Cow-Calf Beef Production on Irrigated Pasture and in Drylot at Carrington

David W. Rodgers and Howard M. Olson

Irrigation development increases the number of crop and forage production options available to farmers and ranchers (11). Since its establishment in 1960, the Carrington Irrigation Branch Station has extensively tested crop options and their productive potentials. Adapted varieties of forage crops have proved to be consistently good yielders. However, their excessive bulk and thus high transportation costs often limit the opportunity for marketing. It is apparent that the conversion of forage to readily marketable animal products at or near the site of production is desirable.

Introduction

Authorization by the 1971 State Legislature to establish a livestock research project at the Carrington Irrigation Branch Station has provided an opportunity to evaluate irrigated forages in livestock production. Establishing the project depended upon the Garrison Diversion Conservancy District providing funds to construct the needed facilities. The district provided about $100,000.

Several types of livestock enterprises were considered, all of which could utilize large amounts of forage, and a beef cow-calf enterprise was selected. The project was initially stocked with bred Hereford heifers purchased from two commercial herds.

A fundamental objective of the livestock research program was to measure irrigated forage production in terms of pounds of beef produced per acre. Further, based on observations in other irrigated areas, it was apparent that different feeding management systems needed to be evaluated (8, 11). Two systems were selected for study at Carrington. They included (1) the traditional seasonal grazing, and (2) open lot confinement feeding of machine harvested forage to cows with calves at side.

Pasture Arrangement and Establishment

Six irrigated pastures have been used in cow-calf grazing studies (Fig. 1). These pastures are irrigated by one center-pivot irrigation system moved between two pivot points. Approximately 29 acres are irrigated from each pivot point. Electric cross fences with spring-type electric gates that allow passage of the sprinkler system support towers divide the 29 acres into three 9.7-acre pastures.

The three pastures under the east pivot (Pastures 1, 2 and 3) were double-seeded in 1971 to a mixture of Lincoln bromegrass, 8 lbs; Sterling orchardgrass, 6 lbs; Garrison Creeping Foxtail, 2 lbs; and Vernal alfalfa, 1 pound. Oats seeded as the companion crop was later harvested for grain. The three pastures under the west pivot (Pastures 4, 5 and 6) were double-seeded in 1972 to 8 pounds of Lincoln bromegrass and 8 pounds of Sterling orchardgrass. Barley harvested for silage was used as the companion crop.

Livestock watering tanks are located near the pivot points and are supplied via buried plastic pipe by a well located at the Livestock Unit buildings. Salt and mineral boxes and a portable livestock rub also are located near the pivot.

Pasture Fertilization

Periodic fertilization of irrigated forages is necessary to realize fully their continued productivity (5, 7). Nitrogen and phosphorus are the primary soil nutrients limiting forage production in North Dakota (4). Previous soil tests and forage fertility trials at the station had indicated phosphorus levels were adequate, but that periodic applications of nitrogen were necessary. Ammonium nitrate (33-0-0) spread as dry fertilizer in late fall or early spring and liquid fertilizer (28-0-0) injected into the irrigation water during the growing season were the nitrogen sources used in this study. Annual application rates of nitrogen on the alfalfa-grass and grass pastures are listed in Table 1. An average of 70 and 205 lbs. of nitrogen were applied annually to the alfalfa-grass and grass pastures, respectively.

Table 1. Fertilization of Irrigated Pastures

	(lbs. nitrogen/acre)	
	Alfalfa-grass pastures	Grass pastures
1973[1]	113	139
1974[1]	48	246
1975[1]	50	231
Average	70	205

[1]Includes previous year's late fall fertilization

Pasture Irrigation

Proper pasture irrigation requires supplementing natural rainfall to maintain adequate soil moisture levels for crop growth. Scheduled irrigation on the grazed pastures was based on a computer pro-

Rodgers is assistant animal husbandman and Olson is superintendent, Carrington Irrigation Branch Experiment Station.

Appreciation is expressed to Clayton Haugse, Department of Animal Science, and to LeRoy Schaffner, Department of Agricultural Economics, for their assistance in analyzing the data.

Table 2. Monthly Summary of Rainfall and Irrigation of Alfalfa-Grass and Grass Pastures

	Rainfall, inches			Irrigation, inches					
				Alfalfa-grass pastures			Grass pastures		
Month	1973	1974	1975	1973	1974	1975	1973	1974	1975
April	.84	3.19	4.25						
May	1.20	4.79	2.63	2.79			1.76		
June	3.36	.90	8.34	3.14	2.36		2.97	2.01	1.13
July	1.32	1.82	.59	4.02	4.42	3.28	3.06	6.48	1.66
Aug.	1.60	2.65	1.04	1.07	6.46	3.35	5.22	[2]	3.48
Sept.	4.36	.53	1.33	2.04	1.00	2.18	1.05	1.14	
Oct.							1.05		2.15
Totals	12.68	13.88	18.18	13.06	14.24	8.81	15.10	9.63	6.27
Rainfall plus irrigation . . .				25.74	28.12	26.99	27.78	23.51	24.45

[1]Average rainfall (April 1-Sept. 30) is 13.46 inches.

[2]A break in an underground water supply line prevented needed irrigation.

graming procedure developed by Dr. Earl Stegman of the Department of Agricultural Engineering at NDSU. Climatic data, soil moisture levels (determined by neutron probe) and recent water applications were analyzed each week during the growing season by a computer. Printout from the computer designated soil moisture deficits, days before next irrigation and the amount of irrigation water to apply. A monthly summary of irrigation and natural rainfall on the irrigated pastures is shown in Table 2. Total water requirements of irrigated pastures have been 24 to 28 inches during the growing season each year.

Rotation Grazing and Forage Production

A six-pasture rotation grazing system was used in this study. Grazing was started each year in late May when grass growth was 6 to 8 inches tall. Approximately 90 cows and calves were used as a unit to graze each 9.7-acre pasture. When it was estimated that proper forage utilization had been achieved (4 to 5-inch stubble height), all cows and calves were moved to a second pasture. This procedure was repeated until all six pastures had been grazed. The cycle was then repeated, with each pasture being grazed at least three different times during the grazing season. This grazing technique provided an average of 5 days grazing with 25 to 35 days of regrowth between grazing periods.

Forage production and utilization were measured throughout the grazing season each year by clipping plots with battery operated grass shears. Five cages were randomly located throughout each pasture before turning in the cows and calves. After a pasture had been grazed, the cages were moved and clippings beneath them were taken. In addition, as soon as the cattle were moved to the next pasture, five residue plots were cut in the grazed area to determine what per cent of available forage had been used. All plots were 3' x 4' in size and were cut at a 2-inch clipping height.

Total forage production during the grazing season was estimated by subtracting the total residue in the five residue plots from the total forage produced in the five caged plots for each clipping except the last. Residue remaining after the last clipping was included as forage production since it would not be included in subsequent caged plot clippings. In addition, some regrowth during the fall was not measured.

Per Cent Alfalfa In Alfalfa-Grass Pastures

Irrigated grass legume pastures for cattle almost universally suggest an ever-present danger of death losses due to bloat (8). The incidence of bloat usually is associated with the percentage legume in the mix. To determine the percentage by weight of alfalfa in the alfalfa-grass pastures, two 3' x 4' plots were clipped and sorted each time a pasture was grazed. Table 3 summarizes the per cent alfalfa in the mix as determined by this procedure.

Table 3. Per Cent Alfalfa In Alfalfa-Grass Pastures

Year	No. samples sorted	% Alfalfa by weight
1973	20	54
1974	18	45
1975	20	33

Alfalfa declined in abundance during the three-year study period, indicating the need for its periodic re-establishment. Similar declines in abundance of alfalfa in a grazed alfalfa-grass stand under irrigation have been noted by other observers (6, 7).

Bloat problems developed in both cows and calves grazing alfalfa-grass pastures in August and September during the 1973 grazing season. Nu-

merous animals were treated for bloat, and one cow and one calf were lost. Poloxalene bloat guard blocks were fed according to recommendations and no bloat problems were encountered during the 1974 and 1975 grazing seasons. The use of bloat guard blocks and the decline of alfalfa in the alfalfa-grass pastures probably both contributed to the lack of bloat problems in 1974 and 1975.

Drylot Confinement

Drylot confinement of cows with calves at side is an alternative management option to grazing irrigated pastures. Recent studies in nearby states have shown that about twice as many cows can be maintained on a given forage acreage if a drylot rather than a conventional pasture system is used (1, 10). In areas where irrigation development is taking place, land resources soon become limited and expensive. Drylot confinement can offer an alternative way to expand a livestock program under these conditions.

Approximately 30 cows and calves were maintained in drylot at the Carrington Station to determine the production requirements of drylot confinement in North Dakota. During the growing season when the rest of the cow herd was grazing irrigated pasture, confined cows and calves were fed silage and chopped alfalfa hay in fenceline bunks. An average of 36.7 lbs. of silage and 14.7 lbs. of chopped alfalfa hay were fed daily per cow-calf pair (Table 4). In addition, the calves had hay available in a feeder inaccessible to the cows and were creep fed oats during August and September of 1973 and 1974.

Results and Discussion

Irrigated pasture forage production develops very rapidly during early June. To use this flush of growth early in the grazing season, additional grazing animals need to be placed on the pastures for a short period of time, or the extra available forage can be harvested as hay or haylage. The latter method of harvesting extra forage was used in this study, with one 9.7-acre pasture being harvested for hay during the first grazing cycle in 1973 and 1975.

An average of 104 days of grazing were provided by the six irrigated pastures during the 3-year study period (Table 5).

Alfalfa-grass pastures provided 26 per cent more days of grazing than grass pastures (Table 5). Clipping data and stocking rate data indicated similar differences (Table 6). Alfalfa-grass and grass pastures produced 3-year average yields of 6,517 and 5,774 lbs. of oven-dry forage per acre, respectively. Grass pastures increased their productivity from an average of 5,342 lbs. per acre in 1973 to 5,510 lbs. per acre in 1974 and 6,470 lbs. per acre in 1975. This increase in productivity may have been the result of higher rates of nitrogen fertilization in 1974 and 1975 (Table 1). Alfalfa-grass pastures declined in productivity over the 3-year study. The decline in abundance of alfalfa in the stand from 54 per cent by weight in 1973 to 33 per cent in 1975 (Table 3), along with lower rates of nitrogen fertilization in 1974 and 1975, may explain this relationship. Since alfalfa in grazed irrigated alfalfa-grass pastures can be expected to decline in abundance from year to

Table 4. Summer Drylot Cow-Calf Rations

	Daily Feed Intake/Cow-Calf Pair, Lbs.			
	1973	1974	1975	Average
Silage (68% H_2O)	40.3[1]	33.8[2]	35.9[2]	36.7
Chopped alfalfa (12% H_2O)	13.2	15.7	15.3	14.7
Total daily feed intake	53.5	49.5	51.2	51.4
Total daily D.M. intake	24.5	24.6	25.0	24.7
	Additional Total Seasonal Feed Provided/Calf, Lbs.			
	1973[4]	1974[5]	1975[6]	Average
Hay (12% H_2O)[3]	235	225	300	253
Oats (12% H_2O)	115	76	0	64
Total	350	301	300	317

[1]Barley silage
[2]Corn silage
[3]Estimate based on number of bales fed
[4]Baled alfalfa hay
[5]Baled brome-alfalfa hay
[6]Chopped alfalfa hay

Table 5. Days of Grazing Provided by Three 9.7-Acre Alfalfa-Grass Pastures and Three 9.7-Acre Grass Pastures

Grazing cycle[1]	1973	1974	1975	Average
	Alfalfa-Grass Pastures			
1	14[2]	21	15	17
2	21	22	22	22
3	19	14	17	17
4	3		6	3
Total	57	57	60	58
	Grass Pastures			
1	19	9	17[3]	15
2	16	18	16	17
3	13	18	10	14
4		3		1
Total	48	48	43	46
Length of grazing season	105	105	103	104

Grazing dates 5-30 to 9-12, 5-28 to 9-16[4], 5-23 to 9-3

[1]Alfalfa-grass pastures were grazed first in 1973 and 1975.
[2]Ten days of potential grazing put up for hay.
[3]Twelve days of potential grazing put up for hay.
[4]Included 6 days on additional meadow.

year (6, 7), increased annual rates of nitrogen fertilization appear necessary to maintain a given level of forage productivity.

The per cent residue remaining after grazing in each pasture was measured by clipping residue plots and subtracting their yield from the caged plot yields. Utilization was then calculated by subtracting per cent residue from 100. Average utilization rates for grass and alfalfa-grass pastures was 64 per cent and 58 per cent respectively (Table 6). Utilization rates of 75 per cent have been used by other researchers in similar grazing studies (6, 11). Under-utilization was probably achieved in the alfalfa-grass pastures in this study, particularly during the first and second grazing cycles. Starting the grazing season 2 to 3 days earlier would have helped alleviate this problem. The average utilization rate of 64 per cent in the grass pastures was felt to be adequate.

Grass pastures provided an average of 6.33 animal unit-months of grazing per acre. Alfalfa-grass pastures had a higher average stocking rate of 7.71 animal unit-months of grazing per acre (22 per cent greater).

Table 6. Forage Yield, Per Cent Utilization and Stocking Rate on Irrigated Pastures

		Forage yield	% Utilization[2]	Stocking rate A.U.M./Ac.[1]
Alf.-grass pastures	1973	7693	60	8.12
	1974	5872	59	7.37
	1975	5987	55	7.65
	average	6517	58	7.71
Grass pastures	1973	5342	61	6.21
	1974	5510	63	6.14
	1975	6470	67	6.64
	average	5774	64	6.33

[1]Lbs. oven dry forage/acre (caged plot yields-residue plot yields + residue remaining at the end of the grazing season).
[2]$100 - \frac{\text{residue plot yield}}{\text{caged plot yield}}$
[3]A cow-calf pair grazing for 31 days equals 1.3 animal unit months (A.U.M.).

Table 7. Cow and Calf Gains on Irrigated Pasture and In Drylot[1]

	1973		1974		1975		3-year average	
	drylot	pasture	drylot	pasture	drylot	pasture	drylot	pasture
Cow Gains								
No. of days	106	105	111	111	99	101	105	106
No. of cows	29	90	27[2]	91	28	91	28	91
Avg. initial wt., lbs.	900	897	894	880	964	947	919	908
Avg. final wt., lbs.	895	897	965	973	1010	1019	957	963
Total gain, lbs.	-5	0	71	93	46	72	37	55
Avg. daily gain, lbs.	-.05	0	0.64	0.83	0.47	0.71	0.35	0.51
Calf Gains								
No. of calves	29	84	28	86	28	86	28	85
Avg. initial wt., lbs.	117	117	119	121	138	126	125	121
Avg. final wt., lbs.	269	269	269	295	290	295	276	286
Total gain, lbs.	152	152	150	174	152	169	151	165
Avg. daily gain, lbs.	1.42	1.43	1.35	1.57	1.54	1.68	1.44	1.56

[1]Data includes dry cows and cows that lost calves during the study.
[2]One cow developed prolapse problems and was slaughtered.

All cows were first-calf heifers in 1973. They had been wintered on corn silage and chopped alfalfa hay and were in a fleshy condition when the drylot and pasture trial began. This fleshy condition, coupled with the first heifer's additional energy requirements for growth as well as lactation, limited gains in 1973. However, seasonal gains of 71 and 93 lbs. in 1974 and 46 and 72 lbs. in 1975 were achieved by drylot and pasture cows, respectively (Table 7). Analysis of the data indicated cows grazing irrigated pastures gained significantly more ($P < .01$) than cows in drylot. In addition, gains were also significantly different ($P < .01$) between years. Yearly variation in cow gains can be anticipated with changes in the quality of forage grazed and with differences in initial condition of the cows.

Drylot calf daily gains were substantially less than daily gains of calves grazing irrigated pasture, by midsummer of 1973 and 1974. In an attempt to keep drylot calf gains similar to pasture calf gains, oats were fed to drylot calves during August and September. However, in 1975, drylot calf gains were similar to pasture calf gains and no oats were fed. Fewer disease problems were encountered in drylot calves in 1975 than in the previous two years, and this may account for the drylot calves' improved performance. Calves grazing irrigated pastures gained significantly more ($P < .01$) than calves in drylot (Table 7). Average seasonal gain per head was 165 lbs. for pasture calves and 151 lbs. for drylot calves. Similar differences have been recorded by other researchers (3, 10). Calf gains between years also differed significantly ($P < .01$). As the cow herd is developed to contain more mature cows, yearly variations should diminish. The yearly differences observed may more reflect improved milking ability of the dams rather than differences in forage quality.

An average of 238 lbs. of actual calf gain per acre was produced by the 58 acres of irrigated pasture for the three-year period (Table 8). Calf gains per acre have increased each year as the cows have matured and become better milkers and as the poorer producers are culled from the herd. Further improvement in the cow herd and hence increased gains per acre are anticipated. The ability of alfalfa-grass pastures to produce more forage per acre than grass pastures (6,517 lbs. D.M. (dry matter)/acre vs 5,774 lbs. D.M./acre, Table 6) would indicate increased gain per acre would have been obtained if all pastures had contained alfalfa in the mix. Additional production was obtained from the irrigated pastures in the form of hay and grazing 4 to 6 dry cows each year. If the data are adjusted for haying and the grazing of dry cows, a predicted average of 269 lbs. of calf gain per acre would have been produced if all forage had been utilized by grazing cow-calf pairs (Table 8).

Table 8. Irrigated Pasture Calf Gains/Acre

	Actual	Adjusted[1]
1973	220	252
1974	244	258
1975	250	296
Average	238	269

[1]Adjusted for dry cows and haying in 1973 and 1975.

The estimated costs of irrigating alfalfa-grass and grass pastures were calculated (Table 9). Figures were based on the use of a water drive center-pivot irrigation system irrigating 132 acres. The cost per animal unit month (A.U.M.) of grazing was computed for the alfalfa-grass and grass pastures using the average stocking rates measured in this study.

The estimated cost of irrigating grass pastures was higher than for alfalfa-grass pastures ($146.92/A. vs $119.67/A.). The additional nitrogen requirements of the grass pastures increased the cost per acre substantially. Since grass pastures had lower average stocking rates than alfalfa-grass pastures (6.33 vs 7.71 A.U.M./A., Table 6), the cost of grazing grass pastures was further increased. Average cost of grazing grass and alfalfa-grass pastures was $21.83 and $14.39 per animal unit month of grazing, respectively (Table 9).

References

1. Albert, W. W. and P. E. Lamb. 1967. **Drylot Management for Beef Cows.** Ill. As - 651c.

2. Deutscher, G. H., A. L. Slyter and L. Blome. 1975. **Effects of Mating and Management Systems on Performance of Beef Cows and Calves.** South Dakota State Univ. Program Report, AS Series 75-2.

3. Dodds, D. L. and D. W. Meyer. 1974. **Establishment of Dryland and Irrigated Forages.** Extension Service Circular R-563. North Dakota State Univ., Fargo, North Dakota.

4. Dodds, D. L., L. J. Johnson and C. Soiseth. 1973. **First Year Results — Beef Production on Irrigated Pasture in North Dakota.** North Dakota Farm Research. 30(3):21-27.

5. Dodds, D. L., S. W. Black, L. J. Johnson and C. Soiseth. 1973. **Second Year Observations — Beef Production on Irrigated Pasture in North Dakota.** North Dakota Farm Research. 31(2):6-10.

6. Heinemann, W. W. 1970. **Continuous and Rotation Grazing by Steers on Irrigated Pasture.** Washington Agricultural Experiment Station Bulletin 724.

7. Heinemann, W. W. and L. F. Rogers. 1971. **Irrigated Pastures and a Bloat Preventive Supplement for Beef Production.** Washington Agricultural Experiment Station Bulletin 747.

8. Meiske, J. C. and R. D. Goodrich. 1968. **Drylot vs Conventional Cow-Calf Production.** Minn. Research Report B-118.

9. Nichols, J. T. 1975. **Establishment and Production Practices for Irrigated Pasture and Hay.** Univ. of Nebr. North Platte Station Range Cattleman's Roundups.

10. Nichols, J. T. 1971. **Establishment and Utilization of Irrigated Pastures.** Proceedings, The Range Beef Cow Symposium, Cheyenne, Wyo. p. 103-111.

11. Sumerhalder, B. R., D. C. Clanton and J. T. Nichols. 1969. **Center-Pivot Self-Propelled Irrigated Pasture Study.** Univ. of Nebr. North Platte Station Program Report.

Table 9. Per Acre Costs of Irrigating Alfalfa-Grass and Grass Pastures

Variable costs	Alfalfa-grass	Grass
Seed[1]	1.80	1.30
Fuel and oil	1.11	1.11
Machinery repair	.48	.48
Fence repair	1.15	1.15
Livestock water system maintenance	.42	.42
Salt and mineral	1.50	1.50
Fertilizer at 21¢/lb.[2]	14.70	43.05
Fertilizer injection system upkeep	.41	.41
Irrigation variable cost, 12.55 in. at 90¢/in.	11.30	11.30
Labor, 1.17 hrs. at $3.00/hr.	3.57	3.57
Bloat guard blocks	.60	
Total variable cost	37.04	64.29

Fixed costs	Alfalfa-grass	Grass
Machinery depreciation, interest and insurance	2.14	2.14
Fence depreciation and interest	3.67	3.67
Livestock water system depreciation and interest	1.21	1.21
Fertilizer injection system depreciation and interest	.90	.90
Sprinkler irrigation system[3]	28.31	28.31
Water charge[4]	7.40	7.40
Land charge including taxes[5]	39.00	39.00
Total fixed cost	82.63	82.63
Total cost per acre	119.67	146.92
Minus hay produced the year of pasture establishment	8.75	8.75
Net cost per acre	110.92	138.17
Stocking rate, A.U.M./A.	7.71	6.33
Cost per A.U.M. of grazing	14.39	21.83

[1]Pasture re-established every six years.

[2]An average of 70 and 205 lbs. of nitrogen was applied annually to the alfalfa-grass and grass pastures respectively.

[3]Based on cost of quarter section water drive center-pivot irrigation system.

[4]Cost of water provided by the Garrison Diversion Project.

[5]Land valued at $400/acre and charged at 9.75 per cent interest.