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USE OF IRRIGATED PASTURES AND ECONOMICS OF ESTABLISHMENT AND GRAZING

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INTRODUCTION

The use of irrigated pasture is a potential option for many livestock producers. Irrigated cool-season species, for example, can be used as complementary forage to warm-season rangeland (Nichols et al. 1993) or mitigate some of the effects of drought. Irrigated pasture can result in high animal production per acre; however, achieving the high production levels requires excellent grazing management with high water and fertilizer applications (Nichols and Clanton 1985; Gray et al. 2001). There are a number of management considerations associated with irrigated pasture. This includes practical details such as field selection, species and variety selection, seeding methods, and fence and livestock water development. There is also the need to become familiar with the irrigation, fertilizer, and grazing management requirements needed to sustain highly productive irrigated pasture. Additionally, livestock operations should carefully evaluate their production goals, current resources, forage needs, and economic returns when considering and planning to establish irrigated pasture.

FORAGES FOR IRRIGATED PASTURE

All available forage species, whether cool-season or warm-season, or annual or perennial, would at times, benefit from supplemental irrigation water. However, several plant characteristics, such as adaptation to the climate and soils, productivity, capable of good growth after grazing, and ability to readily establish when using good cultural practices are important when considering what to plant for irrigated pasture.

Annual forages grown under irrigation have potential for use in several situations. This would include such things as a short-term or an emergency need for forage. Some cool-season annuals that may be used include the winter annuals, wheat, rye, and triticale; spring planted oats and barley; or summer planted oats and turnips. Warm-season annuals include sorghum-sudangrass hybrids, sudangrass, and pearl millet. With proper planning, cool- and warm-season annuals can be successfully used in a double-cropping plan. Forage production from a double-crop of annuals can be comparable or even greater than perennial forages; however, there are the extra costs associated with seeding the annuals.

Cool-season perennial grasses are the most popular choice for irrigated pasture. Cool-season pastures permit development of complementary forage systems with associated warm-season rangeland and other forage resources (Fig. 1). Complementary forage systems have the potential to increase production per unit of land, improve animal performance, provide an alternative to harvested feeds, and increase forage availability during drought (Nichols 1989).

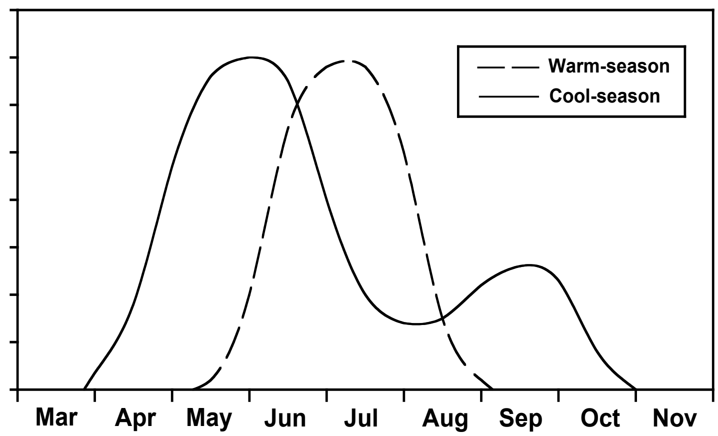

Figure 1. Seasonal growth distribution of cool- and warm-season grasses.

Compared to warm-season grasses, cool-season grasses respond more readily to water and fertilizer, and the timing of their growth coincides with the forage needs of most livestock producers. In some situations, the use of warm-season perennial grasses, such as switchgrass and big bluestem, may be a viable option to complement existing forage resources.

COOL-SEASON PERENNIAL FORAGES

The primary cool-season perennial grasses that have been used in irrigated pasture in Nebraska include orchardgrass, smooth bromegrass, meadow bromegrass, creeping foxtail, intermediate wheatgrass, and pubescent wheatgrass. Mixtures of several grass species are most often recommended rather than the use of a single species. The species in a mixture should be similar enough in animal preference to allow management of the pasture as a whole, but diverse enough to contribute to a range of beneficial traits. Most fields have variation in soil type, fertility, and moisture, and each of the grass species have some differences in their adaptation to the sites within a field. Creeping foxtail, for example, is a species that is well adapted to low, wet soil sites. Additionally, there are growth rate differences between species within the growing season, and the use of a mixture may help provide a more balanced supply of forage. Another important consideration is the inclusion of rhizomatus, sod-forming and bunchgrass species in the mixture. Sod-forming species are more aggressive with respect to filling in bare areas or moving into areas where plants have died. Example mixtures are shown in Table 1.

Table 1. Examples of historically successful mixtures and species for seeding irrigated pastures in Nebraska.[1]

Species	Growth form	Seeding rate[2] lb. PLS /acre	Mixture composition (%)	Seeds per sq. ft.
Example 1				
Orchardgrass	bunchgrass	5	62	75
Smooth bromegrass	sod-former	3	8	9
Meadow bromegrass	bunchgrass	5	8	9
Creeping foxtail	sod-former	1	14	17
Alfalfa	- -	2	8	10
Total		16	100	120
Example 2				
Species	**Growth form**	**Seeding rate[2] lb. PLS /acre**	**Mixture composition (%)**	**Seeds per sq. ft.**
Orchardgrass	bunchgrass	5	64	75
Smooth bromegrass	sod-former	4	10	12
Meadow bromegrass	bunchgrass	7	11	13
Creeping foxtail	sod-former	1	15	17
Total		17	100	117

[1] From: Volesky et al. 2003.
[2] PLS = pure live seed; PLS = germination X purity.

In addition to the primary cool-season grasses shown in Table 1, there are several other species that are currently being marketed. They may have potential for use in irrigated pastures or on specific sites; however, most of these species and varieties have not yet been fully evaluated under plot and/or grazing research trials in Nebraska. These species include perennial ryegrass, timothy, tall fescue, festulolium, Virginia wildrye, and 'Newhy' hybrid wheatgrass. Research trials at the University of Nebraska West Central Research and Extension Center currently have these and other species in plot evaluations. Preliminary observations from these trials are that relative to other species, perennial ryegrass has lower total production, but average forage quality is higher. Summer growth of perennial ryegrass is also good, but the long-term persistence of the species is not known in Nebraska. Tall fescue and festulolium are among the most productive species; however, earlier research has shown that daily gains of yearling steers grazing tall fescue have been relatively low (Nichols and Moore 1977). Intermediate wheatgrass varieties are also among the most productive, primarily because of excellent spring growth. Summer growth, however, has been relatively slow. Total production of orchardgrass varieties has ranked moderate to high, and the species has had good summer growth. Smooth bromegrass, meadow bromegrass, and creeping foxtail have ranked moderate in total production and summer growth. These 3 species, especially smooth bromegrass, have been observed to be very persistent under irrigated pasture conditions. Timothy and Virginia wildrye have had high spring forage yield, but poor summer growth, and as a result, relatively low total production.

Combining legumes into grass mixture provides several benefits, but also can create additional challenges with respect to fertilizer, irrigation, weed control, and grazing management. Addition of a legume in a pasture may result in increased forage yield and quality. Another possible benefit of a grass-legume mixture is that grasses are able to utilize some of the nitrogen fixed by legumes. In an irrigated pasture situation, however, the amount of nitrogen fixed by legumes is influenced by a number of other factors, and the grass response can be variable (Moline et al. 1974). Rehm et al. (1975) reported that alfalfa had a positive growth response to N fertilizer, and there was an absence of nodules on the alfalfa root system. This suggests that there may be little benefit from a legume, and fertilizer N would be needed to meet the total N requirement in an irrigated grass-legume mixture. There also is a potential for bloat, particularly when alfalfa or other bloat-causing legumes produce greater than 40 to 50% of the available forage in the pasture.

Although using a mixture of species has several distinct advantages, management preferences may favor only the use of a single species in a pasture or paddock. This approach does offer some benefits with respect to management flexibility. Cool-season perennial grasses or varieties of a species can vary considerably with respect to initiation of spring growth, growth rate, maturity ranking, or even palatability. Intermediate wheatgrass, for example, is a species that is probably more easily managed and persistent when grown in a pure stand. It also offers excellent potential when the amount of irrigation water is limited.

SEEDING AND ESTABLISHMENT

Most cool-season perennial grasses will thrive on a variety of soil types. Sandy soils can produce substantial forage when properly irrigated and fertilized. Soil samples should be taken to determine fertilizer needs. The seedbed for grasses should be firm, similar to alfalfa. Check for residual herbicides if they had been applied to the field for weed control in other crops. The total seeding rate for all species in a mixture will be about 15 to 20 lb/acre (Table 1). There can be considerable variation in this and the number of seeds per square foot that are sown, depending on the amount of each species in the mixture. Drills that are used for grass seeding should have some form of depth control that places the seed _ to _ inch deep on heavier soils and about 1 inch deep on sandy soils.

Spring or late summer (August) seeding is acceptable for cool-season grasses, but a late summer seeding is usually preferred because of more rapid and uniform germination and fewer weed problems. If residue is not excessive, no-till seeding in late summer after oats, winter wheat, or a warm-season annual is another option. Late summer seeding may have about 60 to 80% of the normal production the following year. A spring seeding may have 50 to 60% of normal production the first year.

FERTILIZATION

Proper fertilization is essential for maximum production from established irrigated pasture. Irrigated cool-season grasses have been found to continue to respond to nitrogen (N) at rates as high as 200 to 250 lb/acre. The level of fertilization that is used should consider what level of forage production or stocking rates are desired, as well as fertilizer costs (Table

2). Split applications of N fertilizer are most efficient with about 50% of the total annual amount applied in the early spring, 25% during the summer, and the remaining 25% in the fall. Soil tests are recommended to assist in determining proper fertilizer rates.

Soil tests are also recommended to determine phosphorus needs of irrigated pasture (Table 3). Applying the proper balance of nitrogen and phosphorus is important in grass-legume mixtures. Applying only phosphorus (P), for example, will enhance the vigor and production of legumes with a lesser effect on grasses. Applying only N will primarily stimulate grass growth. Moline et al. (1974) reported that in several studies, N fertilization reduced the legume composition in grass-legume mixtures. Phosphorus can be applied in a single application either spring or fall.

Table 2. Suggested nitrogen (N) fertilizer rates for irrigated pasture.[1]

Nitrogen (N)	**Pounds of NO_3-N / acre in the soil to 6 ft.**		
Desired stocking yearlings / acre	**0 - 50**	**50 – 100**	**100 – 150**
	- - - - - - - N application (lb / acre) - - - - - -		
3	180	120	80
4	240	180	140
>4	270	240	200

[1] From: Rehm and Knudsen 1978.

Table 3. Recommended rates of phosphate for irrigated pasture.[1]

Phosphorus			**Phosphate to apply annually**	
PPM phosphorus in soil[2]			**Grass pastures**	**Grass-legume pastures**
Bray	$NaHCO_3$	Relative level	- - - - - lb P_2O_5 / acre - - - - -	
0 to 5	0 to 3	very low	60	90
6 to 15	4 to 7	low	30	60
16 to 25	8 to 15	medium	0	30
> 25	> 15	high	0	0

[1] Modified from: Rehm and Knudsen 1978.
[2] Determined by Bray test or $NaHCO_3$ (Olsen P) test.

In Nebraska, the fastest growth rate and greatest production from cool-season grasses occurs during May and June with slower growth and less production during mid- and late-summer. Adjusting the dates of fertilizer application can affect the seasonal distribution of production; however, the response and fertilizer-use efficiency of mid- and late-summer applications may be less compared to a spring application.

IRRIGATION MANAGEMENT

Irrigation management for pasture is important with respect to efficient water use and optimizing forage production. Generally, frequent and smaller applications (0.75 to 1.00 inch) result in the best use of water by the grasses. Many of the cool-season grasses have relatively shallow root systems. Water is usually applied to a paddock after a grazing period has been completed. For pasture mixtures that include a deep-rooted legume such as alfalfa, it is still desirable to irrigate more frequently using lesser amounts to maintain consistent and active growth of the grasses. For maximum production, total water during the growing season (April – October) should be about 32 to 36 inches. In North Platte, Nebraska, for example, rainfall during this period averages 16.7 inches. Therefore, irrigation water needs average about 16 to 20 inches. During a severe drought in 2002, when growing season rainfall was 52% of average, 26.75 inches of irrigation water were required to maintain soil moisture and plant growth at desired levels (Fig. 2).

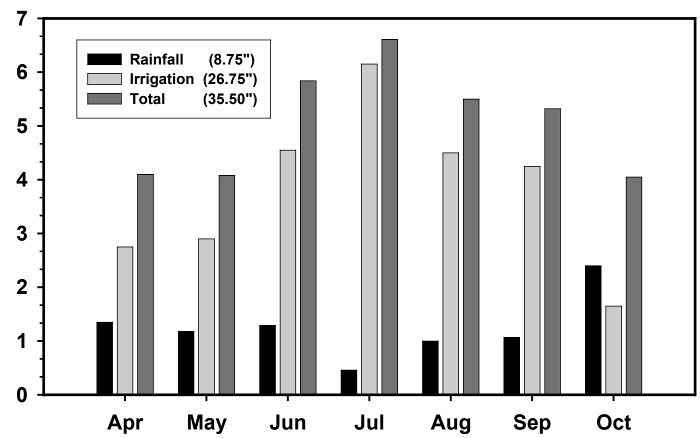

Figure 2. Monthly rainfall and irrigation water on cool-season grasses, North Platte, 2002.

GRAZING MANAGEMENT

The date of spring turn-out is a critical factor associated with the sustained productivity of cool-season pasture. A general guideline is to wait until growth has reached a height of about 8 inches. In west-central Nebraska, this usually occurs about April 25 but can vary by as much as 10 days either side of this date, depending on the spring growing conditions. Initiation of grazing too early in conjunction with high grazing pressures has the potential to reduce productivity the remainder of the growing season.

There are two grazing management principles that are essential to good irrigated pasture production. The first is limiting the number of times a plant is grazed. This can be accomplished by rotational grazing. The second is the maintenance of sufficient residual leaf area to keep the plants productive. A target level of residual plant material after a grazing period is about an 8-inch stubble height. Preliminary results from a study at the West Central Research and Extension Center found clipping stubble height significantly affected total herbage yield and tiller density at the end of the growing season (Fig. 3). Rotational grazing is recommended to most efficiently harvest irrigated pasture. At a minimum, divide the pasture into 5 or 6 paddocks so each paddock has 24 to 40 days to regrow following each grazing. This will require each paddock to be grazed for about 6 to 8 days. Depending on a manager's objectives and desired management intensity, a greater number of paddocks may be established.

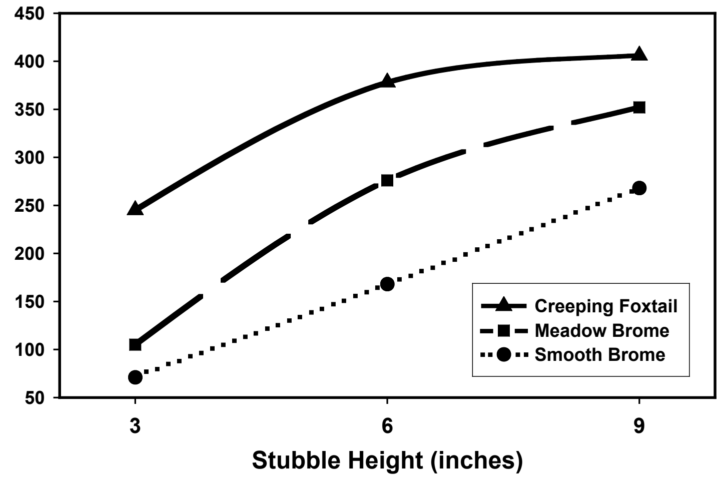

Figure 3. Effect of clipping stubble height on fall tiller density of 3 irrigated, cool-season perennial grasses, North Platte, 2002.

Growth of irrigated cool-season pasture is very rapid during spring and early summer and then slows during the warmer part of the summer. To accommodate this difference in growth rate in a multiple paddock grazing system, one or more paddocks could be cut for hay in the spring while the other paddocks are grazed. Another option to manage this change in growth rate is to reduce the number of livestock after the rapid growth period or to have additional pasture available during mid- to late-summer. The extent of the stocking rate reduction needed during this period can range from 25% to as high as 50%.

Productivity of a pasture will influence the number of animals it will support. In west-central Nebraska, Nichols and Moore (1977) reported that on a silt loam soil and with 260 lb N/acre applied annually, carrying capacities ranged from 10 to 12 AUM/acre. To achieve this level of production requires a good stand and excellent irrigation and grazing management. Potential carrying capacity of irrigated pasture in the Nebraska Panhandle and eastern Wyoming would be less because of a shorter growing season and other climatic and environmental variables. It is important to have some assessment of a pasture's productivity when planning the stocking rates (Table 4). It is also critical to have the flexibility to adjust animal numbers to match the forage supply.

Table 4. Approximate stocking rates (AUM/acre) resulting from different livestock classes and densities for selected time periods.[1]

Head and livestock class/acre	Grazing period (months)	AUM/acre
2 yearlings[1] (600 lb)	4	5.6
3 yearlings (600 lb)	4	8.4
4 yearlings (600 lb)	4	11.2
1 cow-calf pair	5	7.0
1.5 cow-calf pair	5	10.5
2 cow-calf pair	5	14.0

[1] Stocking rate for yearlings considers a 200 lb gain during the 4-month period.

STRATEGIES FOR USING IRRIGATED PASTURE

Whether it's cow-calf pairs or yearling animals, there are several different ways that irrigated cool-season perennial pasture could be used or incorporated into the forage plan of a livestock producing operation. Some of the common options and strategies are outlined as follows:

- Season-long (late April – October) with cow-calf pairs. With this strategy, some adjustments in stocking rate, such as moving a portion of the herd to other pasture, are needed to accommodate the summer slow-down of the cool-season grasses.

- Late April and May grazing with cow-calf pairs. Pairs go to range in June and yearlings are brought in to graze the irrigated pasture the remainder of the season. This is a type of complementary grazing where the pairs are able to capitalize on the earlier cool-season forage. Correspondingly, this provides a deferment to the range, which can be beneficial, particularly during drought.

- Late April to August with pairs. Calves are weaned in August; remain on the irrigated pasture while the cows go to range. This would reduce the problems associated with the summer-slowdown of irrigated cool-season grass. Additionally, it would provide beneficial deferment to native range.

- Late April through July with pairs. Pairs would go to range in August and either weaned calves or cows could graze the irrigated pasture again in the fall. Removing the pairs at the end of July would coincide with the summer slow-down of cool-season grass and allow forage to be stockpiled for fall use.

- Season-long with yearlings. Depending on size and growth rate, 2 groups of yearlings would likely be grazed during a growing season (May – July and August – October). This allows flexibility in stocking rate that can best match forage growth.

- Late April through July with yearlings. Forage growth after July would be stockpiled for fall use by weaned calves or other livestock classes.

- Late April through July with a 'leader' herd of yearlings and a 'follower' herd of cow-calf pairs. Yearlings are removed at the end of July while the pairs remain in the irrigated pasture. In this strategy, the yearlings graze in a separate paddock ahead of the pairs in the rotation. They are consuming the first portion of allocated forage for that paddock which is advantageous to yearling performance. The pairs immediately follow in that paddock and are consuming the remaining portion that is usually at a slightly lower quality.

- Drought reserve and hay production. Irrigated pasture, or at least some portion, could be held in reserve to offset the effects of drought on range. Year to year decisions would be made as to whether that forage was needed for pasture or cut for hay.

ECONOMIC CONSIDERATIONS WITH IRRIGATED PASTURE

Irrigated pasture costs include the costs for establishment of the stand, fence and water development and annual operating costs. Fence and water development costs can be quite variable, depending on whether or not the field was in crop production and whether a ready source of water for livestock is available. The annual operating costs should include things such as fertilizer and labor for moving livestock and upkeep on facilities.

Establishment costs

For estimation purposes we have assumed that the pasture will be developed on an area that has an already established center pivot irrigation system. Costs for development of irrigated pasture on gravity-irrigated fields are similar, based on other budgets that we have developed; however, those situations will not be discussed here.

Tables 5 and 6 show the estimated costs for the seed alone for the mixtures discussed in Table 1. Prices are variable to some degree by area. The prices shown below are based on estimates received from two grass seed suppliers, one in Nebraska and one in Kansas.

Table 5. Seeding costs for mixture one.[1]

Species	Pounds/acre	$/lb of PLS	Cost/acre
Orchardgrass	5	1.50	7.50
Smooth bromegrass	3	1.25	3.75
Meadow bromegrass	5	2.50	12.50
Creeping foxtail	1	6.50	6.50
Alfalfa	2	2.00	4.00
Total	16		$34.25

[1] Prices updated as of November, 2003.

Table 6. Seeding costs for mixture two.[1]

Species	Pounds/acre	$/lb of PLS	Cost/acre
Orchardgrass	5	1.50	7.50
Smooth bromegrass	4	1.25	5.00
Meadow bromegrass	7	2.50	17.50
Creeping foxtail	1	6.50	6.50
Total	17		$36.50

[1] Prices updated as of November, 2003.

Table 7 shows the estimated first year establishment costs for preparing and seeding a typical quarter section center pivot. We have assumed that the pasture will be established in late summer and no-till seeded directly into whatever cover is on the pivot. Note that we have allowed for the cost of a burn-down herbicide to kill all plant growth prior to seeding. One option is to plant the pivot to a forage crop in the spring, harvest the crop and then no-till the grass seed into the residue.

If the area to be established has not been used for grazing livestock in the recent past, it will need fence and livestock water developed. Table 8 shows cost estimates for a 5-paddock pivot with an external fence. If the external fence is not needed, costs for fencing will be reduced by about half. Fencing costs are highly variable. The estimates provided are for hiring the fence installed. If one chooses to install a simpler fence system, the costs could be reduced substantially.

Table 7. First year seeding and pasture establishment costs/acre for a 130-acre pivot.[1]

Item	Cost/unit	Cost/acre
Seed	$36/acre	$36.00
Herbicide	1 qt glyphosate (generic) @ $6.25/qt and ammonium sulfate at $2.89/ac plus application cost	13.64
No-till drill seeding	$12/acre	12.00
Nitrogen 30 lb/ac	$0.23/lb liquid N	6.90
Fall irrigation water (3 inches)	$3.65/ac-inch applied	10.95
Total		**$79.49**

[1] Data sources: seed, blend of tables 5 and 6; herbicide 2003 prices, unpublished; custom rate for no-till drilling small grains, Jose and Brown 2002; N price 2003, unpublished; irrigation water costs include use related depreciation and based on Selley et al. 2001.

Table 8. First year fencing, livestock water development and total costs for a 130-acre pivot, 5 paddock system.[1]

Item	Cost/unit	Cost/acre
Cross-fencing-2 wire HT electric	$0.58/foot—6600 ft plus $300 for energizer	$31.75
Perimeter fence-2 wire HT electric[2]	$0.58/foot—10,560 ft	47.10
Livestock water (tank, hydrant & 1320 ft underground PVC)	PVC buried @ $1/ft, 12' steel bottom tank installed $585 plus hydrant @ $105	15.46
Total fencing and water development		**$94.31**
Seeding & establishment costs	From Table 7	79.49
Grand total		**$173.80**

[1] Data sources: Fencing costs estimated from Wilson and Clark 2002; water development costs estimated from Wilson and Clark 2003.
[2] Perimeter fence assumed around entire one-quarter section.

One strategy for establishing the pasture is to produce a spring planted forage crop such as oats. The oats will ensure that the producer will obtain some return from the land (barring a hail storm!) in the establishment year plus provide a good seed bed for no-till planting of the grass mixture. Table 9 shows the estimated costs and returns for a forage crop of oats. Costs are based on a combination of budgets (Selley et al. 2001) and custom rates (Jose and Brown 2002).

Table 9. Estimated costs and returns for irrigated oats for hay prior to grass establishment.[1]		
Item	**Details**	**Cost/acre**
Seedbed prep, planting and fertilizer & irrigation	100 lbs seed/acre @ $5.95/bu., custom seed @ $10/ac, 5 inches irrigation water @ $3.65/inch and 50 lbs N @ $0.23/lb	$58.35
Harvest cost (custom)	Swathing $8/ac, baling @ $8/round bale & moving bales @ $2/bale	48.00
Interest	3 months @ 5%	2.00
Total cost		**$108.35**
Expected yield	3 tons/ac	
Cost/ton of forage		**$36.12**

[1] Cost estimates based on current prices for oat seed and custom rates (Jose and Brown 2002). Irrigation based on center pivot pumping at 800 GPM, 35 PSI and lift of 125 ft. powered by electricity (Selley et al. 2001).

Annual operating costs

Once the grass is established, it must be maintained. The major annual costs are fertilizer and irrigation water. We estimate that the pasture will take as much as 20 inches of irrigation water in a normal year in western parts of Nebraska and South Dakota and eastern Wyoming and Colorado. Costs for labor to move cattle also need to be recognized. These are not huge but movement does take some time. Table 10 shows our estimated annual operating costs. While the establishment costs have been incurred in the initial year, they can be annualized to include with the other costs to estimate the total costs that must be covered if the operation is to be profitable. Note that costs for land, management, overhead and some equipment depreciation are not included. These are real costs, but other alternatives would also need to pay those as well.

Table 10. Estimated annual operating costs for irrigated pasture.[1]		
Item	**Cost/unit**	**Cost/acre**
N fertilizer (liquid)	200 lb/ac @ $0.23/lb	$46.00
P fertilizer (dry)	50 lb/ac @ 0.13 plus $4/ac application cost	10.50
Irrigation water[2]	20 inches @ $3.65/inch	73.00
Movement of cattle	1 hour/ac @ $8/hour	8.00
Annual O & M on fence & water development	10% of investment	12.00
Total annual operating costs		**$149.50**

[1] Updated estimates for fertilizer material costs as of 2003; fertilizer application cost based on Jose and Brown 2002; irrigation costs and cattle movement cost from Selly et al. 2001.
[2] Assumes center pivot pumping at 800 GPM, 35 PSI and lift of 125 ft. powered by electricity.

Table 11 includes the operating costs plus stand establishment and water and fence development costs amortized over a 25-year period at 5% rate of interest. Table 12 shows the same costs, only annualized over a much shorter period, 5 years. A shorter amortization period is shown as an extreme and to simulate a situation where a lender requires the operator to recover the initial investment plus 5% interest over a 5-year period versus the life of the stand and the facilities, which we estimated to be 25 years.

Table 11. Total operating costs for grazing plus amortized costs for stand establishment including water and fence for 25-year period.

Item	Cost/unit	Cost/acre
Total operating costs	From Table 10	$149.50
Stand establishment	Amortized @ 5% for 25 years	5.64
Fencing and water development	Amortized @ 5% for 25 years	6.69
Total operating and amortized development costs		**$161.83**

Table 12. Total operating costs for grazing plus amortized costs for stand establishment including water and fence for 5-year period.

Item	Cost/unit	Cost/acre
Total operating costs	From Table 10	$149.50
Stand establishment	Amortized @ 5% for 5 years	18.36
Fencing and water development	Amortized @ 5% for 5years	21.78
Total operating and amortized development costs		**$189.64**

Expected returns from irrigated pasture

Estimating costs, while somewhat complicated since everyone's situation is different, is usually easier than trying to estimate the value of the forthcoming production. One of the ways we estimate the production from irrigated pasture is the number of animal unit months (AUMs) of grazing produced. Even if we have a good estimate of the AUMs to be produced, how do you value that production so that it can be compared to the costs? One common way to evaluate the AUM is to estimate the value if harvested by cow-calf pairs that are paying the going rental rate. First, one needs to convert a cow-calf pair to AUMs. A cow-calf pair for an 1100 to 1200 pound cow easily consumes at least 1.4 AUMs of forage per month. If the going rate for cow-calf pairs is $20, then an AUM is worth $14.29 ($20/M/1.4 AU). If we could rent the grass for $30/pair, then an AUM is worth $21.43.

Another way to evaluate an AUM is to compare it to the cost of feeding cows hay. A dry 1200 cow can consume about 25 pounds of alfalfa per day. If the alfalfa is worth $90/ton

($0.045/lb) then the forage value alone is $1.14/cow/day or $0.95/animal unit day or $28.50/AUM.

A third way is to estimate the returns that could be earned by grazing calves on the irrigated pasture. Research at North Platte over a three-year period provides some insight into what one might expect (Nichols et al. 1993). Yearling steer calves gained an average of 1.75 lbs/hd/day for about 150 days. This gain, given their stocking rate, translated into 668 lbs of gain per acre. In some years the calves gained 2 lbs/hd/day or 800 lb/acre. This replicated research used grass mixtures not unlike those we have discussed above. What is the value of that gain? To examine this question we used 10 years of prices (1992-2001) for eastern Wyoming and western Nebraska for calves that fit weight categories of those used in the North Platte research. Tables 13 and 14 show the details for those estimations.

Table 13. Value of gain from yearling cattle on irrigated grass pasture gaining 1.75 lb/hd/d.

Event	Details	Value or cost
On grass early May	606 lb steer May price $88.77/cwt[1]	$538.00
Interest cost for investment	Interest for 5 months @ 5%	11.00
Total cost for steer on grass		$549.00
Off grass late September or early October	866 lb steer Sept/Oct price $75.44/cwt[1]	$653.00
Gain in value	$653-$549	$104/hd
Value of gain	**$104/260**	**$0.40/lb**

[1] Price information in personal correspondence from Livestock Marketing Information Center, Aurora, CO, 2002 and represents average prices 1992-2001 for eastern Wyoming and western Nebraska markets.

Table 14. Value of gain from yearling cattle on irrigated grass pasture gaining 2 lb/hd/d.

Event	Details	Value or cost
On grass early May	606 lb steer May price $88.77/cwt[1]	$538.00
Interest cost for investment	Interest for 5 months @ 5%	11.00
Total cost for steer on grass		$549.00
Off grass late September/early October	906 lb steer Sept/Oct price $75.51/cwt[1]	$666.00
Gain in value	$653-$549	$117/hd
Value of gain	**$117/300**	**$0.39/lb**

[1] Price information in personal correspondence from Livestock Marketing Information Center, Aurora, CO, 2002 and represents average prices 1992-2001 for eastern Wyoming and western Nebraska markets.

While the above information shows the costs and some ways to estimate returns, one must combine costs and returns to see if it may work. Table 15 provides estimates of gross returns per acre for four livestock options. Clearly, the price situation that allows for gain to be worth $0.50/lb is the best alternative of those considered. That type of price situation occasionally happens but gain worth $0.40/lb or lower is more common. It is necessary to compare expected returns from irrigated pasture to other alternatives for the same area.

Table 16, which is based on budgeted estimates, shows the operating costs and expected break-even values for some other crops based on University of Nebraska budgets with some adjustments for yield, fertilizer and input prices (Selley et al. 2001). The break-even values are short term since charges for all depreciation, land, management and overhead are not included. The estimated costs exclude the same items as those estimated for the irrigated pasture.

Table 15. Gross return comparisons for different ways to value grazing.

Event	Details	Gross
Rent cc pair @ $20/month[1]	$14.29/AUM	$143/acre
Rent cc pair @ $30/month[1]	$21.43/AUM	$214/acre
Yearlings @ 1.75 lb/hd/d	$0.40/lb for 668 lbs/acre[2]	$267/acre
Yearlings @ 1.75 lb/hd/d	$0.50/lb for 668 lbs/acre[2]	$334/acre
Yearlings @ 2 lb/hd/d	$0.39/lb for 800 lbs/acre[2]	$312/acre

[1] Assumes that pasture will yield 10 AUMs/acre.
[2] Based on research at University of Nebraska, North Platte (Nichols et al. 1993).

Table 16. Gross returns and short-term, break-even prices for alternative crops.[1]

Crop and expected yield	Operating costs/acre	Break-even price
Alfalfa-5 t/ac	$200	$40/t
Corn continuous-180 bu/ac	$268	1.49/bu
Dry edible beans-19 cwt/ac	$200	10.53/cwt
Sugar beets-20 t/ac	$365	18.50/t

[1] Costs adjusted from those shown in Selley et al. 2001 and include use related depreciation on equipment. Overhead, land and management charges and other depreciation not included.

Net returns per acre are compared, given a range of values for the livestock gains and crop prices in Table 17. Recall that these will be net to land, overhead, management, and partial investment in equipment. If any of these enterprises are to sustain an operation in the long run, these other costs should be considered. Depending on land values and expected return to land, these other costs can be substantial. It appears from this simple budgeting analysis that irrigated grass can be competitive with most crops; however, one is not likely to convert land capable of producing a good crop of sugarbeets to irrigated pasture.

Table 17. Short term net returns for grazing and cropping alternatives at varying prices and values.

Alternative	Price or value range	Range of gross/acre	Range of net returns
Graze yearlings	Gain @ 1.75 lb/hd/d worth $35 - $50/cwt	$234 - $334	$70 - $170
Alfalfa	$50 - $90/t	$250 - $450	$50 - $250
Corn	$1.95 - $2.50/bu	$351 - $450	$83 - $182
Dry beans	$15 - $20/cwt	$285 - $380	$85 - $180
Sugarbeets	$28 - $36/t	$560 - $720	$195 - $355

Irrigated pasture and the current farm program

What impact does converting an irrigated field from a program crop, such as corn to irrigated pasture, have on potential payments from the commodity programs of USDA? The short answer is, none. But an explanation may be in order. Our current farm program has at least three potential types of payments. Only one of those, the Loan Deficiency Payment (LDP), depends on raising a crop of the program commodity. However, LDP is only paid when the average county price falls below the official loan rate for the given commodity. For example, the loan rate on corn will be about $1.95/bu for 2004. Only if the corn price drops below the $1.95 will the LDP kick in. So the $1.95 puts an effective floor on the expected price of corn. But at the lower price, corn is not very competitive with the pasture except at the lower values for gain. So producing pasture is not sacrificing a large potential payment for corn. Direct and counter cyclical payments both are determined from the official base acreage and yield established for the relevant farm. Once the base acreage and yield are established, the producer receives these payments when they are available, no matter what crop is produced. The base acreage and yield were the ones historically in effect on a producer's farm prior to the 2002 Farm Bill or the adjusted base and yield which depended on actual plantings 1998 through 2001. If a producer had converted some commodity ground to irrigated pasture in that time frame, the amount of adjusted base would have been affected. But, the producer was not obligated to file for adjusted base. If a producer is trying to now decide whether or not to convert to irrigated pasture, the base issue is history, at least for now. So unless at some future time the opportunity to adjust base acreage and yield again appears, the base will not be affected by conversions after the 2001 cropping year.

Evaluating the irrigated pasture alternative for specific situations

The examples discussed above for evaluating whether or not to convert to irrigated pasture provide a couple of ways to proceed. There are other situations that do not lend themselves to the relatively simple analysis above. In some cases, for example, adding the irrigated pasture may permit an operation to expand their cowherd, especially if they are just short of grass during the early spring and fall. Some producers may utilize the irrigated grass to develop replacement females more efficiently than without. Whatever the case may be, there are some steps that should be followed in analyzing the potential change.

1. Use partial budgeting procedures. These procedures suggest that you look at only the costs and only the returns that are to change due to the decision. For example, since land costs (taxes and return to land) will not likely change, the analyst can ignore those.
2. Estimate the number of cow-calf pairs that could be carried *with and without* the irrigated pasture.
    a. Examine the forage requirements and availability in your system by time period.
    b. If the irrigated pasture fills a void or shortage in your system, the number of cows to be carried could be affected.
3. Estimate the *change* in costs in your cow-calf enterprise due to the irrigated pasture.

    a. Changes in costs are those associated with establishment of the pasture, including fencing and water development as described above.
    b. Also include the expected net to be given up by not producing the next best alternative crop (opportunity cost).
4. Estimate the *change* in total returns with the irrigated grass pasture.
    a. May be able to increase the number of cows carried.
    b. May be able to improve conception/weaning rates and also weaning weights if you sell weaned calves.
    c. May reduce costs of heifer development and especially consider the impact on rebreeding of first calf heifers.
5. Compare the changes in expected returns to the changes in expected costs. If the expected returns exceed the costs, the change may make sense.

The procedure outlined above sounds simple enough. The challenge is obtaining meaningful data to analyze. We have provided some of that information in this paper. Hopefully, you can find research or sound information from neighbors who already have irrigated pasture to help you evaluate this alternative. The worst thing you can do, however, is to have overly optimistic expectations of pasture yields and livestock performance. And then couple those optimistic expectations with underestimation of the true costs. While one can tear out the grass if the decision looks bad, doing a reasonable job of projecting the impacts is a better option.

Do not forget about the cash flow implications of the decision. Even though your analysis may show that in the long run, converting to irrigated pasture makes economic sense, do you have the cash flow to handle it? Table 8 showed that the conversion cost is nearly $175/acre. That is a total of nearly $23,000 for a 130-acre pivot. And if you also need to expand the cowherd, do you have adequate cash for that change? Make sure that your lender is on board with your change if you will be depending on her to make this change. Cost-share that could reduce your costs for making the conversion may be available from your local Natural Resources District (in Nebraska) or through USDA's Natural Resources Conservation Service (NRCS) and their Environmental Quality Improvement Program (EQIP). Contact your local NRD and NRCS offices to find out how they may help.

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