of loblolly pine.

Methods and Procedure

Legumes in Timberland

A timber-grazing management program was initiated on a 60-acre (24-ha) timber tract. Soils were fine sandy loams and loamy fine sands of the Shubuta, Ruston, Bowie, Eustis, Savannah, and Luverne series. The tract consisted of 30 acres (12 ha) of pulpwood and sawtimber with stocking rates of 250 TPH or less and 30 acres (12 ha) of old field planted with 1681 loblolly pine seedlings per ha in December 1982.

Mount Barker subterranean clover (Trifolium subterraneum) was established on 40 acres (16 ha) of the tract in the fall of 1982. Fifteen acres (6 ha) of the mature timber was treated by spraying hardwood understory with a commercial formulation of 2,4-D and dicamba, prescribed burning with late summer backfire, fertilizing with 336 kg/ha of 0-20-30, and broadcast seeding at 22 kg/ha. The planting operation on the old field site included light disking, fertilizing with 336 kg/ha of 0-20-30, broadcast seeding at 16 kg/ha, and a second disking to cover seed. No warm-season, improved forages were
established on the 40 acres but the area was fertilized in May and July with ammonium nitrate at 56 kg/ha. By the end of the growing season, common bermuda and bahiagrass were the major forage components. The remaining 20 acres (8 ha) in the tract received no forage management treatment.

Cattle grazing commenced on March 1, 1983, with 30 crossbred (Brahman x Hereford) cows and was increased to 60 on March 15. Cows grazed until May 4, when they were removed for 10 days to allow warm-season forage development. At this time, an electric fence was constructed to regulate animal usage in the newly planted seedlings. Sixty yearling stockers (B x H) were subsequently placed on the area and grazed through September 15.

Effects of subterranean clover and cattle grazing on pine seedling growth were evaluated for the following treatments: 1) free to graze with clover present, 2) free to graze with clover eradicated, 3) prohibit grazing with clover present, and 4) prohibit grazing with clover eradicated. Treatments were established in the old field site on 0.04-ha plots. Plots were arranged in a randomized-block design with five treatment replications. Grazing was prohibited by constructing fenced enclosures and clover was eradicated chemically.

An initial seedling damage survey was made in February with subsequent surveys in May, June, and September. Damage was classified as browsed, trampled, broken, and dead. Seedling height and ground-line diameter data were collected during the initial survey and at the end of the growing season. Data were analyzed with a standard ANOVA.

**Pines in Pastures**

A 20-acre (8-ha) loblolly pine plantation planted in an established coastal bermudagrass pasture was used to study effects of warm-season forage management practices on young pine tree growth. Soils on the tract include fine sandy loams and loamy fine sands of the Gilead, Bowie, Ruston, Lakeland and Vaucluse series. The pine plantation contained three age classes of trees: 2-year-old trees, planted in

The tract was fertilized in March 1983 with 336 kg/ha of 0-20-30. Ammonium nitrate was applied in May and July at 56 kg/ha. Grazing was initiated on April 15 with 20 recently bred Brahman x Hereford cows. Low forage availability, which resulted from low night time temperatures and a heavy thatch layer, necessitated cattle removal after 4 days. Thatch was reduced by rotary mowing. Cows were returned to the area on May 4 and stayed in the pasture until September 15.

The following treatments were established to determine growth response of each pine tree age class to forage management practices: 1) free to graze with fertilization, 2) free to graze without fertilization 3) prohibit grazing with fertilization and 4) prohibit grazing without fertilization. Within each group, 0.04-ha plots were arranged in a complete, randomized, split-plot design with treatments replicated three times. Main-plot treatments were free to graze and prohibited grazing while split plots were fertilized and not fertilized. Grazing was prohibited by fenced enclosures.

Growth data were collected in the same manner as in the legume study and analyzed with a standard ANOVA.

Results

Legumes in Timber

Excellent stands of subterranean clover were established in the burned timber and old field sites. The 60-acre (24-ha) tract provided 163 grazing days for 60 AU from March 1 through September 15, with the 40-acre (16-ha) clover planting being utilized heavily in March, April, and May. Reseeding was prolific in the fall; however, much of the initial stand died during an October-November drought. A second germination period occurred following late fall rains. The resulting stand survived snow, ice storms, and 2 weeks of continuous freezing temperatures in December.
Although adverse weather limited clover growth, stand re-establishment was not deterred by intense grazing, fall drought, or harsh winter weather.

Grazing had a detrimental effect on loblolly pine seedling growth and survival. Treatment height growth means were 20.4, 19.6, 28.9, and 30.9 cm for treatments 1, 2, 3, and 4, respectively. Significant height growth differences were detected between grazed treatments (1 and 2) and ungrazed treatments (3 and 4) which averaged 20.0 and 29.9 cm, respectively. Additional mean comparisons revealed clover had no detectable effect on seedling growth.

Cumulative seedling mortality in the old field site averaged 49%, with treatments 1, 2, 3, and 4 averaging 79, 42, 56, and 16%, respectively (Fig. 1). High seedling mortality rates were attributed to grazing and clover treatments. Although seedling mortality rate was significantly higher in the grazed treatment, mortality attributed to grazing was 30 and 13% for treatments 1 and 2. Mortality from the clover treatments exceeded the clover-eradicated treatments by 39%. Periodic mortality rates in Figure 1 show that almost 50% of the clover treatment mortality occurred after June 30 when clover growth had subsided. Mortality differential between clover and clover-eradicated treatments was also influenced by the chemical eradication treatment which resulted in season-long competing vegetation control on treatments 2 and 4.

Pines in Pastures

The pine plantation provided 135 days of grazing for 20 AU. Visible grazing damage varied during the growing season and appeared to depend on forage availability (Fig. 2). Damage between April 15 and May 4, when forage level was low, was 83% for the 2-year-old trees and 90% for the 1-year-old trees. As growing conditions improved, forage levels increased and damage declined to 2 and 25% of 2- and 1-year-old trees, respectively, during the May 4 to June 30 survey period. A late summer drought reduced forage availability; by September 15, damage had increased to 58% and 100% of 2- and 1-year-old trees.
Figure 1. Cumulative and periodic mortality of loblolly pine seedlings planted in an old field.
Figure 2. Grazing damage to 1- and 2-year-old loblolly pine trees planted in a coastal bermudagrass pasture.
Tables 1 and 2 contain 1983 growth data for trees planted in 1981 and 1982. Height was the only growth attribute affected adversely by forage management practices. Fertilization significantly reduced height growth of 2-year-old trees; fertilized trees averaged 64.7 cm and unfertilized 68.8 cm (Table 1). Height growth of grazed and ungrazed 2-year-old trees averaged 60.6 and 72.4 cm but the 12-cm difference was not statistically significant. Grazing significantly reduced 1-year-old seedling height growth; grazed and ungrazed seedlings averaged 17.8 and 40.3 cm (Table 2). Diameter and basal area growth averaged 2.4 cm and 5.1 cm² for the 2-year-old trees and 1.2 cm and 2.1 cm² for the 1-year-old trees and were not affected by forage management practices.

Mortality varied by tree age (Table 3). Mortality rate of the 2- and 1-year-old trees was not influenced by forage management. There was no mortality in the 2-year-old trees while 1-year-old trees averaged 17% with no detectable difference between grazing treatments. Mortality rate of seedlings planted in 1983 averaged 78% but did not differ by treatment.

Conclusions

Grazing capacity in loblolly-shortleaf pine-hardwood forests can be increased by converting forest range to timber-pastures. First year results indicate grazing rates of 2.5 AUH can be achieved in pine stands 2 years or older, when an improved forage crop is established and managed properly. These findings corroborate recommendations made by Byrd and Lewis (1983) for managing pine trees and bahiagrass.
Table 1. Mean growth attributes of 2-year-old loblolly pine seedlings

<table>
<thead>
<tr>
<th>Grazing Treatment</th>
<th>Fertilized</th>
<th>Unfertilized</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazed</td>
<td>58.24</td>
<td>63.02</td>
<td>60.63</td>
</tr>
<tr>
<td>Ungrazed</td>
<td>71.10</td>
<td>73.75</td>
<td>72.42</td>
</tr>
<tr>
<td>Mean</td>
<td>64.66*</td>
<td>68.77</td>
<td>66.72</td>
</tr>
</tbody>
</table>

**Height, cm**

| Grazed            | 2.44       | 2.43         | 2.43  |
| Ungrazed          | 2.32       | 2.39         | 2.35  |
| Mean              | 2.38       | 2.41         | 2.40  |

**Diameter, cm**

| Grazed            | 4.99       | 5.29         | 5.15  |
| Ungrazed          | 4.89       | 5.11         | 5.00  |
| Mean              | 4.94       | 5.20         | 5.07  |

**Basal Area, cm²**
Table 2. Mean growth attributes of 1-year-old loblolly pine seedlings

<table>
<thead>
<tr>
<th>Grazing Treatment</th>
<th>Fertilized</th>
<th>Unfertilized</th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
<td>Grazed</td>
<td>17.74</td>
<td>17.83</td>
<td>17.78**</td>
</tr>
<tr>
<td>Ungrazed</td>
<td>43.29</td>
<td>37.27</td>
<td>40.28**</td>
</tr>
<tr>
<td>Mean</td>
<td>30.52</td>
<td>27.55</td>
<td>29.03</td>
</tr>
</tbody>
</table>

*Height, cm*

| Grazed | 1.27 | 1.23 | 1.25 |
| Ungrazed | 1.18 | 1.17 | 1.17 |
| Mean    | 1.22 | 1.21 | 1.21 |

*Basal Area, cm²*

| Grazed | 2.24 | 2.17 | 2.20 |
| Ungrazed | 1.99 | 2.01 | 2.00 |
| Mean    | 2.12 | 2.09 | 2.10 |
Table 3. Tree mortality after one year of forage management

<table>
<thead>
<tr>
<th>Initial Tree</th>
<th>Grazed</th>
<th>Ungrazed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Fertilized</td>
<td>Unfertilized</td>
<td>Fertilized</td>
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<td>1</td>
<td>21</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>Seedlings</td>
<td>77</td>
<td>68</td>
<td>87</td>
</tr>
</tbody>
</table>

Literature Cited


Coastal bermudagrass with 12x12-ft spaced slash pines (top); pines spaced at 4x8 ft with 40 ft between double rows (bottom). Photos by Cliff Lewis; see article, p. 66-78.
SESSION III

PROBLEMS AND POTENTIALS

Moderator:

Bob Felknor
Executive Director
Louisiana Cattlemen's Association
Port Allen, Louisiana
That segment of the cattle industry which uses pineland range as its pasture often bears the brunt of jokes about "hollow tail," "hollow horn" and "a calf every other year." These entities, which science has somehow overlooked, are a source of both merriment for the jokesters and no doubt undue misery for the long suffering bovine. And perhaps a source of shame for their neglectful owners.

The truth is, though, that when adequate management including minerals, hay and meal are provided as needed, range cattle do well. They do better than many herds that are fenced into starvation and internal parasitism on poorly managed pastures.

The potential exists for producing more beef on modified forest range in which the stand of trees is thinned properly and forage is cultivated for the cattle to graze. Properly fertilized soils in the pineywoods will grow a lot of grass and, if this grass is harvested by grazing cattle or the hay baler before it matures, the nutritional value is high.

Recent research and the cattle management studies by the USDA Forest Service clearly indicate the current and potential value of grazing cattle in the woods — and that's no joke.

Now, from a veterinarian's viewpoint, a discussion of herd health in woods cattle.
Phosphorus, Energy, Protein, and Vitamin A

Phrases such as "a calf every other year," "hollow tail," and "hollow horn" are the result of dietary deficiency of the above-named nutrients.

As most of you know, a characteristic of many of the pine range grazing areas is a marked deficiency of phosphorus in the soil. That means very negligible amounts of phosphorus in the grass growing in that soil. Phosphorus is necessary for bone growth, milk production and normal fertility in heifers and cows. Fewer calves, light-weight calves at weaning, cows with easily broken tails, and cows that become "stiff in the shoulder" are manifestations of phosphorus deficiency in cattle. Four decades ago in south Texas, the calf crop percentage on the King Ranch was improved dramatically when phosphorus deficiency was reversed by feeding a mineral supplement such as bonemeal free choice.

Phosphorus deficiency is a common condition in Louisiana woods cattle right now. Deficient cattle will chew the bones of deceased herdmates. They can develop botulism or may get a bone lodged in their mouths, creating great anxiety. Their blood serum phosphorus levels are well below the normal values for cattle, often under 2 milligrams per 100 milliliters.

When forage is scarce, the need for supplemental energy and protein feeds or maybe some fair quality hay is obvious. Starvation is short-sighted savings in feed costs; the effect on the next calf crop is felt for a long time.

In addition, starving cattle turn to poisonous plants such as oak buds, acorns, bracken fern, yellow jessamine, buckeye, perilla mint and others.

The need for supplemental vitamin A by feed or injection may develop during prolonged periods of drought or severe, prolonged winter conditions. Green forage contains adequate carotene, coloring the cattle serum somewhat yellow and providing a source of vitamin A.
Vibriosis, Trichomaniasis and Brucellosis

These diseases, along with leptospirosis, are major infectious causes of infertility and abortion in Louisiana cattle. The problem is greatest where herds intermingle. "Vibrio" and "trich" are venereal diseases producing no obvious signs other than a 4- to 6-month period of infertility in infected cows and an occasional abortion. Once these infections become well established in a herd, the effects are mainly seen in heifers or first calvers exposed for the first time to infected bulls. I strongly recommend vaccination against vibriosis.

Another disease that is difficult to eliminate or keep out where intermingling of cattle on the range occurs is brucellosis. Raise all heifers as vaccinates (4-8 months of age)!

Leptospirosis is transmitted by way of the urine of infected animals including cattle, skunks, swine, etc. "Lepto" causes abortion in susceptible cows pregnant 6-9 months and it is a serious disease of young calves. Vaccination of heifers, then annual boosters, helps protect the fetus and the calf up to 4 months of age.

Poisoning by Plants and Chemicals

Have you ever watched range cattle grazing and browsing in the early spring? Variety is said to be the spice of life and cows know all about it. They like the smorgasbord approach, browsing leaves and buds from small trees and shrubs. They often straddle a small tree and "walk it down" to reach the tender, edible leaves. Cattle often lightly browse known toxic plants with no apparent harm. "Got to have the right dose to do it," the old toxicology professor said.

Bracken Fern (Pteridium aquilinum)

The plant is common, particularly in sandy soils, and fronds grow from a long black root a half inch in diameter which parallels the surface at a depth of 4 to 6 inches.
Bracken grows in colonies which are easily recognized from a distance on cut-over land.

Bracken toxicity has been known for many years and it has several manifestations depending upon the species of animal affected. All parts of the plant are toxic, with the roots said to be five times more toxic than the aboveground parts. Indeed, poisoning has occurred in cattle, horses and swine that ate roots exposed by deep plowing. Continuous consumption of the fronds or roots for several weeks is required for poisoning to occur. In fact, rotational grazing with three weeks on and three weeks off does prevent poisoning. The total dose of bracken fronds necessary to induce bone marrow depression and signs of toxicity is about equal to the animal’s body weight. Cattle ordinarily eat 2½-3 percent of their body weight in dry matter daily. A 900-lb cow consuming 900 lb of bracken over a period of 6 weeks to 3 months of continuous exposure would be expected to die of bracken toxicosis. Bracken cut and baled in hay retains its toxicity. Mortality continues for 3 or 4 weeks after the animals are removed from the bracken.

Cattle grazing toxic amounts of bracken fern appear to do well until the onset of illness which terminates in death within a few days. A temperature of 107°F and a bloody stool are characteristic, and these features mimic acute infectious diseases such as anthrax. The animal becomes somewhat depressed, stops grazing and appears weak. Blood may drip from the nostrils and from skin punctures caused by large biting flies. Yearling cattle sometimes have difficulty breathing because of swelling in the throat region. The toxic agent is excreted in milk and apparently adds to the exposure that nursing calves receive (Evans et al. 1972, Pamsukca 1978).

At postmortem exam (necropsy), the outstanding features are areas of multiple hemorrhage beneath the skin, on the surface of organs in the abdomen and chest, and membranes on the inner surfaces of the chest and abdomen. The intestines contain variable amounts of black, partially clotted blood.
The hemorrhages are the result of a marked deficiency of blood platelets caused by toxic damage to the bone marrow, a condition called toxic aplastic anemia. Overwhelming infection may occur in some animals due to almost total depletion of disease-fighting white blood cells.

Bovine bracken fern poisoning mimics the bone marrow effect of whole body exposure to ionizing radiation. A man-made toxic substance which is identical to bracken poisoning in cattle has been produced by feeding trichloroethylene-extracted soybean meal.

No practical, effective therapy is known for toxic aplastic anemia in ruminants. Mortality can be striking as in one incident last summer where 50 percent of a herd of 90 cows and calves died. Interestingly, these cattle were said to have been fed a cottonseed meal based supplement during most of the period of exposure. Cattle on similar, adjacent range did not eat sufficient bracken to induce poisoning.

Why do cattle voluntarily eat bracken fern? Some of the cattle owners and veterinarians with whom I've worked have speculated that shortage of a more desirable forage causes cattle to eat the plant. They feel that a cooler, more overcast than normal spring that is not conducive for growth of warm-season grasses, combined with an abundant source of the fern, leads to ingestion of toxic amounts. Others suggest that it is eaten in an attempt to obtain phosphorus, with poisoning being preventable if phosphorus supplements are fed. Others suggest it results from a hunger for fiber. Perhaps they eat large amounts for more than one reason; I do not know the answer. I do know that cattle which apparently have adequate forage and minerals may suddenly eat toxic plants which they have ignored for years. Specific examples are Cassia obtusifolia and Cassia occidentalis.

Rotational grazing, 3 weeks on bracken and 3 weeks off, does prevent signs of poisoning. I advise cattlemen to periodically check stands of bracken for evidence of
extensive grazing and to use the rotation scheme if indicated.

Horse and swine develop a central nervous system disorder that is reversible by injections of thiamin (Vitamin B-1). Sheep may become blind or develop tumors (McCrea and Head 1981). Cattle may develop bloody urine or cancer of the lining of the urinary bladder after prolonged consumption of amounts insufficient to cause bleeding due to bone marrow depression (Jarrett 1978, Evans 1982).

Oak Buds and Acorns

When oak buds, acorns or sprouts are eaten at 50% or more of the diet for a week or two, some animals will develop classic "oak poisoning." Major cattle losses occurred in Louisiana in the fall and early winter of 1982 due to acorn poisoning. A dry, chapped muzzle, loss of appetite, rumen stasis and constipation with passage of hard, black, mucus-covered fecal balls are early signs. Within a few days, intestinal hemorrhage causes a blood red or usually black fluid stool to appear; the animal becomes gaunt and a trickle of blood-stained fluid comes from the nostrils. The urine is clear. Some die of kidney failure or bleed out in the gut; some recover ever so slowly. Derivatives of tannic acid are thought to be the toxic agents. Horses, sheep and swine can also be poisoned but reports are few. Deer do well on acorns, of course.

Although there is no specific treatment, a "preventive ration" was developed at Texas A&M for use in cattle grazing shin oak on the high plains of Texas (Dollahite 1964). The ingredients include cottonseed meal, vegetable oil, and 10% calcium hydroxide compressed into range cubes and fed at 4 lb per cow per day while eating "shinnery." This mixture is said to be somewhat of a fire hazard during pelleting -- truly a "hot ration!"

Red Buckeye, Yellow Jessamine, Cherry

Red buckeye (Aesculus pavia) poisoning is usually a spring condition with buds and leaves producing shaking and
staggering in affected animals. Some die. The buckeye seeds fall to the ground in the late fall and may be a source of poisoning.

Yellow jessamine (Gelsemium sempervirens) or "ivy" poisoned cows are nervous at first but within hours become "broadside downers," sometimes lying comatose for one or two days before dying. Cattle apparently have to eat several pounds of jessamine to cause poisoning. As you may know, this evergreen vine can be present in large amounts on some range areas. Poisoning usually occurs in February and March. The toxic agent is related to strychnine and stomach contents will be positive to strychnine tests.

The genus Prunus includes wild black cherry, choke cherry and laurel cherry, the latter being evergreen and surprisingly toxic. A 50-lb goat was experimentally poisoned by 50 g of leaves (a hat full) from a laurel cherry growing next to Knapp Hall here at LSU. Cyanide is the toxic principle and its effect was rapid with collapse of the goat 3 minutes after dosing. On a happier note, the intravenous dose of antidote reversed the effects within 60 seconds. In an incident across town, on Greenwell Springs Road, a home owner cut down 2 laurel cherry trees and tossed them to his 9 cows. Within 20 minutes, 7 were dead!

**Perilla Mint (Perilla frutescens)**

Our most important toxic weed in the state (in my opinion) is perilla mint, a shade-loving, noxious-smelling, square-stemmed plant with serrated oval-shaped leaves 2-3 inches wide. It looks a bit like a purple basil used in salads; indeed, on at least one occasion, it was being used for basil. The only real hazard appears to be to ruminants, particularly cattle, producing acute emphysema of the lungs. The toxic agent is 3-furyl isoamyl ketone. A few cases are thought to have developed in horses. It made headlines in south Arkansas and northeast Louisiana in the fall of 1983 when dozens of cattle (I want to say 100-150) died. Typically, several animals graze through the perilla as in one case where 6 of 9 cows died within 24 hours after eating the plant.
Old Home Sites

Those ornamental shrubs — azaleas, lantana, oleander and ligustrum — are all quite toxic. In two recent cases, dead woods cattle that had broken through an old fence were found to have bits and pieces of oleander leaves in the rumen contents. As few as 5-10 medium to large leaves (3-6 g each) prove lethal to cattle. Digitalis-like chemicals are present in all parts. Features of azalea poisoning, a common event, include weakness due to a sharp drop in blood pressure, drooling and usually but not always vomiting. Lantana causes liver damage, and ligustrum- poisoned cattle have watery green diarrhea. Deaths are expected with all of these.

Treatment for most poisonous plant cases is limited to supportive care and putting 1-2 lb of activated charcoal in a water slurry into the animal by drench or stomach tube.

Trash Dumps, Oil Fields and Rights-of-Way

Range cattle are curious creatures that will eat chemically treated seed that has been dumped; they will drink crankcase oil and salt water, eat arsenic, chew lead batteries, etc. Oil-field sites, when not carefully operated, provide exposure to arsenic, brine, chromates, ethylene glycol, lead, TOCP (triorthocresyl phosphate) and other distinct hazards.

Cattle truly have a taste for arsenic salts. Weed killers such as MSMA (monosodium methanearsenate) and other forms of arsenic are a leading cause of chemical poisonings in the bovine. Pipelines, highways, and fence lines treated with arsenic are a real hazard if cattle can reach the sprayed forage.

MSMA-poisoned cattle have a thin, watery, green stool. They are weak, dull and very thirsty, often standing or lying in a pond or creek. Thorough necropsy and collection of liver, kidney, urine and stomach contents for total arsenic determination is necessary to establish a diagnosis of poisoning.
Herbicides Used on Forests

There is little risk of harm to animals when herbicides approved for forest application are used according to label instructions.

Materials such as Tordon, Roundup, Velpar, 2,4-D, to mention a few, would pose a hazard to livestock if they were allowed to drink or eat directly from containers or spills of the concentrate or prepared spray.

Parasitism

Internal parasites, particularly stomach worms, are a problem in woods cattle only when the animals are temporarily concentrated on pasture during the winter months. On range the re-exposure rate is ordinarily low, since fecal contamination isn't concentrated in the grazing area.

External parasites such as lice, ticks, mosquitoes, hornflies, deer flies and horseflies surely reduce weight gains when levels are high. The biting flies transmit anaplasmosis and probably bovine leukemia. Biting gnats (Culicoides) transmit bluetongue virus, a somewhat common infection of cattle in this region. Louisiana Cooperative Extension Insect Control Guides are available from the county agent and contain specific recommendations for external parasite control.

Bloat

The large compartments of the bovine stomach are known as the reticulum and rumen. Bloat is a condition in which the reticulum and rumen contain a large volume of gas that cannot be relieved by belching. Rapidly growing ryegrass or wheat and clovers, particularly Persian clover, are sometimes associated with bloat in cattle.

Although ryegrass and wheat are seldom a cause of bloat, clover pastures can be troublesome. The bloat produced is the frothy type; the stomach is distended by a
stable foam. When the upper part of the abdomen is distended on both sides, the bloat is life threatening. Affected animals have shallow, open-mouth breathing and will die within minutes after collapsing. Animals found dead on pasture may have died of bloat. Careful postmortem examination by a veterinarian can determine if bloat was the cause of death.

A stab incision into the abdomen near the top of the rumen on the left side of the animal will allow the foam to escape. A special sharp-pointed, hollow-tube instrument known as a trocar is recommended.

When clover makes up more than 40% of the pasture, the bloat potential increases considerably. A feed additive known as poloxalene fed in molasses blocks or in liquid molasses can prevent bloat. Feeding instructions must be followed to the absolute letter if it is to work.

Summary

Effective management is necessary if reasonable calf-crop percentages and weaning weights are expected from cattle on pineywoods range.

Phosphorus supplementation is essential, requiring troughs for mineral feeding the year around. Products used must be at least 10-12% phosphorus. A two-compartment feeder with bonemeal or dicalcium phosphate on one side and trace mineralized salt on the other should be adequate. The animals must have access to minerals daily. Hay, protein meal, and energy feeds will be required when forage for grazing is depleted.

Immunization of bulls and cows annually for prevention of bovine genital vibriosis and leptospirosis is recommended. Brucellosis vaccination of heifers at 4-12 months of age is required. Bulls should receive anaplasmosis vaccine as yearlings plus annual boosters. Bulls should be examined for breeding soundness before turning them in with the cow herd.
Cattle should be sprayed or dipped once or twice to control lice in the fall and early winter.

Deworming should be timed to be of most value with emphasis placed on young, weaned replacement cattle carried on pasture.

Veterinary medical assistance should be obtained when illness, mortality, abortions or reduced fertility is encountered.

**Literature Cited**


**Discussion**

**Question:** Dr. James at Utah State has documented cases of pine needle poisoning from ponderosa pine
which causes abortion. Have you seen any of these problems from the pines here?

Dr. Nicholson: I have not associated abortion here with pine needles. We have been curious about that, however.

Question: What about Crotolaria and mountain laurel?

Dr. Nicholson: Mountain laurel is only located in Washington Parish in Louisiana, but east of here it is a common source of poisoning. Crotolaria is a legume brought here by the USDA as a cover crop. It is very toxic. We don't see much of it in Louisiana.

Question: Does it take a large volume of mountain laurel to cause poisoning?

Dr. Nicholson: Our most common ornamental poisoning is from azaleas, which have the same toxin as mountain laurel. A few pounds of any of these plants is a lethal dose.

Question: Under what conditions would grass tetany be a problem in range systems in this state?

Dr. Nicholson: We don't usually see it on warm season forages. It is mostly seen on cool season forages like ryegrass and wheat, particularly in the pineywoods area where soil pH is low.
AGROFORESTRY EXPERIENCES IN THE SOUTH

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National Forests in Alabama
Montgomery, Alabama

Historical records indicate that a rather rudimentary form of agroforestry (perhaps a better name would be forage forestry) was practiced in the South prior to European settlement. The native Indians, apparently in an effort to stimulate forage growth and subsequently direct foraging animal movement, routinely burned the woods. Their efforts to manipulate plant and animal production to favor their economy was quickly copied by the early European settlers.

Over the years, the Indian's primeval philosophy and style of natural resource management has been greatly refined. One situation remains the same, however; forage, once for wild game, now for domestic livestock and wild game, is a viable understory resource in the South's piney woods.

Unlike their Indian ancestors, today's landowners have hundreds of years of natural resource management history, plus a wealth of genetic improvement in plants and animals to assist in agroforestry management activities. Unfortunately, even though there have been a multitude of technological gains in natural resource management, many of the South's private landowners are "going it alone" in their attempts to integrate cattle and timber. Studies reveal
that Southern landowners practicing agroforestry are doing so without much aid from research-developed technology.

Apparently there is no one source of technical assistance on the best way to integrate forage and forest management. In fact, many landowners reported that when they sought agroforestry advice, they were discouraged from practicing such management. These landowners went on to say that many of the natural resource management advisors that they encountered tended to be biased towards single use and within their own specialties: forestry, range or agronomy. It seems the "cows and trees are incompatible" philosophy that developed with the massive Southern reforestation movement and open-range era of the 1920's and 30's still prevails.

These aforementioned comments were gleaned from farmers, timber and cattle managers, and others on eleven ownerships during a recent four-state forest range grazing field tour. The tour was conducted by seven Range and Forestry specialists and scientists from the USDA Forest Service, Winrock International, and the School of Forestry, Wildlife, and Fisheries at Louisiana State University. The aforementioned field tour began in Mississippi, progressed eastward through Alabama and Georgia, then south to the panhandle of Florida. Ownerships visited varied from a pulp and paper company, to a grazing allotment on the Conecuh National Forest, to a farmer with less than 200 acres of forest land.

The primary management objective for the forested acres of these ownerships was sawtimber production. Management patterns were extremely varied. Most of the landowners were applying research-developed forestry technology, such as thinning and prescribed burning, to promote timber production. Although indirectly applied, these practices were also having a marked impact on forage production, which resulted in variable timber and livestock management philosophies. Some landowners practiced intense forestry and regarded forage only as a by-product that the cows could have if they wanted. Others, more sensitive to their
management prescriptions, purposefully produced forage for cattle, browse for wildlife, and high quality timber.

Generally, the farmers and cattlemen visited built livestock programs around range, improved pastures, row-crop residues, and winter annuals. In so doing, they tended to regard native forest forage as supplemental forage for the spring and summer months. Occasionally a landowner would extend his forage or timber production potential by integrating trees with improved pasture grasses or improved pasture grasses with trees.

The preferred pasture grass to combine with trees was bahiagrass. The preferred trees to combine with grass were slash pine. In many cases, this proved quite satisfactory as was seen on a Conecuh National Forest Grazing Allotment. Here, an 80-acre tract, known as Spicer Field, was planted to slash pine on an 8' x 12' spacing during the winter of 1970-71. Residual bahiagrass germinated and returned to the area the following summer. When the trees were 8 months old, 30 head of cattle were placed on the area for a period of 6 months. When the trees were 4 years old, the herd had increased to 80 and allowed to graze for 7 months. Annual fertilization of the grass allowed the herd to be maintained at 80-90 head for the next 5 years. When the trees were 10 years old, 4.6 cords of pulpwood per acre were harvested from the tract and the number of cattle reduced to 60. At the end of the 12th growing season, the trees averaged 40 ft in height and 7 inches in diameter. Net returns during the first 13 years were $754/acre and projected net returns for the rest of a 30-year rotation are $3441/acre (Table 1). Costs do not include interest expense or the purchase price of cattle.

A similar story was shared by a South Georgia farmer. This individual has actively managed one tract of 250 acres of timber and pasture for 30 years. One hundred acres of this tract were planted to slash pine and bahiagrass during the winter of 1954/55. The remaining 150 acres were left in natural pine and native grasses.
Table 1. Costs and returns for timber (slash pine) and cattle grazing on an 80-acre grazing allotment, known as Spicer Field, in the Conecuh National Forest. Data through age 13 are known while data through the remainder of a 30-year rotation were projected based on similar costs and cattle prices. Site index is 80.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age 1-13</th>
<th>Age 14-30</th>
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<tbody>
<tr>
<td>Tree and Grass Planting</td>
<td>($ 70)</td>
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<tr>
<td>Fertilization</td>
<td>( 691)</td>
<td>($894)</td>
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<tr>
<td>Timber Marking</td>
<td>( 38)</td>
<td>( 38)</td>
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<tr>
<td>Fence Maintenance</td>
<td>( 324)</td>
<td>( 459)</td>
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<tr>
<td>Cattle Diet Supplements</td>
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<td>(203)</td>
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<td>Winter Hay</td>
<td>(289)</td>
<td>(279)</td>
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<tr>
<td>Medicine and Veterinary</td>
<td>(167)</td>
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<tr>
<td>Surplus Hay (year 1)</td>
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<td>---</td>
</tr>
<tr>
<td>Sale of Beef</td>
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<td>2262</td>
</tr>
<tr>
<td>Pulpwood Sales</td>
<td>75</td>
<td>142</td>
</tr>
<tr>
<td>Sawtimber Sales</td>
<td>---</td>
<td>3075</td>
</tr>
<tr>
<td>Net Return/Acre</td>
<td>$ 754</td>
<td>$3441</td>
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</table>

Cattle, stocked at a rate of 1 animal to 2.5 acres, have grazed free choice on the entire tract since 1955. Cross breeding of Angus, Hereford and Charolais has, over the years, resulted in 91% calving. Weight gain on calves has routinely averaged 2 lb per day. Minerals and salt have been made available on a continuous free-choice basis. Conversely, hay and protein have only been provided during critical or selected times. A farm pond has provided water for the cattle and also served as a favorite fishing spot. The area has been fertilized annually with 500 lb of 5-10-15 and 100 lb of ammonium nitrate per acre by broadcast
application. Lime has been applied every fourth year at the rate of 1 ton per acre.

Timber management during the period included two commercial thinnings with 8.5 cords/acre removed, periodic prescribed burns, and two rotations of working trees 10" DBH and larger for naval stores.

The timber stand at age 27 (1981) was as follows:

- Basal area/acre: 83 ft²
- Volume/acre: 23.14 cords
- Smallest tree d.b.h.: 6.0 inches
- Largest tree d.b.h.: 14.0 inches
- Average tree d.b.h.: 11.0 inches
- Average total height: 61 ft
- Average merchantable height: 45 ft
- Site index: 85
- Naval stores faces/acre: 25
- Total trees/acre: 131

Naval stores began when trees were 19 years old. The initial face was worked 5 years. Then the same trees were worked as back-faces for a second rotation. In 1983 the trees were worked out and harvested.

During the first eight years of the naval stores operation, 2500 faces were worked. Five hundred standard barrels of crude gum were produced for an average price of $71.43 per barrel. Income from this amounted to $35,715 or $14.28 per tree. After allowing 55% for total production cost, $6.42 per tree is left as profit. This amounts to $160.50 per acre for eight years of work.

Future plans for the area include the continuation of beef production based on established forage and timber management practices, the establishment of a second naval stores operation, and additional emphasis on hunting and fishing recreation. The entire tract will be monitored for hardwood brush encroachment and for removal of trees that may die as a result of wind, lightning or insect damage.
Although less quantifiable, similar improved pasture grass and pine management stories were heard on other stops along the tour. Cows and trees are a way of life to these landowners, and they are committed to integration of the two resources.

In addition to progressive forage and timber management, almost all of the livestock owners visited were progressive in genetic improvement of cattle and herd management. Nearly every landowner was readily able to work his cattle, regardless of breed. The most common breeds of animals observed on the tour were Angus, Brahman, Charalois, Hereford, Shorthorn and Simmental. The bulls tended to carry nearly full bloodlines; the cows were mostly crossbred, with Brahman blood often evident. Most of the landowners believed that a Brahman-English cow cross was necessary for maximum growth and survival on forested range. Bull:cow ratios were generally low with one bull per 60-90 cows. Although more bulls are recommended, calving rates were high and most landowners did not believe that additional bulls were worth the expense.

Nutritional supplementation was also commonly practiced. Salt and trace minerals generally were available year-round. Protein supplementation varied, however; many landowners provided ready access to liquid protein concentrates, range cubes, or range blocks year-round. Others provided supplementary energy only during the winter months when forage quality was at its lowest.

In addition to combining forage and timber production, some of the landowners were using livestock to maintain wild turkey and quail habitat. All recognized the value of using livestock to reduce woods rough and, in the case of forest industry, to promote good public relations with neighboring residents.

Many of the landowners found that their cattle management activities brought them closer to the land. This enabled them to see opportunities for wildlife habitat improvement, recreation, and prevention of roadside dumping and arson.
On many of these tracts, the addition of cattle fostered more intense forest management. Thinnings were conducted with more regularity. Prescribed burning was easily applied because of reduced fuel buildup. Site preparation costs were greatly reduced. Hunting was more productive and enjoyable because of understory brush control. The inclusion of cattle also provided additional and more regular income. The South Georgia farmer referenced earlier explained that there is good forage potential on forest lands if proper management practices are applied. He further explained his interest in forest grazing by stating, "We need to have something to supplement this tree farming until the trees get big enough to give us a little revenue."

Discussion

Question: Of the landowners visited, how many were private landowners as opposed to corporate landowners?

Mr. Biles: Most of the owners were private landowners; one was corporate forestry, and one was on a National Forest.

Mr. Felknor: The operations appeared to be top-notch compared to what we normally see here.

Mr. Biles: That's a good observation. These people were committed to their operations and were progressive in many of their other farming and ranching techniques.
LIVESTOCK GRAZING ON FOREST RANGE: A PANEL DISCUSSION BY FORESTLAND MANAGERS AND CATTLEMEN

Pete Rials
Area Manager
Boise Southern Corporation
DeRidder, Louisiana

The forest range resource in our area is open range; we don't have a stock law. Open range and forest management don't always mix.

Our Number 1 problem is wildfire. We have to solve this problem before we can feel comfortable about other uses on our forest. This year we have already experienced wildfire on about 4000 acres. Considering the cost of replanting plus our equipment and time spent in fire suppression, this has probably cost Boise Southern from $250,000 to $300,000. We feel that leasing is preferable to open range.

We have about 80,000 acres leased for grazing. We don't get much money for it; about 6 cents per acre. If that's a deterrent to wildfire, we don't have to receive a cent for it. Many people say that it isn't cattlemen who are setting the wildfires. However, studies show that, when there are cattle on open forest range, the likelihood of wildfire is about $2^{1/2}$ times greater. So we feel it is really necessary to lease our land. Fencing is required to lease the land, but fencing sometimes inhibits forest harvesting operations. People leave gates open and cattlemen get upset about that. There is also some grazing damage to young pines, but this has not been a major problem.

We do believe that the forest range forage should be utilized. If agroforestry provides a way to reduce wildfire, Boise Southern would be very interested in an expanded operation.
Discussion

Question: Does Boise Southern have a wildlife or hunting lease program?

Mr. Rials: No, we don't. We pride ourselves in that most of our land is open for public use.

Question: Is wildfire less on the lands leased to cattle producers?

Mr. Rials: Yes. In the studies I have done, our leased lands are about 6 times less likely to burn than open range. So leasing is a substantial deterrent to wildfire.

Question: Doesn't Boise cooperate with the Louisiana Department of Wildlife and Fisheries to develop wildlife management areas?

Mr. Rials: Yes, Boise does. In our area we have two large wildlife management areas.

Question: Do you have a prescribed burning program?

Pete Rials: Yes, we have the best burning program in the South. We will burn from 100,000 to 120,000 acres per year. We do it to control hardwoods, reduce fuel for fire protection and to keep somebody else from burning in an uncontrolled manner. We start as early as 5 years old in slash pine and try to burn every 3 years.
H.E. McFatter  
Cattleman, Farmer, Timber Producer  
Baton Rouge, Louisiana  

I'm not a forester; I'm a timber producer. I'm from the area that Pete Rials is located in. I grew up running cattle and sheep in open range country. My place is located in southwest Louisiana. We have native longleaf pines and some loblolly along the swampy areas. The pine plantations are primarily slash pine. My operation is diversified. I raise rice, soybeans, cattle, and timber. Most of my timber holdings are away from the farm. The reason that I'm diversified is because I found at an early age that I didn't need to have all my eggs in one basket. The last few years, it sure has made a difference.

I use cattle primarily as scavengers, letting them follow the beans and the rice stubble. I plant ryegrass in the bean stubble and sometimes in the rice stubble. I graze the mama cows and stocker cattle on the ryegrass. This has been working well until this year; because of the severe freezes, I didn't get much out of the ryegrass. It has been an expensive year because most of us didn't have enough feed. I usually sell my stocker calves in April and May. I buy stocker calves in addition to those I produce.

My permanent pasture is very limited. This is because I use timberland for grazing. This makes it possible for me to put all the good land into row crops. One of my permanent pastures is located near 300 acres of timberland which I lease for grazing. The permanent pasture is seeded to common bermudagrass and over-seeded with ryegrass in fall. Cattle graze the ryegrass during winter months and have access to the timber. The timberland doesn't provide much grazing in winter, but I plow the fire lines and plant ryegrass on the fire lines. Cattle use the timberland and fire lines during bad weather. They always come back to the permanent pasture. During summer months they graze the timberland almost anytime, but they always come back to the permanent pasture because of the phosphate, potash and lime. However, there is something about the woods grass they like.
They'll leave the most luscious pasture and start grazing the fresh, tender grass that comes up in the timber in spring.

I don't pay a grazing fee for this timberland. My agreement with the owners is that I fence the land, plow the fire lines, and control-burn the timberland each year. The landowner benefits because he doesn't pay for these expenses. The brush is being controlled very well and this land has never experienced wildfire in the last 15 years.

In addition to this timberland, I use some swampy land during winter for cows and calves. They don't get much grazing out of it, but they get a lot of protection.

There is also open range adjacent to my farm that I use for about 6 months each year. About April 15th I put in dry cows, red heifers and yearlings that I plan to sell in the fall. They do well on the open range. The timber companies that own this range do a good job of prescribed burning. They found out that if you control-burn, you minimize the chances of wildfire. The fellow who wants to make a burn to get grass will pick the right day and the right time, but I think you are wise to start control-burning at an early age to minimize wildfire damage. The timber companies try to burn a third of the open range each year, and this provides adequate forage for the cattle. The problems are reduced to a minimum.

I try to use cows that carry at least a quarter and no more than a half Brahman breed. This is probably a must for open range. There are advantages and disadvantages of open range. Timberland will supplement your improved pasture. Also, there will be fewer problems with intestinal parasites, pink eye and foot rot. A disadvantage is the loss of calves to rustlers. It's easy to shoot a small calf and load it into the trunk of a car or bed of a pick-up. You have less control of the cattle because you can't see them every day. Loggers and other people can be inconsiderate of fences, but I work with the people and don't have problems.
I think cattle and timber are compatible. The program is not for everybody; it takes a special kind of a person to make it work. The person who can make it work needs some native wisdom. He needs a good knowledge of the range and its limitations. He needs to recognize when the range is overstocked, be knowledgeable about the relationship between timber and grass production, and be able to work with the landowner. Most of the timber owners are very reasonable. Our cattle producers must look for ways to produce it cheaper; I don't think we will have an increase in price.

**Discussion**

**Question:** Why don't people run sheep on the range any more?

**Mr. McFatter:** I ran sheep for years. As the forest grew up, there was so much cover that it was impossible to control the coyotes. If it were not for the coyotes, I would have sheep because they are very compatible with forestry in my area. They do well in the woods. You don't have to buy supplements for them.

**Mr. Mosher:** There are ways for controlling coyotes. The question is whether you are willing to do it. In Douglas County, Oregon, we have a very strong predator control program supported from the general fund of the county. We have 100,000 ewes in the county. We have 4 full-time trappers who do an excellent job. The other option that is applicable here, especially on your flat land, is electric fence. We build predator control fences on land with 40-degree slopes. We use both net wire fence and electric fence. They can be built to keep out dogs, coyotes and even deer and elk. To fence out coyotes there should be an apron on the ground or bury the fence.
Comment from Audience: Cattle, forestry, and deer work well together. I know we lease Mississippi bottomlands for $4-$7.25 per acre for hunting, but I know some of this land leases for as much as $12 per acre. With sheep and goats there would be more competition with deer. So the economic question is whether you would loose the hunting lease or have to deal with management problems associated with this. There will also be an increase in wildlife lease fees in the next few years.

Mr. Mosher: I agree in some respects. However, we find that in hardwood brush, the regrowth after sheep grazing is better quality for deer and elk than if sheep were not in there. As long as the timing is right so that there is regrowth before winter, this is good. Also, during winter most of our deer are on the sheep ranges, because that's where we control coyotes. They like the feed we are producing on the improved pastures as well as the sheep do. The deer usually wait until the sheep leave before they use a pasture.

Dr. Johnson: We purposely omitted wildlife topics when planning the program to avoid overshadowing the concepts we are talking about. We have a resource base of about 200 million acres. There wouldn't be a market for all the beef this land could produce. Consider the intensive agroforestry concept such as the Spicer Field example or from Cliff Lewis' examples, in contrast with open range grazing. When the native range is burned and grazed moderately, the cover is greatly eliminated. People will not pay as much for hunting on this land as for land providing a greater illusion of wilderness. Grazed land generally has smaller wildlife populations,
also. But if we can convert the grazing operation from 20 acres per cow to 2 acres, this leaves 18 acres for wildlife management. This could bring a higher price for hunting, especially if managed for wildlife.

Multiple-use suggests that everything is done on the same acre. I think we are working with the concept of a diversified land management system. Our educational systems stand in the way of this by training people to be narrow minded. There are innovative land managers out there. We, in education, are trying to catch up with them. We have not been leading the development of new innovations.

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Jeff Hughes
Director of Environmental and Association Affairs
Southern Timber and Wood Products Division
Crown Zellerbach Corporation
Bogalusa, Louisiana

I can identify with Wayne Mosher and Al Nation who spoke of the need for peasant wisdom in the cattle business. I was raised during the depression on a subsistence farm in Tangipahoa Parish, about 1200 acres of good old pine land. My family was in the timber business. They cut their timber in the 1920's when everyone else did, and I was raised on land that was growing trees while I spent my time running cattle so we could pay taxes every year. My first college tuition was paid from the first pulpwood thinning that came from the timber. When I finally had to make a decision as to what to study in college, I studied timber.

Whether I should have studied timber or cattle really didn't matter, because I soon found that one of the major
problems that occupied my time was trying to work out a relationship with the people who were running cattle on the forestland of the timber company I was working for.

We have had a varied program with Crown Zellerbach. It's kind of run the gamut of the range from one extreme to the other. I think the picture Norwin Linnartz described yesterday of improved firelanes was part of our program in Beauregard Parish that I worked out under his prescription back in 1958. We fenced the land, disced and fertilized the firelanes, planted the seed, built fences, and built watering ponds so that cattle and sheep using our land could manage while we were growing trees. At that time and in that place, that program worked. We designed other programs in other places. In later years, we helped the Livingston Parish Cattleman's Association organize. Then we leased large community pastures to the Association, not to individuals, so they would be a power there to help keep cattle off the roads and eliminate fire problems and garbage dumping. In other areas we have had different programs.

Ten years ago, I made a study to determine if we could improve the return from our grazing program. Since then, the amount of land grazed is 70% less, the amount leased is 18% less, the number of leases is 5% less and, most important, the number of cattle is 61% less. The number of cattle owners is 70% less.

Al Nation said that the time may come when timbermen will have to show that timber will not detract from cattle production. I don't disagree, but there has been a slightly changed attitude. Assuming that landowners have the right to make use decisions with their private property, and lands owned by industrial corporations are private property, then I think that cattle owners and landowners have a big problem to face.

This is a changing world. The landowner and the cattle owner are going to be faced more and more by competition for other land uses, particularly recreation. Very little has been said about wildlife in our previous discussions, but a point was made that
it is possible to have cattle, timber, and wildlife all at the same time. But, there is a surge in demand for recreation, especially in the area where we own land. My company owns 700,000 acres between the Mississippi River and the Alabama River from the Gulf Coast north through Jackson and Vicksburg, Mississippi. We have about 150,000 acres leased for grazing and about the same amount of land leased for hunting. The rest is open to the public. We cooperate with state agencies to develop wildlife management areas. We have two in Mississippi and are negotiating for one in Louisiana.

Right now, I have no applications for new grazing leases, but I do have applications for an additional 200,000 acres of hunting leases.

If we ask a cattleman to pay more than 25¢ per acre per year for a lease, we usually meet serious opposition. People offer us 30-50 times that much for hunting leases. These are local people and a lot of them are the cattle people themselves. People who can't see how they can pay 10¢ per acre for grazing have been in my office and paid $3.25 per acre for hunting on the same land.

In closing, foresters and cattlemen have to work together to better achieve their objectives. But, they can't forget the rest of the world. They can't depend on a symposium every 10 years to do this. They have to meet regularly to talk and work out solutions.

_Discussion_

Mr. Felknor: I understand what you are saying about grazing and hunting rights. We get $20 per year for membership in the Cattlemen's Association and they tell us they don't see how they can afford to spend that. The whole time we are drinking a $2.50 drink and drink 3 of them right there. So there is obviously some form of profitability in recreation that they realize, and it's hard
to realize profitability in the cattle industry today.

Question: Do any of your grazing and hunting leases overlap?

Mr. Hughes: Yes, but not many of them. On most the cattle stocking is low, so there haven't been many problems.

Question: Did you start leasing hunting rights from pressure to do so or because of potential profits?

Mr. Hughes: We did it to gain control of our land. We had almost lost the right to make use decisions on our land. The public had adopted the attitude that it was theirs. We could not control our land as an owner should be able to. The cattlemen helped us with this, but a hunting club may have 30 people and exercise much more control. We use it as a source of income also but try to deal mostly with local people.

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A.J. Roberts
Livestock Producer and Mayor
Forest Hill, Louisiana

I have an 8-month permit on the Kisatchie National Forest. I hope landowners and federal employees who are here will take your notes home and put them to use; don't put them in file 13, where most of them probably go.

I run about 50 head of brood cattle and started about 30 years ago. I worked as a bus driver for about 27 years. After serving at Fort Polk in World War II, I settled in Forest Hill. I grew up in the city. I had seen pictures of cattle, horses and so forth, but I had not had dealings with
them. When I came to Forest Hill, I learned to ride a horse and wanted to mess with livestock. I asked one man who was grazing the land if I could put some cattle where his were ranging, and he said no. So, I asked another, and he said yes. From that time to now, I have run as many as 80 cows, but I only had a permit for 45 head. Since then, I have started cooperating with the rangers. As years went by, grazing fees have gone from 25¢ per head to 70¢. Cattlemen think that's too much because cattle prices today are rock bottom. A man does not go into the cattle business to make money. He has to grow into it, and then doesn't make money. My wife owns a washateria and gave me the cattle a long time ago.

About 15 years ago, there were about 120 grazing permits on the Kisatchie National Forest. Today there are probably only 50 or 60. So, there is room for more cattle. We have no problem with recreationists. They cut our fences and we fix them. We hope they don't hit a tree with their motorcycles and get hurt. I have found a nice yearling on the ground with the hindquarter cut out. Sometimes one is shot.

On the National Forest, I don't think there is any wildfire. They do a lot of burning themselves. Of course, they didn't burn my area. There's about 4-6 inches of pine straw and mold, and it will probably be about June or July before the grass comes through. But they tell me it will be burned next year if the timber people come out and cut the timber that's marked (it's been ready for sale for 3 years). So maybe next year I'll have some sunlight and get some grass. I'm trying to hold on. As long as I can get low interest loans from my wife, I probably can.

I hope there are some people here from the National Forest headquarters in Atlanta because I'm told that's where all the orders come from. All of the rangers are good at passing the buck. You ask one for something and he says that's not his department. You ask another one and he says that Bud doesn't want to do that.
What we would like is 10 acres of cleared land to plant bahia to cut hay off of and ryegrass for winter pasture. Most people ask, "What right do the cattlemen have to this land?" Well, before World War II their parents owned this land, and the U.S. government came in and paid X dollars for the land and told the owners to get out.

They also want us to tag the cattle. Within 3 or 4 months the tags are gone. I find them in the woods.

If I could get $1.25 or $1.50 per pound for my calves, I wouldn't object to 70c for the grazing fee. Today, I do well to get 65-70 cents for them. We were told that grazing fees would go up and down with the market. But when they started up, they have never come down. Rather than pay our fees in January, we would like to pay in August when we sell the calves. We have money then. From December until March we have to borrow money to feed cattle.

I don't raise cain with the Forest Service people most of the time, but I believe when you give and give and give, you should take once in a while.

**Discussion**

**Question:** What would happen if the Forest Service put up grazing leases to the highest bidder?

**Mr. Roberts:** It might put me out of business, but I might be able to compete. The only people who will get into the business today are the big companies like T.L. James that can afford a big investment. The little producer must do it on a small scale.

**Mr. Meaux:** You'd have to have a long-term lease if you had to bid on it.

**Mr. Felknor:** Are you suggesting offering the land for bid to other uses, such as hunting clubs, as well as to cattlemen?
I didn't have specifics in mind. I was just thinking of the fact that we have the capability to increase or change the productivity of the land. There should be some means to recover the investments or provide incentives to do this.

My name is Jerry McIlwain. I am Director of Fisheries, Wildlife, and Range for the Southern Region of the Forest Service.

I think that in the past we have had some of our intensive grazing areas under special use fees. When this land was put under grazing permits, the fees for these lands went down considerable. If these lands were put on a competitive basis, we would probably get more from them. As some of you know, the grazing fees in the West are set by formula established by law. In the East, we have a variety of options, but we have been following the western scheme. We are studying our options now. Our fees are set now by animal units and I feel that the fees are very low.

Basically, there is a lack of understanding from both sides. This is especially true from people outside of agriculture. One educated gentleman asked me why the highway department has signs showing a cow with both horns and udder. People here and in Washington, D.C., don't know that we have a coyote problem. A little lady at an environmentalist meeting wanted to neuter coyotes rather than use compound 1080. The farmer told her the problem was not that they are raping our animals, they are eating our animals.
Our company has been a closed family corporation for over 60 years. However, the people believe in diversification and operate with an open mind toward new ideas and innovations. We have interests in many things: heavy road construction, building construction, oil and gas, dredging, real estate, forestry, row-crop farms, pecans, and cattle. We believe that every operation is unique. When devising a plan, everything has to be in proper perspective. No two of our operations are similar. Our land comprising 90,000 acres in central Louisiana is within a 20-minute drive of Alexandria. So, it is open to all kinds of pressures from lookers, hunters, and vandals. For many years, we were aware of the abundance of a high quality forage but were unable to use it until about 3 years ago when stock laws came into effect. At that time we made plans to determine if cattle could complement the forestry operation and if it would be profitable.

Now I have about 35,000 acres fenced. It's cross-fenced into 4-6,000 acre blocks. During the last 3 years we experimented with one of these areas. We plowed, limed and fertilized all of our firelines in the area. We have a wide electrical transmission line that we use also. We planted ryegrass, oats and clover for winter feed. Our operation is a little different from others because we try to run better quality cattle and run greater numbers. All of our cattle are in the Beefmaster breeder's universal upgrading program. We have Beefmaster bulls. This breed is \( \frac{1}{2} \) Brahman, \( \frac{1}{4} \) Hereford and about \( \frac{1}{4} \) milking Shorthorn. The breed perpetuates itself, so we don't have to rotate different breeds to maintain the Brahman blood.

The cattle are fed a complete, high magnesium, high phosphorus mineral free-choice yearlong. They also have, free choice, a 32% protein liquid feed. In winter they are fed a commercial feed called forage supplement or 3 in 1
mixture. They also have the winter grass we planted. We also try to have a high quality hay available.

We keep all of our options open in marketing. All of our sales depend on prices. We have the ability to retain our calves after weaning, selling them as feeders in spring, or carrying them all the way through the feedlot. We sell the way that will provide the most profit. We don't know if we always do the best thing. However, we provide jobs and use a natural resource that previously went up in smoke during fuel reduction control burns.

J.B. Meaux
Cow-Calf Operator
Grand Chenier, Louisiana

My primary reason for moving from marsh to piney woods range was hurricane Audry in 1957. In 1961 hurricane Carla caused more problems. So I moved the cattle to some of our land in Beauregard Parish and leased some other land for 10¢ per acre. I have leased from 4 different companies.

We started out by driving cattle back and forth. This didn't cost us anything because everybody helped each other. Light roping calves were selling at a high price. Heavier calves pulled the cows down and breeding wasn't as good.

For the first few years we didn't have many problems. Then 3-wheel cycles and 4-wheel drives came along, especially on weekends. And during the last few years we had to truck our animals because there was too much traffic on the roads. Then the gasoline prices went up and the grazing leases went up. One allotment that I leased originally for $360 is now up to $1980.

Over the years, the field people in the woods have changed. The older people understood our problems, the younger people were harder to deal with. It's hard to build
fences and more expensive to maintain them now. So, I quit grazing on land in the woods other than the open land we own.

When I grazed the marsh, we rotated cattle between fresh and salt-water marsh. We rested salt marsh range in summer and rested freshwater marsh in winter. Rotation grazing allowed me to raise more cattle. In the marsh, people will give $1600 just for a blind to hunt ducks from. So, we are diversified in this area too.

**Discussion**

Question: Do you still lease timber company land?

Mr. Meaux: No. We just can't afford to do it now; we cut down from 600 head to about 200 head of cattle.
SUMMARY AND OVERVIEW OF AGROFORESTRY IN THE SOUTHERN UNITED STATES

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This symposium has built upon symposiums held previously on the topic of multiple use of land, emphasizing grazed forage (pasture or range) and forestry. One of the earlier gatherings was the International Hill Land Symposium held at Oregon State University in April 1983. The theme was "Foothills for Food and Forest." It was mentioned earlier that copies of the proceedings are available for sale for those who might be interested. The "Southern Forest Range and Pasture Symposium" was held in New Orleans, Louisiana, March 13-14, 1980. Drs. Dennis Child and Evert Byington served as editors, and they are in the audience today. A third major symposium was the International Hill Land Symposium held in 1976 at Morgantown, West Virginia. Each of these symposia emphasized the integration of grazing and forestry as a part of their program to increase the production of food and fiber.

Since the middle of this century, the South has increased its number of forage and livestock operations. As emphasized earlier by Alan Nation, the Southeast currently raises more cattle than any other region. Its current level of 16.5 million head equals or exceeds those in the Southwest, West, and Great Plains. It is projected that a 10-million-head increase in possible in the Southeast under present conditions.

The emphasis on forage (range-pasture-forage crops), forestry, and livestock is reflected in the land use pattern in the South as well. About 15 to 20% of the farmland is used for crops, and 80% is used for forestry and forage/livestock production. Of the latter, nearly 60% is used for grazing.
In the use and management of our Nation's resources, the critical importance of the decisionmaker must not be overlooked -- whether the decisionmaker is an individual, corporation, group, or government agency. That decisionmaker operates from a particular base to achieve as many goals as possible at minimum cost. He is constrained by many factors, including information, such as knowledge about the physical and biological characteristics of the land, and personal ability, skill, and dedication. There are also different levels of decisionmakers, and they may be the landowner, manager, or operator. These levels may be vested in the same institution or as separate entities. However, each will have an influence on the resource use.

The personal goal and objective of that individual decisionmaker is crucial. That objective may be to preserve a way of life through the provision of security against adversity of old age. However, that is not generally the basic objective, rather it is to obtain a net economic return or profit for the resources that have been invested.

Society often places demands upon the use of land and other resources. Society may seek to coax private landowners or managers to undertake certain actions by using specific incentives; providing information; providing credit and input materials, such as fertilizer (which may be subsidized or not); providing transportation, such as highway construction (subsidized or not); and helping to develop markets for the commodities produced. In the United States until recently, the landowner/manager could rarely gain many rewards for providing beautiful scenery (it was likely to be enjoyed mainly by other persons), for maintaining healthy watersheds (the water was likely to be appropriated and used by others), or for providing outdoor recreation opportunities for others (often other persons used the land without permission and sometimes in spite of specific prohibitions). Trespassing has been common and is often serious in some areas. However, leasing arrangements are helping overcome this problem. For example, when landowners and managers maintain good habitats for wildlife, which are often uncontrolled and free moving and which in many cases belong to the State, they may find that a more
A lucrative opportunity is to lease their land to hunters. In fact, this potential for game ranching is being developed in many areas.

The essence of the presentations and discussions today has centered on agroforestry. Agroforestry is the integration and management of forestry and livestock grazing or cropping activities to reach an optimum production of high-quality food, fiber, and timber products. It involves the integration of two or more disciplines, the acquisition of new management skills, and a balance among the competing demands of forestry, grazing, and cropping activities. As Mr. Travis Joiner emphasized in his panel presentation, "Each operation is unique."

Last week I was in Puerto Rico and visited the Corozal Research Station. It emphasizes research on plaintain, bananas, yams, passion fruit, and some rather exotic commodities. I was impressed with the program and can see where much had been accomplished since my last visit nearly 3 years ago. Later I visited with the research leader of the Tropical Agricultural Research Station at Mayaguez, Dr. Tony Sotomayor, who is a sorghum and cereal crops geneticist and breeder. He described some work in which they are combining forage production and pine tree production. The pines had been planted at different densities and were being harvested periodically for use as posts and eventually for regular timber production. It was a true case of agroforestry being researched, with considerable potential to help Puerto Rico become self-sufficient in supplying its timber and livestock demand.

As stated a number of times during this symposium, the forage resource in the Southeast is essentially untapped. There is need to maximize grass utilization and to minimize the amount of concentrates fed to cattle. The use of multiple animal species for grazing is often warranted. Studies are being made on consumer preferences with regard to meat with reduced fat and marbling percentages, which have resulted from predominantly forage-fed beef with limited concentrates in the diet.
The challenge for each of us is to determine how to fully utilize the available resources without damage. The concept of agroforestry, as discussed here today, has demonstrated considerable promise in this regard. Briefly, here are some of the effects on our resources from such a farming system:

**Soil**—Reduced erosion.

---Maintain or increase fertility through nutrient cycling, especially nitrogen. The rate of nutrient cycling can be greatly increased by grazing animals. Wayne Mosher earlier cited nutrient recycling within 2 to 3 weeks under grazing animals, compared with 2 to 3 years under normal bacterial decomposition of crop residue. It is even more rapid in the South and the subtropics or tropics.

**Water**—Minimize competition for moisture between trees and the understory through removal of forage and browse by grazing animals.

---Increase percolation rates of water and infiltration (dependent upon the stocking density and available forage).

---Reduce runoff.

**Air**—Control or reduce pollution, namely through the dispersal of waste.

**Vegetation**—Must be properly managed and used at the optimum stage of growth and quality.

---Reduce or eliminate weeds and brush through grazing by multiple animal species.

---Legume based pastures enhance the capabilities for nitrogen fixation.
Germplasm enhancement through breeding, selection and evaluation is possible with both trees and forages.

**Animals**—Keys to productivity include reproductive performance, productivity through growth and weight change (cross-bred types provide increased adaptability and growth potential), and cost effective management.

—By stocking with several animal species, one can take advantage of the dietary preferences among various animal species. For example, sheep consume greater browse than cattle, and goats consume shrubs and brush. Of course, wildlife are natural browsing animals.

—Maintain health. This includes avoiding internal parasites and, as pointed out by Dr. Nicholson, poisonous plants and forage sprayed with pesticides and other contaminants.

**Human resources**—Improved management. One can be an efficient manager, for example, by doing things right but still not be an effective manager, which means doing important things right. To be successful requires that a person attain knowledge and, more importantly, skills—plus the desire, motivation, or dedication and willpower. I found it significant that in Dr. Larry Biles' comments on the agroforestry experiences this afternoon, he cited success as being dependent upon the landowners/managers being dedicated and committed individuals with progressive attitudes. Therefore, success is equal to skill plus will.

I am also reminded of A.J. Roberts' comment that if that one cattleman would have sold off his rogue cow, the parish would most likely not have had a stock law today.
Sometimes it is the little things that make a difference. This reminds me of a wealthy woman who was traveling overseas and saw a bracelet she thought was irresistible. So she sent her husband this cable: "Have found wonderful bracelet. Price $75,000. May I buy it?" Her husband promptly wired back this response: "No, price too high." But since the cable operator omitted the comma, the woman received this message: "No price too high." Elated, she purchased the bracelet, and needless to say, at her return her husband was dismayed. It was just a little thing -- a comma -- but what a difference it made.

There is an increasing awareness of the importance and complexity of managing our basic natural resources to provide a net economic return without permanently damaging our resources. This complexity is being addressed at many different levels within our society, and I would like to quote Congressman George E. Brown, Jr., from his remarks at a session on conservation, research and technology during the Agricultural Outlook Conference in 1982. "We need to begin to look at agriculture as a system and get away from developing individual technologies to deal with the individual problems. Frequently, there exist common solutions to seemingly separate problems, but these solutions only become apparent when we look at the larger system. We also need to develop better communication between researchers in different disciplines."

Today, the emphasis is on a systems approach to develop the least-cost production method of management. This symposium has addressed the utilization of our forest, forage, and livestock resources. Here are some of the issues that must receive continuing attention:

Forage seed selection;
Legume-based pastures;
Proper legume seed inoculation;
Forage establishment;
Weed control;
Controlled grazing for which fencing is required;
Predator control under many circumstances, particularly in sheep grazing;
Natural fertilizer cycling;
Mineral supplementation; and
Forage conservation and supplementation
as appropriate, such as with hay.

Under the human resource element, an important consideration is the need for research, which should be considered as an investment. Thus, research scientists are significant human resources that must be tapped. In agroforestry, the gaps in our knowledge that need further research include such items as:

Choice of tree species and silvicultural regimes;
Levels of grazing and cropping production;
Selection of plants for shade tolerance;
Nutrient cycling;
Effective shade and shelter on crops and animals.

In Dr. Larry Biles' comments, he mentioned that the number one concern of the landowner/manager/operator was the lack of integrated resources management advice; for example, technology transfer of integrated information. In other words, the art of putting it all together is another role of the human resource. Technology transfer was one of the key functions of this symposium, and this requires an effective means of communication.

The question now is, where do we go from here? Although there is not a mandate as scheduled, perhaps we next need to emphasize the development of integrated cropping systems, along with the full utilization of forest, forage, and livestock resources. This would provide the opportunity for fattening cattle on a minimum of concentrates in a period of 60 days or less which can be done in the vicinity where they were produced. This will require the consumer to express a demand for such a product. So often we are masters of the status quo and avoid change whenever possible. However, consumer preferences are beginning to change and, in time, will surely change in accepting a leaner red meat -- if we maintain taste and other quality factors.
Let me reemphasize Jeff Hughes' comment about people accommodating and supporting each other and the need for the forester, cattleman, wildlife manager, and leassor to all sit down together and talk about their problems forthrightly.

I would like to share the story of a little boy who could not play outside because it was raining. His father, who was trying to take a Sunday afternoon nap on the sofa, became annoyed.

"Go to the other room, son; daddy wants to sleep. Find something in there to play with."

"Like what?"

"Anything," snapped the father.

"There isn't anything," replied the lad.

Grabbing the newspaper, the man tore out a page with a large map of the world printed on it. With a scissors, he cut it into dozens of odd-shaped pieces like a puzzle.

"There, see if you can put it together, and don't bother me till you are done."

The father thought his problem was solved, but 10 minutes later there was a tug on his shirt.

"You can't be done yet!"

But there on the floor was the neatly constructed world.

"How did you do it?" he asked.

"Easy," said his son. "A man's picture was on the back, and when I got him together, the world was right."

As Mr. McFatter emphasized, it takes a special person to run cattle in the woods -- one with "native wisdom." In
order to put it all together, we must deal with people. People with will and a skill (native wisdom) equal success.

The bottom line is to produce products (meat/timber, food/fiber) that are in demand by the consumer, to be able to make a profit, and to live the life worth living. Let me challenge you to take your notes from this meeting, add to your knowledge your native wisdom, and put it together in order to make agroforestry a success.