



Converting Cropland to Perennial Grassland

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Establishing perennial pasture can be a profitable enterprise on marginal cropland. This publication examines some agronomic considerations of converting cropland to grassland, methods of establishing pasture on croplands and how to manage established pastures. Two farm profiles illustrate these processes.

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 (Holistic Management International) Robert Moore and his son Taylor took a path to a brighter future with less personal stress and lower overhead cost than when they raised row crops. 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 work with nature by letting the natural grasses return. With a wide variety of grasses available, they can graze from mid-February to mid-November. After giving up row cropping, they increased their cow herd from 200 to 600 animals. Their 2000 acres are divided into 50-acre paddocks with about 200 head in a paddock at a time. With their row cropping enterprise they had 20 employees working full time. 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."



Cattle grazing on pasture in Benton, Arkansas. Photo courtesy NRCS.

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. Producers without livestock experience may benefit from working with a neighbor who runs livestock to get a feel for it. An easy way to get started is 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. For detailed information see the ATTRA publications at www.attra.org/livestock.html.

Besides the potential for lowering risk, stress and overhead costs, switching from cropland to perennial grassland will reduce or eliminate soil erosion while improving soil organic matter. Soil health generally improves under grassland because long-term grass production produces well-aggregated soil. Aggregated soil is one with a crumbly structure capable of high water infiltration, porous air exchange and the ability to accommodate fast and deep plant root growth. Grass plants extend a mass of fine roots throughout the topsoil, contributing to the physical processes that help form aggregates.

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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 cover provides protection from raindrops and erosion. Thus, perennial grasses create a combination of conditions optimal for the formation 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 (i.e., Frasers et al., 1996). Organic matter and biological activity generally decline when pastures are tilled up and planted with crops. By way of comparison, pastureland that is converted to crops by plowing and no-till may suffer a 45% decline in soil microbial biomass in the top 2 inches of soil. In general, the top 4 inches of soil contain higher microbial biomass and more earthworms under no-till or permanent pasture as compared to plowed ground (See *Table 1*).

In a Kansas study, five sites were selected, each with native perennial grassland bordered by a field annually cropped with wheat. The perennial grass fields were managed as hayfields without fertilization for the past 75 years, whereas the wheat fields were historically cropped with wheat and rotations of sorghum and soybeans. The annually cropped fields were maintained with annual inputs of fertilizer. The soils were sampled three times during the growing season on both sites in each treatment. Researchers noted that soil carbon, nitrogen and water-stable aggregates were all significantly greater in perennial grasslands than in annual croplands to a depth of 23 inches. Microbial activity was also significantly different, including the presence of nitrogen-fixing bacteria. These data suggest that perennial grasslands, even after years of annual harvest, can support higher levels of soil



A mixture of native grasses and forbs in Linn County, Iowa. Photo courtesy NRCS.

fertility and structure and more complex soil food web than annual cropping systems (Culman et al., 2009).

Economic considerations

Before making the final decision to convert cropland to pasture, a detailed financial analysis should be done and all the costs of both the crop enterprise and the livestock enterprise should 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 systems. 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 for several years. An example budget for dryland corn vs. establishing a big bluestem pasture is included on the next page. Detailed grazing budgets are available in the ATTRA publication *Grazing Contracts for Livestock*.

Precautions

After soil moisture, weed control is the most important factor to consider prior to the establishment of grass pastures, especially native warm season perennial pastures. Perennial forbs and warm-season grasses such as crabgrass germinate in cooler soils and can have a severe impact on pasture stand establishment.

Related ATTRA publications

Assessing the Pasture Soil Resource

Nutrient Cycling in Pastures

Pasture, Rangeland and Grazing Management

Pastures: Sustainable Management

Switchgrass as a Bioenergy Crop

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*

Table 2. Budget Comparison: Dryland Corn vs. Big Bluestem Pasture for Grazing in Nebraska

Inputs	Cost/ac corn	Cost/ac pasture
Seed cost	31.76	46
Custom planting	10	10
Herbicide	30.60	5.83
Custom spray	5	3.33
Fertilizer	23.54	22
Custom spread	4.50	4.50
Harvest and haul	22	
Fence		92.06
Water		106.65
Burn		3
Total annual inputs (pasture: fertilizer, herbicide, and burn)		36.66
Total establishment costs (pasture)		263.87
Amortization (pasture estbl., fence, water) *		24.60
Total inputs (for pasture: annual inputs + amortization)	127.40	60.26
* Establishment cost amortized for 15 years at 5% interest on 80 acres.		
Return	Corn **	Pasture
Yield (bu/ac)	85.90	
Market price (\$/bu)	2.03	
Beginning cattle wt (lb/ac)		2458
Cattle cost (\$/cwt)		84.78
Beginning cattle value (\$/ac)		2083.89
End cattle wt (lb/ac)		2863
Market price (\$/cwt)		79.09
End cattle value (\$/ac)		2264.35
Gross return (\$/ac)	176	180.46
Inputs (\$/ac)	127.40	60.26
Net return (\$/ac)	48.60	120.20
** Does not include price supports or cost shares.		
<i>Table adapted from Tables 2 and 3 in Vogel, et al. 2005. Big Bluestem Pasture in the Great Plains: An Alternative for Dryland Corn. Rangelands. Volume 27, Issue 2.</i>		

Grass establishment can be improved by utilizing cultural and mechanical control measures to reduce weed pressure. For instance, annual cropping with small grains and field peas for one or two years will provide an opportunity to control weeds several times during the season while building soil organic matter. Also, nurse crops can sometimes reduce weed pressure and provide a cash crop in the form of hay, silage, or grain. Weeds can also be controlled in newly planted grass stands by mowing two or three times during the growing season. Mow the weeds down

to the tops of the grass plants so as to reduce the impact of defoliation on the grass. Mowing can be effective against annual weeds especially as they mature, but prior to seed set. Mowing can also reduce perennial weeds by effectively depleting root reserves by successive mowings when the plant is at the boot stage.

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 similar to land that has been in pasture several years. Some herbicides persist for more than one year. 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, especially in semi-arid climates. Since grazing pressure should be light until the perennial forage is well established, income may be reduced for the first year or two. Therefore, it is preferable to gradually convert a crop farm into pasture rather than all at once (Nation, 1995).

When faced with the decision to plant either one (monoculture) or several (polyculture) forage species, Canadian grazing researcher E. Ann 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 and slope that occur in any landscape. Clark advises planting a diverse mixture of forage species to occupy all available ecological niches with productive, economical forage plants (see **Plant selection** below).

The most common causes of grass seeding failures are:

1. planting the seed too deep,
2. crusted soil surface,
3. competition from weeds, and
4. 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 worth the time to reduce competing vegetation and do a good job of seedbed preparation and planting. Planting is an expensive operation, there are few shortcuts and you don't want to have to replant the field.

Most forages can be established using a no-till drill equipped with a grass-seed box. Residual vegetation should be controlled prior to 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 providing erosion-resistance



NRCS conservationist and Yolo County farmer inspect a native grass planting near a restored wetland. Photo courtesy NRCS.

by reducing bare soil that results from conventional tillage.

A good seedbed is essential if planting is to be done after conventional tillage. The soil needs to be worked to break up clods, followed by firming the seedbed with a roller or cultipacker. Clods should be no larger than an inch and only a few that size and a footprint should sink no deeper than one-eighth inch (Bluhm, 1992). 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, such as clover and annual ryegrass. The seed may be broadcast or drilled or planted in a grass seeder such as the Brillion™ seeder. If broadcast, the field should be dragged with a light chain or harrow to facilitate seed covering. Use higher seeding rates for broadcast plantings.

Plant selection

Plants are differentiated by the season in which they grow, their life cycle, their morphology or structure, whether they are native or introduced and their water requirements. Plant species are also differentiated by their response to soil type, depth and drainage. Plants should be selected with consideration of these factors, keeping in mind the goals for the pasture (for example, hay, grazing, silage/haylage, summer or winter grazing, etc.) as well as the seasonal variation in forage growth and productivity (Vough et. al., 1995).

Pastures can be planted to single species or mixtures of various grasses and legumes. Single species plantings can be easier to manage, especially for hayfields, since you are concerned with the maturity of only a single plant species. Mixed

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.

plantings offer more of a challenge for hayfields because plants in the mixture will often mature at different times, making decisions about harvest time more problematic. This, however, can be overcome in part by selecting species that mature at approximately the same time. For example, when planting an alfalfa-orchardgrass mix, it is advised to plant a late-maturing variety of orchardgrass to match the maturity of the alfalfa. The hay from this mixture should be harvested in accordance with the maturity of the alfalfa, or when the grass is at the late boot stage or flowering stage.

Legume-grass mixtures are ideal for hay or for rotational grazing. According to Vough et al., (1995), these mixtures have several advantages over single-species stands because:

1. legumes fix atmospheric nitrogen, reducing the need for nitrogen fertilizer,
2. legumes increase the protein concentration of the forage,
3. legumes extend grazing into the summer when cool season grasses begin to decline,
4. mixtures are better at competing with weeds for soil resources,
5. mixtures are usually higher yielding than single species stands,
6. mixtures with legumes are easier to cure as hay or ferment as silage,
7. mixtures tolerate a wider range of soil conditions and
8. mixtures reduce the bloating effect of legumes on ruminants.

Some other forage characteristics that should be considered in selecting the right species are warm season plants vs cool season plants, annual plants vs perennial plants, native vs introduced and dryland vs temperate or irrigated pastures. These topics are covered in greater detail in publications such as *Southern Forages* and *Dryland Pastures in Wyoming and Montana* (see **Further Resources**).

Conventional establishment

Planting information is widely available (seeding dates, rates, depth to plant, etc.) from local Extension offices and University Experiment Stations. These local sources

are the best available and should be consulted for accurate information on adapted forage species and how to plant them. Seed calculators are also available that provide an easy way to determine costs of various seed mixtures. One of these can be found on the Web at www.economics.nrcs.usda.gov/technical/tools/#RangelPasture. In addition, the University of Wisconsin Extension has a seeding rate calculator which can be accessed at www.uwex.edu/ces/forage/pubs/seeding_rate_calculator.xls.

General guidelines for establishing forages are shown below in abbreviated form from *Southern Forages* (Ball et al., 2007). 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 calcium, 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 mown, tilled in, or in grazed off to ground level prior to seeding the new forages.
3. Consider using a nurse crop such as oats to control weeds during pasture establishment. Oats should be cut for hay or silage when the pasture seedlings are established



Southern Iowa farmer uses a grass drill to interseed native grasses into a cool-season field of grasses. Photo courtesy of NRCS.

to reduce plant competition from the nurse crop.

4. 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.
5. Inoculate legumes with appropriate bacteria to assure adequate nitrogen fixation.
6. Plant at an appropriate time of year for the forages you are growing.
7. Use the correct seeding rate.
8. Plant to the appropriate soil depth. 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.

Frost seeding

Seed can be broadcast over frozen ground in early spring (frost seeding). The daily freezing and thawing cycle will help to work the seed into the soil. For best success, mow or graze the pasture in the fall to less than two inches for better seed-to-soil contact. 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, resulting in a more uniform stand. Wisconsin trials at two locations showed the greatest success with perennial ryegrass, followed by red clover and orchardgrass. Bromegrass and timothy showed intermediate success and reed canarygrass had the poorest establishment (Paine et al., 1996).

Low-input establishment methods

In some cases cropland inundated with persistent perennial grasses 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. In this case, grazing management is the best low-input method for establishing a pasture. Information on grazing can be found in the ATTRA publication *Rotational Grazing*.

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 deposition. 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 new grass stands. This method is more appropriate when introducing a new forage species into an existing pasture. A portion of ingested grass and legume seed passes 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.

Innovative farmer and author Joel Salatin of Swoope, Virginia, (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 soil compaction. Cattle should be removed when the ground gets too soggy, especially on clay-based soils.

Management after establishment

New grass plantings are susceptible to drought and insect damage and are easily damaged by cattle during wet weather. Avoid grazing until the grass can be grazed without uprooting the plants. Even then keep the grazing light—rotate the animals through fast with a high stocking rate for a very short time on each paddock. Graziers who run livestock on cropland to clean up residues or graze cover crops have noted that soil compaction can occur. This is likely due to the fact that annual cropland is often tilled each year in order to control weeds, turn in cover crops, or prepare a seedbed for planting. Tillage is known to destroy soil structure and burn up organic matter and when livestock impact is added soil compaction becomes a serious side

effect. Row crop farmers can ameliorate soil compaction problems by discing to a depth of no more than six inches prior to planting the next crop, but this will not be possible on a permanent pasture (Samples and McCutcheon, 2002). 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 several 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 (Fredricks, 2001). In his classic book *Better Grassland Sward* Andre Voisin (1960) 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

The Shepherds

Dan Shepherd and his father Jerrell changed their farming focus from commodity grains to pecans, buffalo and eastern 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 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 eastern 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 markets their buffalo products directly to customers—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 eastern gamagrass pastures using management-intensive grazing. During the summer, the herd is moved about every four days.

Their eastern gamagrass seed operations net about \$700 per acre on 400 acres. In 2000 they netted around \$300 per acre from the pecan operation. Through their store they



NRCS soil conservationists evaluating a warm season grass stand with a landowner. Photo courtesy NRCS.

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 purchase additional products.

Dan offers others some tips for making the transition: don't look to alternative agriculture as a bailout. 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.

La Brisa Ranch

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 pay-back 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.

Summary

Establishing a new pasture is a time-consuming and expensive process. Pay careful attention to proper plant material selection, soil tith and seedbed preparation, soil fertility and the addition of compost or manures, green manure plow-down and amendments with rock powders. Plant materials should be adapted to the native soil pH and water holding characteristics, annual precipitation, temperature, seasonality and grazing system. The biological diversity of newly established pastures is enhanced through grazing management, especially through planned grazing systems that provide adequate rest and regrowth.

Further resources for information on pasture establishment

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The Samuel Roberts Noble Foundation. Pasture & Range Information. www.noble.org/Ag/Research/Forages.htm

A Landowner's Guide to Native Warm-Season Grasses in the Mid-South. University of Tennessee Extension. www.wildlifemanagement.info/files/nwsg_9.pdf

Reseeding Marginal Cropland to Perennial Grasses, Forbs and Legumes. Oklahoma State University Extension. <http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2549/NREM-2581web.pdf>

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Economics of Grazing Systems Versus Row Crop Enterprises. University of Missouri - Forage Systems Research Center. <http://laes.missouri.edu/fsrclresearch/afgc95km.stm>

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Notes

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