Converting Cropland to Perennial Grassland

Agronomy Technical Note

1-800-346-9140
ATTRA
National Sustainable Agriculture Information Service
www.attra.ncat.org

Abstract: Converting cropland to perennial pasture is often a profitable move, especially if the cropland is marginal. This publication examines some economic considerations of converting cropland to grassland, methods of establishing pasture on croplands, and how to manage established pastures. Two farm profiles illustrate these processes.

By Preston Sullivan
NCAT Agriculture Specialist
November 2003

Table of Contents

Introduction 1
Economic Considerations 2
Precautions 6
Conventional Establishment 6
Low Tech Establishment Methods 7
Management After Establishment 8
Successful Transitions 8
Enclosure 9
References 9

Introduction

For several generations the Moore family in Navasota, Texas, raised corn, milo, and cotton (Leake, 2001). After finally having enough of rising production costs, persistent drought, and low commodity prices, they decided to break the family tradition and switch from row crops to cattle. After taking training in Holistic Management (Allan Savory Center for Holistic Management), Robert Moore and his son Taylor took a path to a brighter future with less personal stress and lower overhead cost than when they were row croppers. For years they had battled johnsongrass, bermudagrass, and crabgrass in their cotton fields. Now these grasses and others such as Dallisgrass, burr clover, and bluestem are their allies. Moore explains they are working with nature by letting the grasses that want to be there return. Their cattle love these forages. With a wide variety of grasses available, they can graze from mid-February to mid-November. After giving up cropping, they increased their cow herd from 200 animals to 600. Their 2000 acres are divided into 50-acre paddocks with about 200 head in a paddock at a

ATTRA is the national sustainable agriculture information service operated by the National Center for Appropriate Technology, through a grant from the Rural Business-Cooperative Service, U.S. Department of Agriculture. These organizations do not recommend or endorse products, companies, or individuals. NCAT has offices in Fayetteville, Arkansas (P.O. Box 3657, Fayetteville, AR 72702), Butte, Montana, and Davis, California.

time. With their cropping enterprise they had 20 employees working full time. Now the father and son work together with one full-time employee. Before cattle they worried about crop success and prices and were often relieved just to break even. Now they can live off what they make. Taylor remarks, "We're definitely happier now and have less stress."

The personal decision to switch from cropping to pasture may have been easier for the Moores since they already had livestock in their farming operation. Those without any animal experience would benefit from working with a neighbor who runs livestock to get a feel for it. An easy way to see how you would like it would be to graze some of your standing corn in the vegetative stage. ATTRA can provide a number of publications on grass farming and cattle, sheep, and goat farming to get you started.

Besides the potential for lowering risk, stress, and overhead costs, switching from cropland to perennial grassland typically reduces or eliminates soil erosion and improves soil organic-matter levels. Soil health generally improves under grassland because long-term grass production produces the best-aggregated soils. Aggregated soil is one with a crumbly structure capable of high water infiltration, porus air exchange, and the ability to accommodate fast and deep root growth. A grass sod extends a mass of fine roots throughout the topsoil, contributing to the physical processes that help form aggregates. Roots produce food for soil microorganisms and earthworms, which, in turn, generate glue-like compounds that bind soil particles into water-stable aggregates. In addition, perennial grass sods provide protection from raindrops and erosion. Thus, a perennial cover creates a combination of conditions optimal for the creation and maintenance of well-aggregated soil.

Well-established grass will eventually restore soil health above the level present in annual cropland. We can see this by looking at microbial and earthworm populations under pasture versus crops. A New Zealand study showed a decline in organic matter and biological activity when pastures are tilled up and planted with crops. In the study, pastureland was converted to crops either by plowing or using no-till. Crops of corn and winter oats were planted into the former pasture. The plowed area suffered a 45% decline in soil microbial biomass in the top 2 inches of soil. The top 4 inches of soil contained higher microbial biomass and more earthworms under no-till or permanent pasture compared to plowed ground (See Table 1).

Table 1.

Effects of Tillage Practices on Microbial Biomass and Earthworm Numbers

Tillage method	Microbial biomass, pounds/acre	Earthworms/meter^2
Pasture	911a*	429a
No-till	905a	363b
Plow-till	749b	110c

**Numbers followed by the same letter in columns are not significantly different.*

In an Australian study (Dalal, 1994), several cropping sequences were compared to grass-legume pasture to determine to what extent these various cropping sequences or pasture restored fertility and microbial activity to a degraded soil. Treatments were conventional till wheat, no-till wheat, chickpea-wheat rotation, medic-wheat rotation, alfalfa-wheat rotation, grass-legume pasture for 1.5 years, grass-legume pasture for 2.5 years, and grass-legume pasture for 3.5 years. The 2.5- and 3.5-year mixed grass-legume pasture treatments produced much more microbial biomass and higher nitrogen mineralization rates than any of the other treatments (Dalal, 1994).

Economic Considerations

Before making the final decision to convert cropland to pasture, a detailed financial analysis should be done. In this comparison, all the costs of both the crop enterprise and the livestock enterprise need to be accounted for. Several price scenarios, for both grain yields and pounds of gain, need to be compared to determine the income potential of different production levels. Please realize that in the first year of pasture, only light grazing will be feasible (resulting in less income) until the grass gets well established. Grazing system development costs (permanent perimeter fence, water development, etc.) can be amortized over 10 years. See Tables 2 through 4 for some idea of costs associated with the transition from corn, soybeans, and wheat to grassland under a stocker cattle operation.

An article by Terry Gompert (Gompert, 2001) of Nebraska provides a comparison tool useful to estimate potential pasture yields from croplands currently in grain production. Gompert makes an analogy between feeding cattle in a feedlot the corn from ground producing 200-bushels per acre with the beef yields from that same corn field if it is put into well-managed pasture. The same ground should yield about 1600 pounds of beef per acre from pasture or corn. Detailed tables (see enclosed article) show the pounds of beef production expected and the animal month units from land,

Table 2.

Budgets for selected crops on a $ per acre basis

Variable Costs		**Corn 150 bu/ac**	**Soybeans 50 bu/ac**	**Wheat 65 bu/ac**	**Your Farm**
Fertilizer					
	N	28		17.8	
	P_2O_5	9.90	7.5	10	
	K_2O	11.05	11.5	4.5	
Lime		8	7	7	
Herbicides		26	30	3	
Insecticides		8			
Seed		34	20	15.5	
Drying and Storage		25	7		
Mach repairs, fuel, hire		30	26	20.4	
Crop insurance		7	3	3	
Interest on inputs*		5.83	3.55	2.70	
Fixed Costs					
Labor		25	18	23	
Building repair/Depreciation		6	6	6	
Machinery depreciation		20	17.5	18	
Interest on investment		24	20	13	
Overhead (insurance, utilities)		10	13	15	
Land (cash rent equiv)		60	60	60	
Total costs		$ 337.78	$ 250.05	$ 218.90	
Total /bu. cost		$ 2.25	$ 5.00	$ 3.37	

** Interest on purchased inputs (fertilizer thrrough seed) at 7% for 8 months*

Compiled from budget estimates from Illinois, Michigan, and Tennessee

Table 3.

Intensive Grazing Enterprise Budget

Stocker Calves, 61 head purchased, 59 head sold

Managed Intensive Grazing, 40 acre pasture divided into 8 paddocks

			Per head	Per acre[1]
Returns	net wt.	$/lb		
800# with 4% shrink	768	$0.83	$637.44	$940.22
Variable costs				
Purchase cost	500	$0.90	$450.00	
Other variable costs				
Salt and mineral			$3.19	
Machinery operation			$4.00	
Vet & Med			$6.00	
Trucking & Commision			$11.00	
Utilities, Insurance			$6.00	
Death loss			$5.00	
Interest			$30.00	
			$65.19	$96.16
Total Variable Costs			$515.19	$759.91
Income over variable costs			$122.25	$180.32
Fixed costs				
Taxes & Depreciation			$15.00	$22.13
Labor (1.5 hrs @ $10/hr)			$15.00	$22.13
Land (pasture 0.67 ac/hd * $35/ac)			$23.45	$34.59
Total Fixed Costs			$53.45	$78.84
Total Costs			$568.64	$838.74
Net Return			**$68.80**	**$101.48**
Total cost of gain ($/lb)				
(Other variable costs + fixed costs)/net pounds of gain			$0.44	$0.65
Total value of gain ($/lb)				
(Sales value/hd - purchase value/hd) / net pounds of gain			$0.70	$1.03

[1] *Per acre costs and returns are figured as (costs per head times number of head sold / number of acres)*

Compiled By Tim Johnson, ATTRA Program Specialist

Table 4.

Budgets for pasture establishment on $ per acre basis

Variable Costs			Grass seeding	Legume/ grass mix	Legume/ fescue mix	Legume/ grass mix
Fertilizer						
	N	30 lbs	$6.12			
	P_2O_5	50 lbs	$13.50	$13.50	$13.50	$13.50
	K_2O	100 lbs	$14.00	$14.00	$14.00	$14.00
Lime		2 tons	$36.00	$36.00	$36.00	$36.00
	Total Fertilizer costs		$69.62	$63.50	$63.50	$63.50
Seed	Oats	1.5 bu	$7.50	$7.50		
	Bromegrass	10 lbs	$10.50			
	Birdsfoot Trefoil	6 lbs		$10.20		
	Orchard grass	3 lbs	$3.45	$3.45		$15.12
	Fescue	18 lbs			$14.40	
	Ladino Clover	1.5 lbs			$5.25	
	Red Clover	6 lbs				$6.30
	Total Seed costs		$21.45	$21.15	$19.65	$21.42
Machinery, repairs, fuel, hire			$12.37	$12.37	$12.37	$12.37
Interest on inputs*			$11.25	$10.37	$10.27	$10.39
Fixed Costs						
Labor			$14.80	$14.80	$14.80	$14.80
Machinery depreciation			$23.95	$23.95	$23.95	$23.95
Sum of Variable and Fixed costs						
			$153.44	$146.14	$144.54	$146.43
Land /Rent			$35.00	$35.00	$35.00	$35.00
Total Costs for Pasture Establishment			$188.44	$181.14	$179.54	$181.43

** Interest on purchased inputs (fertilizer through seed) at 7% for 12 months*

Compiled by Tim Johnson from Extension Service budget estimates from Missouri, Iowa, Oregon based on expected corn yields. Gompert concludes that soil, water, temperature, genetic plant potential, and management will be the primary factors affecting pasture yield potential.

Precautions

Typical U.S. cropland is low in organic matter and may contain herbicide residues, as well as an abundance of annual weed seeds (Nation, 1995). Consequently, this land cannot be expected to perform similarly, at first, to land that has been in pasture several years. Some herbicides persist for more than one year and could be replaced with shorter-lived herbicides during the last year of cropping prior to conversion to pasture, depending on the herbicide in question and the type of forage that is being established. For example, atrazine carryover would be fine for establishing bermudagrass, gammagrass, or switchgrass, but it could be a problem for many legumes. Soils low in organic-matter can crust over and prevent small grass and legume seed from emerging. Since grazing can be done only lightly until the perennial forage is well established, income reductions are often seen at first. Therefore, it is preferable to gradually convert a crop farm into pasture rather than all at once (Nation, 1995). A new pasture grown on low organic matter soils could be established as a grass-only forage fertilized with nitrogen fertilizer. Since the weed seedbank is full, chemical weed control in a grass-only sward will be easier than with a mixture of grass and legumes. Legumes can be added the second year in the South or the third year in the North, if adequate soil calcium, potassium, and phosphate are present to support them.

When faced with the decision to plant one forage type or several forage species, Canadian grazing researcher E. Ann Clark (Clark, 2001) suggests that, in monoculture plantings, many unsown species typically encroach on the planting to occupy niches left vacant by the sown species. No single forage species is capable of thriving in all the variations in soil type, drainage, aspect, slope, etc. that occur in any landscape. Clark advises planting a diverse mixture of several species. This idea is in direct conflict with the previous paragraph recommending herbicides for control of all those weeds coming up with the grass stand that are occupying niches left vacant by the sown species. Organic growers would be better off using Ann Clark's practice, since they cannot use herbicides.

The most common causes of grass seeding failures are planting the seed too deep, crusted soil surface, competition from weeds, and excess dryness following planting. Poor germination is often blamed, but recommended seeding rates are adequate to provide a good stand even with lower than normal germination rates. If there is a question about seed germination, have the seed tested before planting. It is well worth the time to reduce competing vegetation, and do a good job of seedbed preparation, seeding, and covering the seed. Planting is an expensive operation, there are few shortcuts, and you don't want to have to redo it.

Most forages can be established using a no-till drill equipped with a grass-seed box. Residual vegetation should be killed with herbicides prior to or at the time of planting to reduce competition with the new seedlings. Generally speaking, no-till is the preferred establishment method, requiring only a single trip across the field and not creating erosion-prone bare ground from tillage.

If the planting is to be done with tillage, a good seedbed is essential to the success of the new planting. The soil needs to be worked down to break up clods and then firmed. Clods should be no larger than an inch, and only a few that size. A footprint should sink no deeper than one-eighth inch, (Bluhm, 1982). Ideal seeding equipment will have the seed covered no more than half an inch deep. Generally, a 1/4-inch depth is appropriate for smaller seeds. The seed may be broadcast or drilled or planted in a grass seeder such as the Brillion™ seeder.

Conventional Establishment

There is widely available planting information (seeding dates, rates, depth to plant, etc.) from local Extension offices, University Experiment Stations, and other local sources. These local sources are the best available and should be consulted for accurate information on adapted forage species and how to plant them. Also available are several seed calculators that provide an easy way to determine costs of various seed mixtures. These can be found on the Web at <http://waterhome.brc.tamus.edu/nrcSdata/models/rangecal/>.

General guidelines for establishing forages are shown below in abbreviated form from *Southern Forages* (Ball et al., 1996). More detailed planting guidelines for each forage species are typically available from local Extension offices and should be sought out for additional guidance.

1. Soil fertility and pH levels should be determined through soil testing. Fertility and pH levels should be adjusted to those desired by the crop to be planted. Legumes typically require medium to high levels of lime, phosphorus, and potassium. If possible, apply lime a year ahead of planting to allow adequate time to begin working.

2. Reduce existing weed growth. Grassy weeds present a prohibitive hazard to establishing new forages. Reducing existing weed growth is particularly necessary in no-till planting. Existing vegetation can be killed with herbicides, tilled in, or in some cases grazed off to ground level prior to seeding the new forages.

3. Use high quality seed. Using outdated seed or seed with poor germination can result in stand failure. It's generally wise to stick with higher quality seed from well-adapted forage types for best success.

4. Inoculate legumes with appropriate bacteria to assure adequate nitrogen production.

5. Plant at an appropriate time of year for the forages you are growing.

6. Use the correct seeding rate

7. Appropriate planting depth and good seed-to-soil contact are necessary to assure a good stand. Seed lying on top of the ground or in loose fluffy soil is less likely to germinate than seed planted at the right depth and packed down. To avoid this problem, use a drill to plant the forage seed or a precision seeder such as the Brillion seeder, or pack the ground after seeding with a cultipacker or similar device.

Seed can be broadcast over frozen ground in early spring (frost seeding). The freezing and thawing cycle will work the seed into the soil. For best success, mow the pasture to less than two inches for better seed-to-soil contact before seeding. Seed at a time when daily temperatures are ranging above and below the freezing point. Higher success rates can be realized from frost seeding than from feeding seed to cattle, and the stand is more uniform. Wisconsin trials at two locations showed the greatest success with perennial ryegrass, followed by red clover and orchardgrass. Bromegrass and timothy were intermediate successes, and reed canarygrass had the poorest establishment (Paine et al., 1996).

Low Tech Establishment Methods

In some cases cropland plagued with persistent perennial grass weeds such as bermudagrass, quackgrass, and johnsongrass can be grazed without any establishment of other forages. In this case, one need only plant fence posts and begin grazing. Light grazing followed by adequate recovery time will encourage the new grass stand to thicken.

Some success has been realized by feeding forage seed to cattle through the herd's mineral or grain supplement and establishing the pasture through manure deposit. This generally results in an uneven distribution of grass plants that will take several years to get established, and thus is not useful for establishing grass where none existed before. The method is more appropriate when introducing a new forage species into an existing pasture. A portion of ingested grass and legume seed does pass through the cow intact and will germinate. Hard seeds tend to pass through and germinate better, because softer seeds take up water in the rumen and are more subject to being digested. About 25 to 35% of legume seeds will pass through and will have 60 to 80% germination (Undersander, 1996). Some of these seeds, when deposited under cool and wet conditions, will germinate and establish (Undersander, 1996). Less success is realized when the manure dries out in warm weather.

A similar strategy could be used where there is cropland near pastureland. A portion of the pasture would be allowed to go to seed, and the remainder of the pasture grazed rotationally.

Cattle are grazed on the rotational side for 3 to 4 hours, then on the seedy portion for another 2 to 3 hours, then they go stand on the former cropland and deposit seed-laden manure. Over time, the pasture will become established. It does take longer to establish pasture this way, but it is cheaper.

Innovative farmer and author Joel Salatin of Swoope, Virginia, (Salatin, 1993) has had success feeding his cattle mature hay that has some seed heads in it on areas where he wanted to establish new forage grasses. Caution is advised here to avoid compacting the soil too much. Cattle should be removed when the ground gets too soggy. This is especially true on clay-based soils.

Management After Establishment

New grass plantings are susceptible to drought and insect attacks and are also easily damaged by cattle during wet weather. It is wise to avoid grazing until the grass can be torn away from the plant without any roots coming up, or when the ground is wet. Even then keep the grazing light—run the animals through fast with a high stock rate for a very short time. On previously-tilled cropland, lighter animals such as sheep may be the best first grazers of newly planted grass because of their lighter weight and because they offer good weed control. If no sheep are available, use calves less than 400 pounds. On some soils it may take up to three years for formerly-tilled cropland planted to pasture to firm up enough to support heavy Holstein cows in wet weather.

Building soil organic matter and utilizing proper grazing management in the first few years after forages are established on cropland is critical to the success of new pasture (Fredericks, 2001). In his classic book *Better Grassland Sward*, Andre Voisin discusses the "years of depression in reseeded pastures." Voisin notes a decline in productivity about three years following plow up and reestablishment of pastures, due to soil organic matter being used up by the new plants. The "depression" was worse the more the soil was tilled. Manure applications helped offset the depression.

Successful Transitions

Dan Shepherd and his father Jerrell changed their farming focus from commodity grains to pecans, buffalo, and gamagrass seed when they realized they had no control over wholesale grain prices (SARE, 2001). After switching, the Clifton Hill, Missouri, father and son team captured niche markets they formerly never had access to when selling only commodity grains. The family started farming corn, beans, and wheat on 1900 acres in the 1960s. Dan's late father came to realize that they could just get by economically doing what others are doing, or they could make a lot more money doing what others won't do. The gamagrass seed operation consumes about 80% of Dan's time, with the other two new enterprises—pecans and buffalo—taking up the remainder. Dan is a firm believer that to succeed in alternative agriculture you've got to communicate to sell your products. Even though most farmers are good at production, few want to be in sales. The family direct markets their buffalo products—including breeding stock, meat, hides, and horns—through their store located on their property. Through the store they also market their pecans, sweet corn, pumpkins, peaches, jellies, and other nuts they buy out of state. Dan's wife, Jan, runs the store and manages the books. Dan oversees the farm operation and does all the buying.

Once their pecan orchard was established, they continued to grow commodity crops in the alleys between the young trees. As the trees matured and began producing nuts, the row crops were crowded out. After that, the orchard floor was seeded to bluegrass. Though the bluegrass does not produce a high tonnage of forage, their buffalo herd readily consumes what it does produce. Their herd started in 1969 and is rotated through the gamagrass pastures using management-intensive grazing. During the summer, the herd is moved about every four days.

Their gamagrass seed operations net about $700 per acre on 400 acres. In 2000 they netted around $300 per acre from the pecan operation but expect that production to at least triple in the coming years. Through their store they sold 70,000 ears of sweet corn at 10 cents each, but even at that low price they net about $1000 on 15 acres. While not being a big moneymaker, the sweet corn draws lots of customers to the store who buy additional products.

The Shepherds feel everything fits together, with the various enterprises spreading the workload out more evenly. They help sponsor "Buffalo Day," when many area residents gather to eat buffalo burgers donated by the family. The family has time to participate in their local Rotary Club and have hosted young people from Russia, Thailand, Belgium, and France who stay for four months then go to another family.

Dan offers others some tips for making the transition: don't look to alternative agriculture as a bail out. Rather, think of getting in or making the change to the system in good times, not bad (SARE, 2001). The products of alternative agriculture require different markets. The average learning curve for anything new is up to eight years. Given all the risk, it's a lot easier to sit back and say it won't work.

The silt-laden flood plains of the lower Rio Grande Valley in south Texas are home to Scott Phillips, who manages the La Brisa ranch owned by the Sheerin family. Much of their crop ground had been farmed for 15 years and proved too marginal to produce enough income to service the property debt. Phillips decided to use animals to restore productivity to the failing cropland. Livestock were turned in on a failed corn crop, which provided many days of grazing. When the corn was consumed and the animals removed, the land grew a crop of volunteer annual grasses, weeds, and corn. As time went on, plant succession progressed to include some perennial plants with the annuals. The ranch produced a profit on livestock even as prices were declining (Gadzia, 1995). The following year additional cropland was taken out of vegetable production and put into pasture.

Their system was also tried on some of the best land, which was planted to oats, ryegrass, legumes, and haygrazer until perennial grasses and forbs could become fully established. Stocking rates were very high, and the animals were moved as often as every twenty minutes on a four-hour cycle in the morning, followed by four-hour moves for the rest of the day, to maximize efficiency. This moving sequence allowed them to gain an extra day of grazing in each of the areas. At these high stocking rates the manure cycles so quickly that almost no flies are seen—even though no fly control is used. Within an hour, trampling, dung beetles, and other insects have almost completely removed all the manure. Weight gains are estimated at 1.3 pounds per day.

The owners and managers expect the real payback will come when the land is put back into vegetables. They have already seen a reduction in soil salts, and expect their fertilizer, weed, insect, and disease control to be reduced from the improved soil health. Longer-term plans are to rotate all their cropland into pasture on a three- to four-year basis.

Enclosure

Gompert, Terry. 2001. Conversion to pasture should start with your best land. Stockman Grass Farmer. June. p. 1, 5.

References

Allan Savory Center for Holistic Management
1010 Tijeras, NW
Albuquerque, NM 87102
505-842-5252
www.holisticmanagement.org

Anon. 1999. Does it pay to reseed? Pasture Talk. March. p. 7.

Aslam, T., M.A. Choudhary, and S. Saggar. 1999. Tillage impacts on soil microbial biomass carbon, nitrogen and phosphorus, earthworms and agronomy after two years of cropping following permanent pasture in New Zealand. Soil and Tillage Research. Vol. 51, No. 1-2. p. 103-111.

Ball, D.M., C.S. Hoveland, and G.D. Lacefield. 1996. Southern Forages. 2nd edition. American Potash and Phosphate Institute and the Foundation for Agronomic Research. Norcross, Georgia. 264 p.

Bluhm, Wilbur L. 1992. Basic principles for establishing native grasses. A Pacific Northwest Native Plant Directory and

Journal. Issue 3. p. 1-4. Hortus Northwest.

Clark, E.A. 2001. A Passion for Pasture. ACRES USA. November p. 28-31.

Dalal, R.C. et al. 1994. Evaluation of forage and grain legumes, no-till and fertilizers to restore fertility degraded soils. Transactions: 15th World Congress of Soil Science, Acapulco, Mexico. July. Vol. 5a: Commission IV Symposia. p. 62-74.

Fredricks, Carl. 2001. Getting through the 'years of depression.' Graze. March. p. 12.

Gadzia, Kirk. 1995. Healing cropland with livestock. Stockman Grass Farmer. November. p. 23-25.

Gompert, Terry. 2001. Conversion to pasture should start with your best land. Stockman Grass Farmer. June. p. 1, 5.

Leake, Linda. 2001. Flower Children. Hay and Forage Grower. January. p. 19-20.

Nation, Allan. 1995. Quality Pasture. Green Park Press of Mississippi Valley Publishing Corporation. Jackson, Mississipppi. 285 p.

Paine, L., D. Undersander, and D. West. 1996. Establishing new pastures. Pasture Talk. March. p. 10, 16.

Salatin, Joel. 1993. Low-cost pasture establishment. The Stockman Grass Farmer. August. p. 29.

SARE. 2001. The New American Farmer: Dan and Jan Shepherd. Farmer profile available from <www.sare.org/newfarmer/shepherd.htm>.

Undersander, Dan. 1996. Passage of seed through cattle and survival in manure. Pasture Talk. December. p. 14.

IP244/SLOT245

The electronic version of
Converting Cropland to Perennial Grassland
is located at:

HTML
http://www.attra.ncat.org/attra-pub/grassland.html

PDF
http://www.attra.ncat.org/attra-pub/PDF/grassland.pdf

By Preston Sullivan
NCAT Agriculture Specialist