Brood Cow Efficiency Management Study
Progress Report II

By

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Introduction:

Calf weaning weight, nutrient requirements of the cow and the overall cost of production in the cow/calf business are production parameters that ultimately are affected by a cow's level of milk production, body condition, and mature body weight. Several investigations have been conducted to measure the interrelationship of cow size, maintenance requirements and calf weaning weight, which clearly show that energy requirements for maintenance are dependent on cow weight, and that as mature cow weight increases progeny weight also increases (Klosterman et al., 1968; Urick et al., 1971; Jeffrey and Berg, 1972; Miguel et al., 1972; Benyshek and Marlowe, 1973; Turner et al., 1974; NRC, 1984; Rode and Bowden, 1987) .

Weaning weight can be raised by increasing mature body weight, increasing milking ability, or through a combination of both factors. Although selection for increased milk production among beef breeds results in heavier calves at weaning, infusing dairy blood into the beef herd is a more rapid method for increasing milk production (Cundiff, 1970), but is also associated with poorer reproductive performance when post partum energy levels are inadequate (McGinty and Frerichs, 1971; Halloway et al., 1975, and Wyatt et al., 1977) .

Lactation status not only affects maintenance energy requirements which are higher for cows of high milk production potential per unit of body weight than cows with low milk production potential (Ferrell and Jenkins, 1982), but also increases forage intake of free ranging beef cows. Kronberg et al., (1986) found that the forage intake of lactating Hereford and Simmental x Hereford cross cows was 23% and 39% more, respectively, than their non-lactating counterparts.

Since rebreeding success, which is dependent on gestation and post partum lactation energy levels, and range carrying capacity contribute heavily to the overall cost of production in the cow/calf enterprise, this brood cow efficiency management study is designed to document the energy input necessary to support rebreeding success, to identify the range ecosystem impact of cow types that are diverse with respect to body weight and milking ability, and to establish an economic model for each experimental breed type. Within the investigation there are three major relationships of importance, which include the relationship between nutrition and reproduction, the relationship between nutrition and total beef production, and the relationship between grazing intensity and plant density change.

The breed combinations selected have been categorized according to their expected mature body weight and lactation potential, and are being bred to Charolais sires in a terminal crossing system, in which the Hereford breed serves as the foundation and control breed. The breeding scheme and breed combinations are shown in the following table:

Cow Breed	**X**	**Sire Breed**	**=**	**Calf Breed**
Hereford (Cont.)		Hereford		Hereford
Hereford		Charolais		Char. x Hereford
Ang. x Hereford		Charolais		Char. x Ang. x Heref.
Milking Shorthorn x Ang. x Hereford		Charolais		Char. x M-Shorthorn x Ang. x Hereford
Simmental x Hereford		Charolais		Char. x Simmental x Hereford

There are two principle phases in the investigation which is scheduled for seven lactations: a drylot wintering phase and a summer grazing phase on native pasture. During the wintering phase each breeds gestation and lactation dry matter intake is being monitored and adjusted to levels that will promote optimum rebreeding efficiency.

Procedure:

In 1986, the initial breed groups were housed in Dickinson, N.D., and fed long crested wheatgrass hay in round bales and one pound of dry rolled barley per head daily during the gestation phase. As each cow calved, she and her calf were weighed and transferred to ranch headquarters where they were allowed free choice access to the complete mixed lactation ration shown in Table 1. Measured intake of feed was discontinued on May 21st when the groups were moved to spring pasture. Breeding exposure to fertility tested Charolais bulls began on June 1st and were removed on July 31st.

In 1987, the cow groups were allowed to graze crop aftermath until December 14th when they were moved into drylot and start-on the silage based gestation rations shown in Table 2. The groups were maintained on the rations for a one week adjustment period before being weighed on two consecutive days. Weights from the two consecutive weighings were averaged and the gestation phase was started on December 22nd. As each cow calved, she and her calf are weighed and transferred to a separate set of cow lots reserved for each breed after calving, and started on the complete mixed lactation ration shown in Table 2. The groups were maintained on these rations until being turned out on spring pasture April 30th. In 1986, 30 percent of the MS x A x H cows were open at the end of the breeding season. Therefore, in 1987 we began feeding eight pounds of dry rolled barley per head during the first heat cycle of breeding to the high lactation Milking Shorthorn and Simmental cross cow groups. Fertility tested Charolais bulls were put with the cow groups beginning on June 1st and were removed on August 1st.

In 1988, the groups were handled in much the same way as in 1987, but didn't graze crop aftermath quite as long. They were adjusted to the silage based winter gestation rations shown in Table 3, and weighed on trial December 15th. The drylot lactation phase was longer in 1988 because of the drought. Since spring pastures grew very slowly, the breed groups were held in drylot until May 27th. Feeding of eight pounds of dry rolled barley supplement to the high lactation groups (MS x A x H and S x H) began on May 27th also. Fertility tested Charolais bulls were put with all groups on June 1st and removed August 15th. Length of the breeding season was extended two additional weeks because of the prolonged heat experienced during June and July.

The experiment began in 1986 with an unequal number of cows in each breed group that were properly bred to Charolais. In all subsequent years the herds are being maintained at ten cows. Replacements for cows that have had to be removed from the study have been very limited. Replacements are being made at two specific times during the production year. Cows that lose calves anytime before the start of the breeding season on June 1st are replaced with a comparable pair from an established reserve gene pool. Those cows that are pregnancy tested and identified as open at weaning are replaced with a comparable bred cow from the reserve pool when the winter gestation feeding period is started.

Dry matter intake levels during gestation have ben regulated based on body weight measurements taken biweekly. The breed groups are being fed to gain approximately two pounds daily during the last trimester of pregnancy so that they will have a net gain after calving ranging between .2 and .4 tenths of a pound per day. The (H) and (A x H) groups are being fed 22 pounds of dry matter as a basal ration, and the (MS x A x H) and (S x H) groups are being fed 24 pounds of dry matter as a basal ration. Adjustments to the basal dry matter intake levels are being made upward or downward based upon body weight changes at each biweekly weighing, and are further adjusted for cold weather according to the following schedule: 15°F (no adjustment), 0°F (+9%), -15°F (+18%), and -30°F (+27%).

Efficiency in beef production is measured as the feed energy input per unit of beef produced, where energy input is expressed in terms of megacalories per kilogram of liveweight. In this study, efficiency is being measured in megacalories per pound of liveweight weaned and is obtained by charting the total calculated digestible energy consumed against the pounds of calf weaned from all exposed cows. Additional measurements include: 1) pre and post calving gain, gestation and lactation dry matter feed consumption, and the economics of wintering, 2) mean milk production estimates at selected dates during the grazing season, 3) mean animal weight gains and gain per acre of pasture, and 4) mean herbage disappearance, percent difference, and plant density on sandy, shallow, and silty range sites.

During the grazing season, stocking rate, estimated milk production, pregnancy rate and pounds of beef produced per acre are recorded for each breed. Native pastures, representative of mixed grass prairie, consist of three dominant grass species: blue grama (Bouteloua gracilis), western wheatgrass (Agropyron smithii), needle and thread (Stipa comata), and threadleaf sedge (Carex filifolia). Range sites were selected for similar vegetation, soil, slope and position of slope and are representative of three major soil types: sandy, shallow, and silty. Data collected from these sites includes herbage production sampled by clipping the vegetation to ground level inside a 0.25 meter square frame both inside and outside exclosure cages. Herbage is separated into grass, forb, and shrub components and oven dried at 80° centigrade prior to weighing. Herbage production for each component and total production for each range site is then determined.

Milk production is estimated using the weigh-suckle-weigh method in June, August, and October of each year, which correspond to the varying stages of pasture maturity in the northern great plains.

Data accumulated in this study has been summarized in several tables. The ration dry matter composition and the ingredient cost per pound of dry matter for the years 1986, 1987, and 1988 have been summarized in Tables 1, 2, and 3. Table 4 depicts the three year mean pre and postcalving cow gains, dry matter feed consumption and feeding economics for 1986, 1987, and 1988. A summary of efficiency is shown in Table 5, and an economic model for the various cow types is shown in Table 6. Weigh-suckle-weigh milking ability estimates are shown in Table 7, and grazing results have been compiled in Tables 8, and 9. Table 8 presents the mean weights and gains on native pasture, and Table 9 summarizes mean herbage disappearance and post grazing percent differences for each breed type on sandy, shallow, and silty range sites.

Results and Discussion:

Three out of seven production cycles scheduled for this long term investigation have been completed. Within each production cycle, two specific periods are bing measured in detail which include a drylot wintering period and a summer grazing period on native range. Drylot wintering begins in mid December after the cow types have completed grazing crop aftermath, and continues until approximately mid May when the breed groups are turned out on crested wheatgrass pasture. Starting and completion dates have varied each spring and fall in response to in season precipitation and its effect on grazable forage. The summer grazing period on native range begins the third week of June each year, and is completed when pastures are sufficiently grazed based on clipping appraisals.

While considerable data remains to be collected and conclusions can not be drawn, trends are developing relative to the inputs necessary to obtain reproductive success.

The Nutrient Requirements of Beef Cattle (1984) handbook, which is used world wide by producers, scientists and industry, currently recommends that dry pregnant mature beef cows weighing approximately 1100 pounds should consume 21.0 pounds of dry matter that contains 53.2% TDN, and it further recommends that 1200 pound cows in the same stage of pregnancy consume 22.3 pounds of dry matter containing 52.9% TDN. Beef cows wintered under the more adverse conditions of the northern great plains require additional dry matter intake above NRC recommendations. Using an all roughage diet, the cow types in this investigation have been fed from 13% to 15% more dry matter daily. Although the differences are not large, the dry matter increase being used has not quite maintained post calving cow weight among all breeds. Empty body average daily gain after calving has been -.20 (H), +.10 (MSxAxH), -.18 (AxH), and +.14 for the Simmental x Hereford group, which falls short of our net gestation gain after calving goal of .2 to .4 tenths of a pound, but differences obtained were not significant.

During a short 47 to 53 day drylot lactation period after calving, the cow types have been fed ad libitum in preparation for the upcoming breeding season. Dry matter intake has ranged from 27.9 pounds among the Hereford cows to 34.2 pounds among the Simmental x Hereford cows. Lactation potential, during the early part of the breeding season in June, has been estimated using weigh-suckle-weigh methods to range from a low of 13.3 pounds of milk among the Hereford cows to a high of 18.7 pounds/day among the dairy x beef (MSxAxH) cows. The short term elevated plane of nutrition being used after calving, which is approximately 30% above NRC recommended levels, is designed as a specific short term allocation to put the cow types in a gaining condition before being turned out on crested wheatgrass pasture. Once on pasture, the heavier milking MSxAxH and SxH cows are being given eight pounds of barley per head daily during the first breeding cycle. Efforts to maintain dry matter intake levels within acceptable limits without overfeeding have resulted in some reproductive failures within all cow types, however, the largest number of open cows has been in the control Hereford group. Weaning percentages for the respective breeds have been 85.7% (H-Ctrl), 89.3% (MSxAxH), 92.6% (H), 92.6% (SxH), and 92.9% among the Angus x Hereford cows. The impact of reproductive failure among the cow types is further reflected in the pounds of calf weaned per cow exposed, which has been 454.2 pounds (H-Ctrl), 522.4 pounds (H), 544.8 pounds (MSxAxH), 554.7 pounds (AxH), and 563.8 pounds for the Simmental x Hereford group. Statistically, the pounds of calf weaned per cow exposed in the control Hereford group is the only weight that differs significantly from the other breed types.

Efficiency is being measured by charting the calculated mega-calories of digestible energy (DE) consumed against the pounds of calf weaned per cow exposed. When compared to the straight-bred Hereford cows, the AxH cows consumed 8.1% more DE, the MSxAxH cows consumed 9.3% more, and the SxH cows consumed 9.9% more DE. Digestible energy consumption per pound of calf weaned from exposed cows is 8.88 Mcal (AxH), 8.99 Mcal (H), 9.16 Mcal (MSxAxH), 9.24 Mcal (SxH), and 10.08 Mcal for the Hereford control group. How does this measurement of efficiency compute in terms of dollars and cents to beef cattle producers raising cash crop calves from cow types typical of the ones being used in this investigation? To answer this question, a partial economic model has been developed and is shown in Table 6. Direct costs for feed and processing that have been incurred are shown as wintering expenses. The wintering expense shown does not include costs for other variable and fixed costs that a producer would normally incur. Gross return was determined using the actual average weaning weight, and the Dickinson, North Dakota, average market value within each weight class during the September – December 1988 period. Net returns computed were $8,360.97 (H-Ctrl), $9,490.35 (SxH), $9524.53 (MSxAxH), $9563.10 (H), and $9,876.12 for the AxH group. At this time in the investigation, a difference of $1515.15 exists between the most efficient (AxH) cows, and the least efficient (H-Ctrl) group. In addition, when the other cow types are compared to the AxH cows, much smaller net return differences exist. Returns were $313.02, $351.59, and $385.77 dollars less for the (H), (MSxAxH), and (SxH) cow types respectively.

Cow and Calf gains on native pasture have been monitored during the grazing season. The heavier milking cow types (AxH, SxH, and MSxAxH) gained the slowest during the summer on native range, but their calves, as a group, gained the fastest. Cow gains were 51 pounds (H-Ctrl), 40 pounds (H), 30 pounds (AxH), 20 pounds (MSxAxH), and 17 pounds among the Simmental x Hereford cows. Straightbred Hereford control calves and the Charolais x Hereford crossbred calves nursing Hereford dams gained significantly slower than calves nursing the other cow types. Calf gains were 244 pounds (H-Ctrl), 247 pounds (H), 265 pounds (AxH), 275 pounds (SxH), and 278 pounds among the MSxAxH cows.

Mean herbage disappearance and percent differences between ungrazed and grazed clippings are shown in Table 9 for each breed on sandy, shallow, and silty range sites. The drought of 1988 resulted in lower forage production and greater depletion by grazing from each range site. At this time in the study, relatively small, non significant, differences exist in the amount of forage disappearance being measured between breed types. In general, the grazing element of the study hasn't progressed sufficiently to identify the effects of breed type on stocking rate as measured by changes in plant density.

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Table 1. Ration Dry Matter Composition and Ingredient Cost per Pound of Dry Matter, 1986

	Int'l. Feed Numb.	Dry Matter Ration %	Dry Matter Cost/Pound
Gestation:			
Crested wheatgrass hay	2-05-424	96.3	.025
Dry rolled barley	4-00-535	3.7	.037
Feeding charge			.0025
		100.00	
Crude Protein: 9.6%			
Calcium: .38%			
Phosphorus: .27%			
*Mineral fed free choice			
Lactation:			
Alfalfa	1-00-071	19.1	.0222
Crested wheatgrass hay	2-05-424	21.4	.025
Corn silage	3-02-822	39.8	.01944
Dry rolled barley	4-00-535	13.1	.037
Sunflower meal		5.9	.0584
Trace mineral salt	6-04-152	.35	.064
Dicalcium phosphate	6-01-080	.35	.191
Processing			.0125
		100.00	
Crude Protein: 11.0%			
Calcium: .54%			
Phosphorus: .38%			

Table 2. Ration Dry Matter Composition and Ingredient Cost per Pound of Dry Matter, 1987

	Int'l Feed Numb.	Dry Matter Ration %	Dry Matter Cost/Pound
Gestation:			
Corn silage	3-02-822	59.5	.01944
Oat hay	1-03-276	39.7	.02108
Trace mineral salt	6-04-152	.51	.064
Dicalcium phosphate	6-01-080	.29	.191
Processing			.0125
		100.00	
Crude protein: 8.1%			
Calcium: .45%			
Phosphorus: .24%			
Lactation:			
Alfalfa	1-00-071	25.6	.0222
Corn silage	3-02-822	46.4	.01944
Oat hay	1-03-276	20.3	.02108
Barley Dist. Dry Grain	5-02-144	2.1	.050
Soybean oilmeal	5-20-637	3.4	.1139
Trace mineral salt	6-04-152	1.1	.064
Dicalcium phosphate	6-01-080	1.1	.191
Processing			.0125
		100.00	
Crude protein: 10.7%			
Calcium: .87%			
Phosphorus: .43%			

Table 3. Ration Dry Matter Composition and Ingredient Cost per Pound of Dry Matter, 1988

	Int'l Feed Numb.	Dry Matter Ration %	Dry Matter Cost/Pound
Gestation:			
Corn silage	3-02-822	57.9	.01944
Oat hay	1-03-276	41.3	.02108
Trace mineral salt	6-04-152	.4	.064
Dicalcium phosphate	6-01-080	.4	.191
Processing			.0125
		100.00	
Crude protein: 8.1%			
Calcium: .48%			
Phosphorous: .26%			
Lactation:			
Alfalfa	1-00-071	24.3	.0222
Corn silage	3-02-822	48.2	.01944
Oat hay	1-03-276	20.5	.02108
Soybean oilmeal	5-20-637	4.8	.1139
Trace mineral salt	6-04-152	1.1	.064
Dicalcium phosphate	6-01-080	1.1	.191
Processing			.0125
		100.00	
Crude protein: 10.7%			
Calcium: .85%			
Phosphorous .44%			

Table 4. Three Year Mean Gestation and Lactation Gain, Dry Matter Feed Consumption and Partial Economics, 1986-1988

Breed	Hereford	MS x Ang. x Heref.	Angus x Hereford	Simmental x Hereford
Gestation:				
No. Head	28	30	30	27
Days fed	87.2	95.7	86.5	92.4
Initial wt., lbs.	1114	1105	1176	1218
Calving wt., lbs.	1097	1115	1160	1231
Gest. wt. change, lbs. 4/	-17	+10	-16	+13
ADGain or loss, lbs.	-.20	+.10	-.18	+.14
Gestation Economics:				
DM Feed consumed, lbs. 4/	2135	2396	2129	2377
DM Feed/hd./day., lbs.	24.5	25.0	24.6	25.7
Feed cost/lb. of DM, $	.0305	.0307	.0307	.0308
Feed cost/hd., $	65.11	73.56	65.36	73.21
Feed cost/hd./day, $	.746	. 769	.756	.792
Lactation:				
No. head	27 1/	29 2/	30	26 3/
Days fed	53.4	47.4	54.5	50.1
Calving wt., lbs.	1093	1115	1169	1223
Spring turnout wt., lbs.	1181	1187	1255	1294
Gain after calving, lbs. 4/	88	72	86	71
ADG after calving, lbs.	1.65	1.52	1.58	1.42
Lactation Economics:				
DM Feed/hd., lbs. 4/	1489	1597	1783	1713
DM Feed/hd./day, lbs.	27.9	33.7	32.7	34.2
Feed cost/lb. of DM, $	.0394	.0394	.0393	.0393
Feed cost/hd., $	58.67	62.92	70.07	67.32
Feed cost/hd./day, $	1.10	1.33	1.29	1.34
Combined Wintering Costs:				
Gestation cost, $	65.11	73.56	65.36	73.21
Lactation cost, $	58.67	62.92	70.07	67.32
Flushing feed, $	----	4.10	----	4.10
Total average wintering cost, $	123.78	140.58	135.43	144.63

1/ One cow removed
2/ One cow removed
3/ One cow removed
4/ Values do not differ significantly.

Table 5. Three Year Mean Summary of Efficiency Among the Various Cow Types, 1986-1988

Breed	**Heref. (Cont.)**	**Here- ford**	**MS x Ang. x Heref.**	**Angus x Heref.**	**Sim x Heref.**
No. of cows exposed	28	27	28	28	27
No. of cows exposed that weaned a calf	24	25	25	26	25
% weaning calves 1/	85.7	92.6	89.3	92.9	92.6
Tot. Mcal. Of dig. energy consumed/ breed 1/	128147.5	126744.5	139732.8	137902.7	140610.1
Tot. lbs. of calf weaned from exposed cows	12717	14104	15253	15532	15222
Lbs. of calf weaned/cow exposed 2/	454.2[a]	522.4[ab]	544.8[b]	554.7[b]	563.8[b]
Dig. energy/lb. of calf weaned from exposed cows, Mcal. 1/	10.08	8.99	9.16	8.88	9.24

1/ Values do not differ significantly.
2/ Values with unlike superscripts differ significantly ($P < .05$).

Table 6. Partial Economic Model Estimating Net Return From the Various Cow Types. 1/

Breed	Heref. (Ctrl)	Here-ford	MS x Ang. x Heref.	Angus x Heref.	Sim x Heref.
Total lbs. of calf weaned from exposed cows	12717	14104	15253	15532	15222
Gross Return / cow exposed, $ (Mkt. value/ cwt.) 2/	11,826.81 ($93.00)	12,905.16 ($91.50)	13,460.77 ($88.25)	13,668.16 ($88.00)	13,395.36 ($88.00)
Less total wintering cost, $	-3,465.84	-3,342.06	-3936.24	-3,792.04	-3,905.01
Net return, $	8,360.97	9,563.10	9,524.53	9,876.12	9,490.35

1/ This partial economic model includes direct costs for feed and processing only. No other variable or fixed costs are included.

2 Market value is based on average value within weight class for the Sept. – Dec. 1988 period at Dickinson, North Dakota.

Table 7. Three Year Average Weigh-Suckle-Weigh Estimates of Milking Ability

	June 18	Aug. 30	Oct. 30	Season Mean 1/
Heref. (Control)	14.4	10.6	6.7	10.6[a]
H	13.3	9.7	6.6	9.9[a]
A x H	14.9	13.1	7.4	11.8[ab]
S x H	17.0	13.7	10.1	13.6[bc]
MS x A x H	18.7	15.0	10.9	14.9[c]

1/ Values with unlike superscripts differ significantly ($P < .01$).

Table 8. Three Year Mean Cow and Calf Gains on Native Range 1986-1988

Mean days grazed: 121

	Starting Weight	Finish Weight	Gain1	ADG
COW:				
Hereford (Ctrl)	1374	1425	51	.42
Angus x Hereford	1261	1291	30	.25
Simmental x Hereford	1335	1352	17	.14
MS x Angus x Hereford	1181	1201	20	.17
Hereford	1185	1225	40	.33
CALF:				
Hereford (Ctrl)	260	504	244[a]	2.39
Hereford	287	534	247[a]	2.42
Angus x Hereford	300	565	265[ab]	2.60
Simmental x Hereford	308	583	275[ab]	2.70
MS x Angus x Hereford	315	593	278[b]	2.73

1/ Values with unlike superscripts differ significantly ($P < .05$).

Table 9. Three Year Mean Herbage Disappearance and Percent Difference among Breeds Grazing Sandy, Shallow, and Silty Range Sites, 1986-1988

Range Site 1/								
	Sandy	**Percent of Total**		**Shallow**	**Percent of Total**		**Silty**	**Percent of Total**
Hereford (Ctrl)	909	32%		403	39%		874	52%
Angus x Hereford	1000	43%		521	42%		950	50%
Simmental x Heref.	826	44%		243	25%		719	45%
Milking Shorthorn x Angus x Hereford	1105	53%		315	41%		640	43%
Hereford w/ cross-bred calf	960	46%		247	26%		706	44%

1/ Herbage disappearance values among breeds on sandy, shallow, and silty range sites do not differ significantly.

2/ The percentage of total herbage production that disappeared.