WELCOME TO THE
2001 CARRINGTON RESEARCH EXTENSION CENTER
BEEF AND BISON FIELD DAY
JULY 19, 2001

AGENDA

Livestock Production Research and Review
9:30 A.M. TO NOON

Bison Research Projects: Energy and Protein.. Vern Anderson

Bison Economics.. Steve Metzger

Fly Ash for Feedlots... Deb Hassette

Feeding Potato Waste to Livestock.. Eric Bock

Cattle Feeding Partnerships and Businesses.. Karl Hoppe

Backgrounding Economics.. Steve Metzger

Field Peas are Excellent in Beef Rations... Vern Anderson

Heifer Diets Affect Lactation.. Manny Encinias

Feeding Cow Cake made with Crambe Meal... Vern Anderson

Special Afternoon Walking Tour (1:00 – 2:30) .... Charles Linderman
Livestock facilities for controlling and using livestock waste

Noon Meal
Noon – 1 p.m.
Sponsored by area businesses and commodity groups

ACKNOWLEDGEMENTS

Our appreciation is expressed to the following for cooperation, contributions, and support of beef and bison studies during the recent past.

Alltech, Inc.
AVIKO Inc.
Carrington Development Corporation
Carrington Jobs Development Authority
Carrington Farm Business Management Program
Certified Angus Beef Program
Dakota Growers Pasta Company
Dow AgriSciences
Energy and Environmental Research Center, University of North Dakota
Foster County Feeders, LLP
Four-Way Bison Partnership
Heartland Inc. and Hubbard Feeds
IBP, Inc.
Kings, LTD
Ladish Malt –Cargill
Manna Pro Corp.
National Bison Association
North Dakota Agricultural Products Utilization Commission
North Dakota Barley Council
ND Barley Feeders, LLLP
North Dakota Buffalo Association
North Dakota Livestock Endowment Foundation
North Dakota National Guard
North Dakota Pea and Lentil Association
North Dakota State University
- Animal and Range Sciences Department
- Agriculture and Bioengineering Department
- Agricultural Economics Department
- Veterinary and Microbiological Sciences Department

North Dakota State Board of Agricultural Research and Education
Northern Crops Institute
Oilseed Partners, LLC
Turner Ranches
United States Department of Agriculture
- National Research Initiative – Equipment Grants Program
- Alternative Crops Program
- Sustainable Agriculture Research and Education Program

Other numerous individuals and organizations
Trade names and companies used are for clear communication. No endorsement is intended nor criticism implied of products mentioned or not mentioned.

LIVESTOCK RESEARCH AND EDUCATION

This publication provides results and information on activities accomplished during the recent past in beef production. Beef and bison research reports are published separately to provide information useful to producers in their operations to become more profitable and sustainable. We hope some of the papers are of value to all.

Beef Research
Beef cow/calf enterprises can utilize more crop residues and co-product feeds and be both biologically and economically sustainable. Cows can add value to cropping system biomass and spread the risk of single enterprise farming. Beef nutrition research includes "new" and "unusual" feeds balanced in diets for the genetic potential of the cows. Similarly, value added concepts in the feedlot enterprise have been proven to be feasible when management and economies of scale are optimized. The tremendous variety and quantity of feedgrains and processing co-products in the region insure competitive feed pricing for North Dakota feeders.

Bison Research
There is a tremendous need for more information on the biology and economics of bison production. The Bison Center of the Northern Plains will continue to contribute as resources allow.

Waste Management
Waste management is a visible and restrictive program that affects all livestock producers. Improving the environment of confined animals by stabilizing soil with fly ash, controlling runoff, irrigating with livestock runoff, and composting plant and animal biomass are areas of current and future focus.

We hope the information in this publication is useful to you and leads to improved quality of life, financial reward, and "success" as a grower of food. If you have questions or comments on past research, suggestions for future studies, or want to interact with one of us, please e-mail us at our individual addresses or call (701) 652-2951. These proceedings are published at the Carrington Research Extension Center website at www.ag.nodak.edu/carringt/.

Eric Bock
Research Specialist
ebock@ndsuext.nodak.edu

Charles Linderman, MS
Extension Waste Management Specialist
Instructor
clinderm@ndsuext.nodak.edu

Steve Metzger
Farm Business Management
smetzger@ndsuext.nodak.edu

Karl Hoppe, PhD
Extension Livestock Specialist
khoppe@ndsuext.nodak.edu

Vern Anderson, PhD
Animal Scientist
vanderso@ndsuext.nodak.edu

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FEED REQUIREMENTS FOR MAINTENANCE AND GAIN OF BISON BULLS FED FOR MEAT

Vern Anderson and Eric Bock
Carrington Research Extension Center
North Dakota State University

Introduction

Producers are feeding bison bulls in a variety of scenarios in an effort to reduce cost of gain and achieve highest carcass values. Winter feeding of high grain diets to weaned bison bull calves has not been successful in most previous cases. Bison show a strong tendency to decrease intake and gain during the winter. However, highly variable performance from winter feeding has been observed probably related to severity of the weather. Subsequent gains for bison on grass or grain have not been evaluated. Compensatory effects from lower energy diets during the winter may improve feed efficiency during spring and summer; however, severely limiting winter nutrient intake could depress future potential animal performance.

This project was undertaken as a non-replicated field trial at the partially completed bison nutrition research facilities. The objectives were to 1) evaluate winter performance of bison fed poor quality grass hay in addition to graded levels of grain from December until March, 2) evaluate compensatory effects when animals on all treatments were fed grain free choice from March until marketed, and 3) determine economics of respective treatments.

Materials and Methods

Bison bull calves (avg weight 490 lb, n=60) from one herd arrived at the Bison Nutrition Research Unit in early December 1999. After an adaptation period of three weeks, animals were weighed and placed on trial December 30, 1999. Ten head were assigned to each pen by gate cut when exiting the trailers with each pen providing 420 square feet per head, and 3 feet of fenceline bunk space. Winter treatments included free choice chopped hay fed in the fenceline bunks with graded levels of dry rolled corn grain and wheat midds (50-50) estimated at 0, 3, 6, 9, and 12 pounds (essentially, free choice intake) as fed per head daily. The sixth pen was provided with one large round bale feeder with the same grass hay as offered other pens, and a creep feeder filled with the same corn/midds mixture. The winter feeding period ended in mid-March when all bison were weighed and rations changes made.

At the end of the winter feeding period, rations were changed so all bison were fed ad lib a high grain diet that included approximately 2 pounds of chopped hay per head daily. Corn silage was added to the bunk fed rations after the winter feeding period. Bison were weighed at the end of four weigh periods closely associated with winter, spring, summer, and fall seasons.

Low quality mature native grass hay was used as the base forage during this trial. The hay was 84.1% dry matter, 10.08% ash, 5.48% crude protein, 40.12% acid detergent fiber, 64.92% neutral detergent fiber, .36% calcium, and .12% phosphorous. The corn/midds mix was 86.10% dry matter, 4.28% ash, 12.95% crude protein, 5.93% acid detergent fiber, 20.71% neutral detergent fiber, .60% calcium and .47% phosphorous. A blended mineral supplement was fed to all bunk fed animals and blocks of the same supplement offered to the self-fed bison.

Carcass data was not collected on these animals due to extenuating marketing circumstances.

Feed intake was recorded daily and summarized for each period. Individual animal weights were recorded and daily gains calculated for each period. Feed efficiency was calculated based on daily dry matter intake and live weight gain. Dry matter intake as a percent of body weight was calculated by determining the average weight of animals in a pen (start weight + end weight/2) for the period and dividing by total dry matter consumed during the period. Costs of gain were calculated using market prices for feed as listed on the table.

Results and Discussion
While treatments were not replicated in this trial, the progressive increase in grain level during winter feeding over several treatments provides an indication of trend lines. Diets fed are presented in Table 1. Treatments are reported as percentages (0, 25, 50 etc.) of ad lib intake.

Table 1. Diets fed to bison bulls as graded levels of energy during the winter and following winter when high grain diets were fed.

			Winter	Treatment		
Item	0% grain	25% grain	50% grain	75% grain	100% grain	Self fed grain & hay
Winter, lb as fed						
Corn/midds	0	2.90	6.21	9.44	12.34	13.00
Grass hay	12.85	10.33	11.11	7.17	5.59	7.71
Supplement	.25	.25	.25	.25	.25	.25
Following winter, lb as fed						
Corn/midds	14.16	14.78	15.38	15.51	15.79	15.74
Grass hay	3.95	3.27	3.57	3.07	3.14	7.15
Corn silage	2.20	2.35	2.39	2.32	2.01	-
Supplement	.25	.25	.25	.25	.25	.25

Gains were higher during the winter than anticipated, probably due to the mild weather, and the fact that the bulls had been adapted to diets with grain prior to arriving at the Carrington Center (Table 3). A very predictable linear decrease in gain appears due to step reduction in grain during the winter feeding period. The 0% grain group lost .22 lb per day, and did not exhibit expected compensatory effects. This fact suggests that the poor quality hay used in the study did not contain sufficient energy to support basal maintenance of the animals. Positive gains were observed with the lowest level of grain offered (2.8 lbs/hd/day) during the winter. Interpolating the results with the no grain treatment using a linear relationship indicates that maintenance requirements (no weight loss or gain) with the quality of hay used requires supplementation of approximately 1.5 lb of grain. At the high end of grain levels during the winter, there appears to be no differences in the self-fed and the ad lib grain treatments, however feed disappearance for self-fed bison includes any wasted or soiled feed not consumed. Dry matter intake appears to be numerically greater for bison fed 50% or more grain during the winter and over the entire feeding period with the density and weight of grain an obvious contributing factor. Intake as a % of body weight varied (2.28 to 2.47) without any apparent treatment effects in the diets but disappearance of 2.66% for the self fed suggests some feed wastage.

There appears to be some compensatory effect for gain, once high grain diets were introduced to animals on limited winter energy levels. However, overall average gains for all treatments above the 0% grain appear to be similar with a range of 1.23 to 1.31 lbs per day including the wintering period.

Gain per feed and feed per gain are indicators of feed efficiency. There appears to be little effect of treatment with the exception of numerically lower values for the 0% grain treatment. This reinforces the need for bison bulls calves to receive some grain during the winter feeding period.

Cost per pound of gain reflects the same observation. Variation in cost ranges from $.41 for 25% and self fed to $.44 for the 50%, and $.49 for the 0% grain. Further research with replicated treatments for statistical confidence would be valuable in determining nutrient requirements for bison.

Implications

There appears to be substantial variation in performance of bison based on grain level. Satisfactory gains were achieved during the winter feeding period in this trial with grain levels of 25% of ad lib intake or greater. Subsequent gains for bison fed higher levels of grain were negatively affected by high grain levels during the winter. Some grain should be fed during the winter to maintain positive gains and serve to warm-up bulls for later higher grain diets, especially if poor quality hay is fed.

Appreciation is expressed to the following cooperating producers for the use of their animals. Four-Way Bison, partners include Dennis Swanson, Bruce Gussiaas, David Swanson, and Jim Cook, Carrington.

Table 2. Weights of bison bulls fed graded levels of energy during the winter and high grain diets during three seasons following winter.

			Winter	Treatment		
Item	0% grain	25% grain	50% grain	75% grain	100% grain	Self fed grain & hay
Initial wt, lb (12/29)	511.2	515.9	524.8	519.8	542.8	522.4
Final wt, lb	861.2	927.2	960.8	938.8	927.6	946.7
Total gain, lb	350.0	411.3	436.0	319.0	384.8	424.3
Days on feed	330	330	330	330	295	295

Table 3. Dry matter intake, and gain for bison bulls fed graded levels of energy during the winter and high grain diets during three seasons following winter.

			Winter	Treatment		
Item	0% grain	25% grain	50% grain	75% grain	100% grain	Self fed grain & hay
Feed intake, lb/day(DM)						
Period 1 (winter)	10.90	11.33	14.67	14.22	15.33	15.53
Period 2 (spring)	11.88	11.11	14.76	14.82	15.54	17.96
Period 3 (summer)	17.88	17.48	17.60	17.27	16.98	19.72
Period 4 (fall)	17.78	18.41	18.66	18.16	18.77	20.99
Post winter DMI	15.85	15.67	17.01	16.75	17.10	19.56
Overall DMI	14.63	14.62	16.49	16.17	16.73	19.16
Feed intake, %BW(DM)						
Period 1 (winter)	2.19	2.18	2.68	2.52	2.57	3.07
Period 2 (spring)	2.36	2.01	2.43	2.26	2.21	2.63
Period 3 (summer)	3.03	2.68	2.55	2.35	2.18	2.57
Period 4 (fall)	2.33	2.21	2.18	2.11	2.15	2.39
Post winter DMI	2.56	2.33	2.34	2.21	2.17	2.50
Overall DMI	2.47	2.29	2.43	2.29	2.28	2.66
Average daily gain, lb						
Period 1 (winter)	-.22	.245	.772	1.284	1.587	1.519
Period 2 (spring)	.535	.826	.830	1.304	1.359	1.565
Period 3 (summer)	1.868	2.052	1.652	1.305	1.156	1.313
Period 4 (fall)	1.605	1.554	1.634	1.185	1.076	1.323
Post Winter ADG	1.494	1.580	1.496	1.249	1.171	1.378
Overall ADG	1.051	1.235	1.309	1.258	1.291	1.424

Table 4. Feed efficiency for bison bulls fed graded levels of energy during the winter and high grain diets during three seasons following winter.

			Winter	Treatment		
Item	0% grain	25% grain	50% grain	75% grain	100% grain	Self fed grain & hay
Gain per feed						
Period 1 (winter)	--	.021	.052	.089	.101	.084
Period 2 (spring)	.045	.074	.056	.088	.087	.087
Period 3 (summer)	.104	.117	.094	.076	.068	.067
Period 4 (fall)	.090	.084	.088	.065	.057	.063
Post winter gain/feed	.080	.092	.079	.076	.071	.072
Overall gain/feed	.055	.074	.072	.079	.079	.075
Feed per gain						
Period 1 (winter)	--	47.62	19.23	11.24	9.99	11.90
Period 2 (spring)	22.22	13.51	17.86	11.36	11.49	11.49
Period 3 (summer)	9.62	8.55	10.64	13.16	14.71	14.93
Period 4 (fall)	11.11	11.90	11.36	15.38	17.54	15.87
Post winter feed/gain	12.50	10.87	12.65	13.16	14.08	13.98
Overall feed/gain	18.18	13.51	13.89	12.66	12.66	13.33

Table 5. Feed costs for bison bulls fed graded levels of energy during the winter and high grain diets during three seasons following winter.

			Winter	Treatment		
Item	0% grain	25% grain	50% grain	75% grain	100% grain	Self fed grain & hay
Total Gain, lb						
Winter feed cost, $/hd/day	.25	.30	.41	.43	.49	.55
Post winter feed cost, $/hd/day	.53	.54	.58	.58	.60	.60
Overall Feed Cost, $/hd/day	.46	.48	.54	.54	.57	.59
Overall feed cost, $/lb gain	.49	.41	.44	.43	.44	.41

Feed costs based on the following feed prices:
Long grass hay - $35/ton, chopped grass hay $40/ton, corn grain, $1.75/bu; barley, $1.50/bu;, corn silage, $20/ton, mineral supplement, $28/cwt.

PROTEIN REQUIREMENTS OF BISON BULLS FED FOR MEAT

Vern Anderson and Eric Bock
Progress Report

Introduction
Nutrient requirements of bison have not been determined. There is increasing demand for more precise information on the nutrient requirements of bison from bison managers, producers, and caregivers throughout the continent. We recognize that there is little opportunity to alter the diet of grazing bison unless supplements are provided, and that bison have evolved over hundreds of years as a healthy and prospering species. There is limited interest in manipulating the diet of grazing bison except in cases of known mineral deficiency or where extra energy is required. However, during severe inclement weather and to facilitate optimum growth of animals destined for meat, feeding of forages and concentrates is increasing. Protein is a major nutrient concern for most ruminants and is generally the most expensive to provide, except for minerals. Anecdotal evidence and limited research suggests bison require lower levels of protein than other ruminants due to metabolic recycling mechanisms. Producers are concerned about excessive protein as well as minimum requirements. This research project was developed to determine the optimum protein level in the diets of bison bulls fed for meat.

Objectives:
1. Determine optimum protein levels for bison bulls during the final feeding phase prior to market.
2. Calculate economic effects of incremental protein levels based on cost of feed, feed intake, gain, feed efficiency, and carcass value.

Experimental Procedure
Eighty bison bulls (avg wt approx. 650 lb) will be allotted by gate cut to 8 pens (10 head per pen) and fed diets to promote optimum growth from arrival at the feedyard until ready for market. Dietary treatments will be initiated approximately three weeks after animals arrive to provide a period of adaptation to new surroundings and feeds. Four protein levels will be offered (2 pens per treatment) using totally mixed diets fed in fenceline bunks once daily. Diets will be formulated with crude protein levels of 9%, 11%, 13%, and 15% with concentrate:forage ratios of 60:40 for the first several weeks transitioning to 75:25 for the remainder of the feeding period. Feeds used in the rations will include native grass hay, corn, canola meal (protein source) and a vitamin/mineral supplement, and corn silage. A mineral supplement containing a comprehensive micro-mineral package will be mixed in the ration. Animals will be weighed at the start of the trial and at approximately 90-day intervals thereafter to provide data on animal performance associated with season. Carcass traits will be measured for all animals after slaughter and compared by treatment. Manure samples will be collected at weigh period intervals to compare fecal nitrogen excretion. Blood samples will be taken by veinipuncture and analyzed for blood urea nitrogen in order to determine relative nitrogen

recycling. Animal performance will be compared with variables including dry matter intake, average daily gain, feed efficiency, feed cost per unit gain, and carcass value. All animals involved in this study will be treated humanely and handled in accordance with best management practices as described in guidelines published by the Institutional Animal Care and Use Committee as prescribed federal regulations.

Literature Review
The absolute level of protein for bison has not been determined although some studies with grazing bison have been conducted to investigate nitrogen recycling. Peden (1972) and Peden et al., (1976) indicate that a negative nitrogen balance occurs at a lower dietary protein level with bison than cattle. Conversely, there is evidence of increased blood urea nitrogen levels with increasing protein (6 vs 15% in the diet, Keith, 1977), suggesting excess levels of protein are recycled, and eventually excreted. However, other evidence at lower protein levels (4, 5, and 6% crude protein) suggests recycling can occur as elevated ruminal nitrogen levels were observed from the 4 and 5% diets over the 6% diet (DeLiberto, 1985). Protein required for maximum or for optimum animal reproduction and growth may be variable depending on adaptation, age of animal, or other causes.   It is apparent that bison can adapt and survive at lower protein levels, but what performance level is achievable or observed at higher levels. Production or management philosophies that maximize growth for meat or maintain herds in native environments may ultimately determine if and how much supplemental feeding is done. Obviously, feeding bison destined for meat is being done and will continue to be important to uniform, quality products. It is important to define performance from a range of protein levels and from this deduce the optimum crude protein requirements of bison fed for meat.

Literature Cited
DeLiberto, T.J. 1985. Comparative digestive physiology of American Bison and Hereford cattle. Ph.D. Dissertation. Utah State University, Provo.

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BIOCHEMICAL AND HEMATOLOGICAL PARAMETERS IN RANCH-RAISED AMERICAN BISON (*BISON BISON*)

CL Stoltenow, DVM, Diplomate ACVPM and
NW Dyer, DVM, MS, Diplomate ACVP, NDSU, Fargo, ND 58105

Introduction

Recent years have seen a dramatic increase in the numbers of American bison (*Bison bison*) raised commercially. As commercial bison production grows, new information is needed on all aspects of production including disease syndromes seen in this species. Critical to the need to assess disease in bison is the need for normal parameters, particularly serum chemistries and hematological values. The few documented previous studies often include low numbers of animals, semi-wild populations, or address specialized groups. There was a need, therefore, for a study evaluating baseline clinical chemistry and hematology values in a large number of American bison. This work is an attempt to produce reliable normal values against which diseased samples can be compared for therapeutic purposes.

Materials and methods

Blood samples were collected during the months of October 1998 thru March 1999, and October 1999 thru March 2000. A convenience sample of 13 herds in eleven states (MN, IN, CO, WY, SD, NC, WI, NM, NE, MT, KS) was selected. Herd selection was based on bison raised in a production setting, voluntary participation in the study, all expenses in collecting the sample by a licensed veterinarian were borne by the participating herd, the bison in these herds were apparently healthy and each herd was located close enough to a national express shipping company to ensure samples could be collected and sent overnight to participating laboratories.

A convenience sample of approximately 30 bison per herd was selected: 10 animals from 0 to 12 months of age, 10 animals from 13 to 24 months of age, and 10 animals over 24 months of age. Bison were physically restrained with a squeeze chute. No tranquilizers or sedatives were used. Four tubes of jugular blood were collected from each animal: one royal blue top, one red top, and two purple tops. ID number, age and sex were recorded for each animal. A minimum of 3 ml of blood was collected in each of the Royal Blue Top and the Red Top tubes. A minimum of 1 ml of blood was collected in each of the Purple Tops. The Royal Blue Top and Red Top tubes were allowed to set at room temperature. The Purple Top tubes were inverted at least 8 times to ensure adequate mixing with the anticoagulant and kept cool.

Locally, the Royal Blue Top and Red Top tubes were spun in a centrifuge to separate the plasma and sera, respectively. Plasma and sera was then transferred to snap top (Falcon®) tubes for shipping. All tubes were sent via overnight delivery to respective laboratories on ice. Differential counts were done manually on Diff-Quik stained slides by a single operator. Data was collated and analyzed using Epi-Info software.

Results
A total of 406 blood samples were collected during the months of October thru March.
The results are categorized in Table 1.

Table 1. North Dakota State University Survey of Complete Blood Counts, Serum Chemistries, and Serum Electrolytes for Bison from 13 herds in 11 States, 1998-2000.						
Test	**Units**	*n*	Mean	Std Dev	95% Confidence Interval	NDSU Reference Values for Cattle
WBC	x $10^3/Fl$	320	4.968	1.936	1.1 - 8.8	4.0 - 12.0
Monos	x $10^3/Fl$	320	0.163	0.149	0 - 0.5	0 – 0.9
Lymph	x $10^3/Fl$	320	2.167	0.992	0.2 - 4.2	2.5 – 7.5
Segs	x $10^3/Fl$	320	2.395	1.413	0 - 5.2	0.6 – 4.0
Bands	x $10^3/Fl$	320	0.049	0.122	0 - 0.3	0 – 0.1
Eos	x $10^3/Fl$	320	0.192	0.223	0 - 0.7	0 – 2.4
Baso	x $10^3/Fl$	320	0.001	0.006	0 - 0.01	0 – 0.2
RBC	x $10^6/Fl$	361	9.375	1.270	6.8 - 11.9	5.0 - 8.0
Hgb	g/dl	361	17.764	1.532	14.7 - 20.8	8.0 - 14.0
HCT	%	361	49.934	4.588	40.8 - 59.1	26.0 – 42.0
MCV	fl	361	53.773	5.595	42.6 - 65.0	37.0 – 54.0
MCH	pg	361	19.135	1.943	15.2 - 23.0	
MCHC	%	361	35.611	1.092	33.4 - 37.8	26.0 – 36.0
RDW	%	361	24.016	3.038	17.9 - 30.1	
PLT	x $10^3/Fl$	361	297.535	126.845	43.8 - 551.2	175.0 – 620.0
Glucose	mg/dl	406	122.623	42.936	36.8 - 208.5	45.0 – 75.0
BUN	mg/dl	406	15.879	6.497	2.9 - 28.9	20.0 – 30.0
Creatinine	mg/dl	406	2.573	0.494	1.6 - 3.6	1.0 – 2.0
T Protein	g/dl	405	8.181	1.096	6.0 - 10.4	6.7 – 7.5
Albumin	g/dl	405	4.182	1.093	2.0 - 6.4	3.0 – 3.5
GGTP	U/L	236	23.941	10.854	2.2 - 45.6	6.0 – 17.4
AlkPhosph	U/L	167	51.683	20.873	9.9 - 93.4	0.0 – 488.0
Calcium	ppm	360	97.699	7.229	83.2 - 112.2	85 – 110

Copper	ppm	360	0.789	0.249	0.29 - 1.29	0.65 – 1.50
Iron	ppm	360	1.486	0.439	0.61 - 2.36	1.30 – 2.50
Magnesium	ppm	360	21.098	2.813	15.5 - 26.7	20 – 35
Phosphorous	ppm	360	62.176	17.116	27.9 - 96.4	45 – 80
Zinc	ppm	360	10.18	0.252	0.51 - 1.52	0.80 – 1.40
Sodium	ppm	360	3327	141.753	3043 - 3611	2900 – 3450
Potassium	ppm	360	224.878	47.722	129 - 320	156 - 226
SE none	ng/ml	157	60.497	11.890	37 - 84	
SE supp	ng/ml	208	239.803	72.685	94 - 385	
SE toxic	ng/ml	30	623.267	132.804	358 - 889	
Selenium	ng/ml	395	197.658	162.347	0 - 522	120 - 200

White cell parameters

The range for total white cell numbers was shifted lower for bison as compared to cattle. Lymphocyte and monocyte numbers were shifted in the same direction as well. However, the range for granulocytes (neutrophils, bands, eosinophils and basophils) was expanded creating a higher end point than that seen for cattle.

Red cell parameters

Red cell indices were somewhat higher (2.0 x 10^6/µl) in bison as compared to cattle. Additionally, hemoglobin concentrations in bison were appreciably elevated over cattle values, as was hematocrit. Finally, although bison and cattle ranges overlapped in the middle, bison platelet numbers were shifted lower than cattle.

Serum chemistry

Glucose, albumin, serum protein and GGTP had similar but somewhat wider ranges than bovine values. Both BUN and creatinine were slightly elevated above bovine levels

Minerals

Calcium, iron, magnesium, phosphorus, zinc, sodium and potassium correlate well with bovine reference values used at the NDSU-VDL. Copper is slightly lower in bison than in cattle. Selenium had a very wide reference range. For a more complete comparison, selenium was stratified by the non-use/use of selenium supplementation and for one group of bison grazing on selenium pastures toxic to cattle. These results are in Table 2. In this study, bison not supplemented for selenium had very low selenium levels. Bison on some type of selenium supplementation had selenium levels very comparable with normal bovine levels. Bison grazing selenium toxic pastures had very high selenium levels, yet no adverse health conditions were reported.

Discussion

The results of this study provide veterinarians and other bison health workers with usable clinical blood values. Blood values that correlate well with previous studies are HCT, Hb, Creat, and BUN (Miller89, Marler75 and Wallach83). The bison in this study had lower WBC parameters than in previous studies (Miller89, Marler75, and Azugg93). The reason for this finding is unknown. As noted in previous studies many environmental factors can cause variation in hematologic and blood chemistries (Franzmann71, Pederson75). Also, one previous study included actively infected animals in the results (Miller89), one study included animals shot with a high powered rifles (Zaugg93) and others were taken from animals on free range or received very little managed care (Marler75 and Mehrer76). The bison in these herds were from managed production units and utilized humane handling techniques to collect the samples. A plausible explanation for the lower WBC levels is that these bison were on a higher plane of health care because producers equate health animals with higher profitability. Also, these herds could have self-selected for higher health status because of the selection criteria.

This is the first study to report selenium levels in bison. Furthermore, this is the first study to stratify bison selenium levels by use or non-use of selenium supplementation and the effect of grazing selenium toxic pastures. These levels would suggest that bison have a much higher tolerance level for selenium than cattle, and they may even have a higher requirement for selenium in their diet. More research is needed in this area.

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STABILIZING FEEDLOTS USING COAL ASH

Debra F. Pflughoeft-Hassett
Energy & Environmental Research Center
University of North Dakota

Abstract

The University of North Dakota Energy & Environmental Research Center (EERC) and North Dakota State University Carrington Research Extension Center (CREC) have teamed up to conduct a 3-year project demonstrating the placement, engineering performance, and environmental performance of coal combustion byproducts (CCBs) for feedlot surfaces. The project demonstrates the use of coal ash in feedlot settings provides operators with an environmentally safe, low-cost option to improve feedlot conditions, animal health, and weight gain.

Background

Livestock producers in North Dakota and the region are seeking a low cost alternative to placing concrete in feedlots. Earthen pens and laneways do not withstand pressure, particularly when wet for any length of time such as during spring thaw. As the integrity of the pen or laneway's surface breaks down, deep mud and poor drainage reduce animal performance and health (as indicated by poor weight gain), increase odor emissions, and prevent regular maintenance operations such as manure removal. Commonly, the soil/manure interface layer is damaged, resulting in deeper leaching of nutrients and an increased risk of groundwater pollution.

Sufficient evidence exists to suggest using CCBs can lead to significant improvements in pen and lane-way conditions. Preliminary work performed at the EERC indicates that several lignite coal ashes are suitable for use in feedlot surfacing. Table 1 describes some of the different classes of CCB. It is important to note that properties will vary with the sources of coal and the combustion process.

Table 1: Description of CCBs

CCB Type	Characteristic	Texture
Fly ash	Non-combustible particulate matter removed from stack gases.	Powder, silt-like
Bottom ash	Collected in dry bottom boilers, heavier than fly ash.	Sand-like, some coarse agglomerates
Boiler slag	Collected in wet bottom boilers or cyclone units.	Glassy, angular
FGD* material	Solid or semi-solid material obtained from flue gas scrubbers	Fine to coarse (dry or wet)
FBC** material	Mainly bed material (sand or other inert material), and a mix of fly ash and bottom ash	Fine to coarse

*Flue Gas Desulfurization
**Fluidized Bed Combustor

Project Overview

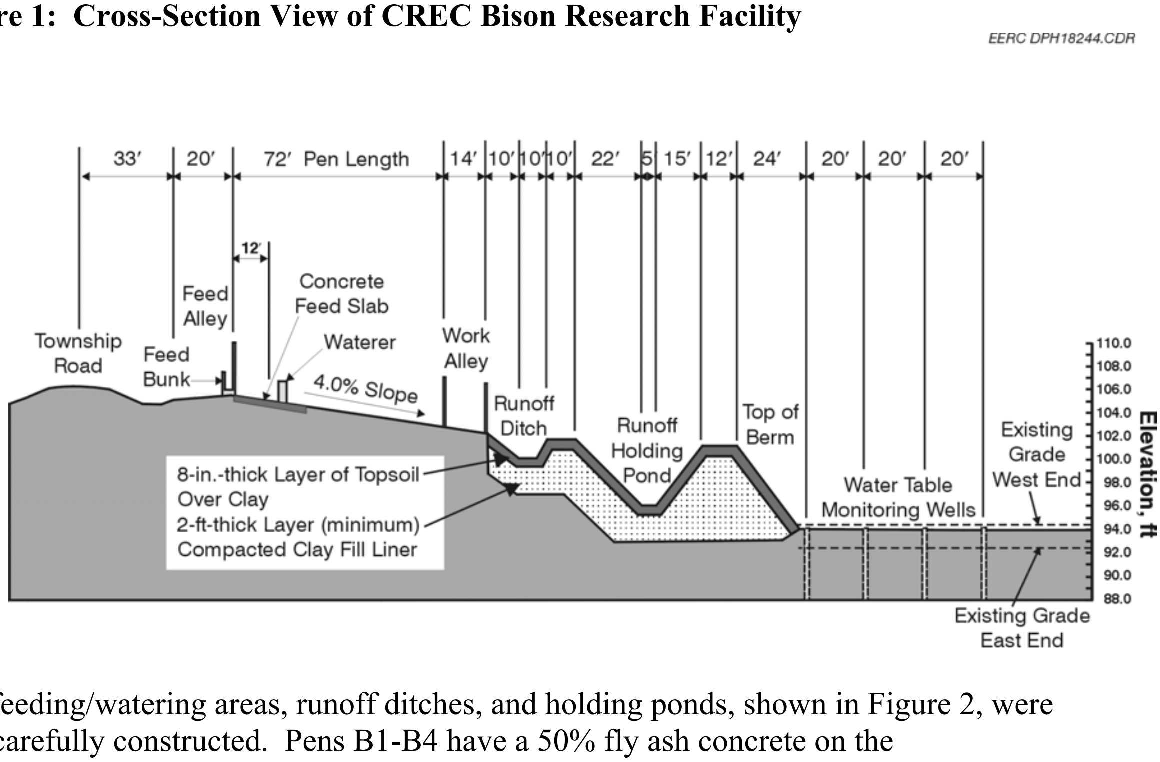
With funding from Great River Energy, Otter Tail Power Company, the North Dakota Industrial Commission, the North Dakota State Board of Agricultural Research and Education, and the U.S. Department of Energy, a research team has been developed to demonstrate the use of coal ash in feedlot settings. The research team is comprised of the EERC, CREC, and Power Products Engineering, Inc. Criteria being evaluated in the demonstration include engineering performance, environmental performance, and the economics of the materials and placement techniques.

Year 1

Work accomplished in Year 1 of the project includes engineering laboratory development of ash-based surfaces planned for the demonstration phase of the project and laboratory evaluation of environmental performance of ash submitted by project partners. Preliminary performance testing was also conducted on ash in two different feedlot surface applications.

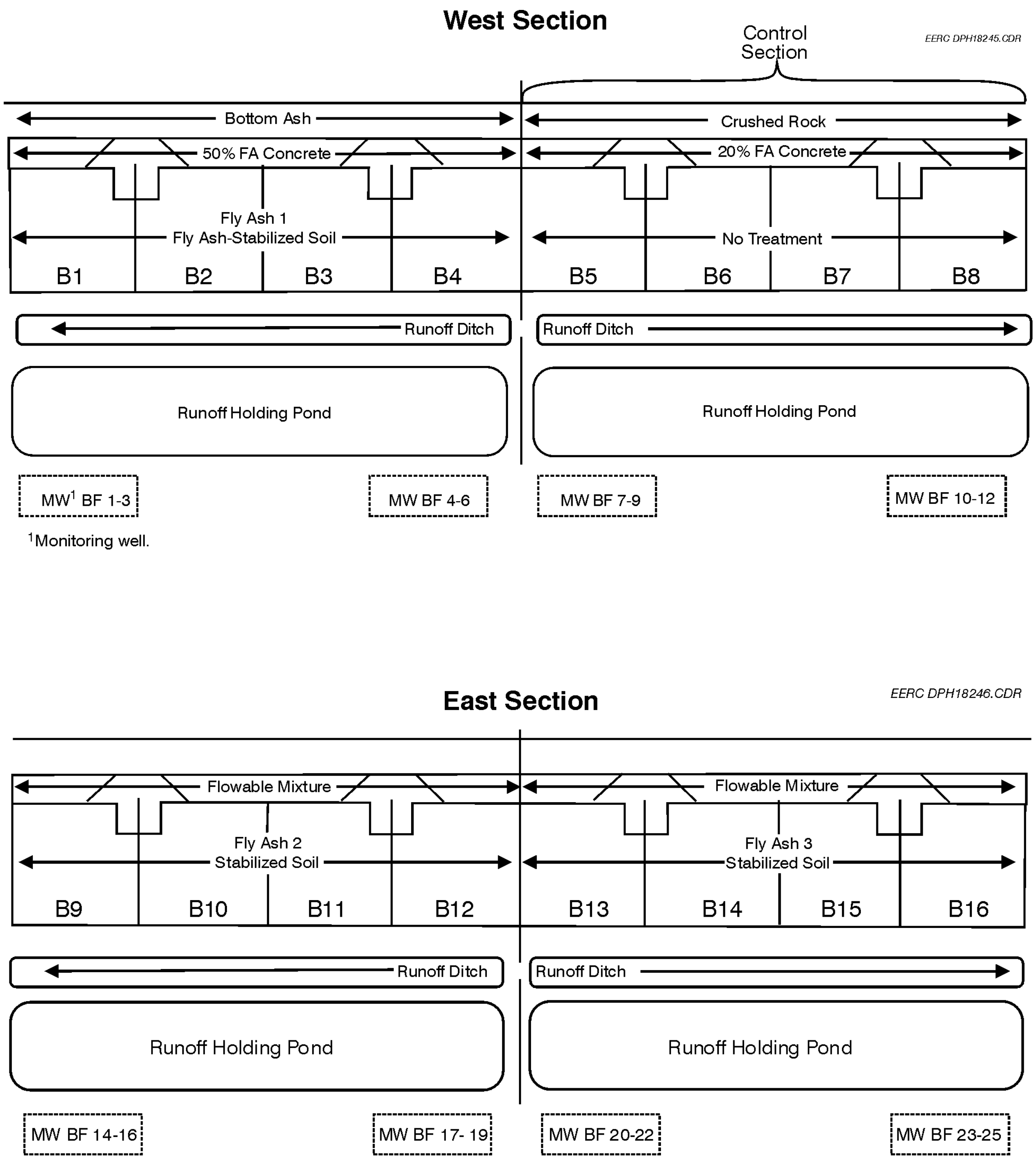
The primary focus for Year 1 was at the CREC bison research facility. The CREC site consists of 16 well designed pens each 75' X 60'. A cross-section view of the facility is shown in Figure 1. Each pen holds 10-12 bison and has identical sloping. See Figure 2 for a schematic of the feedlot layout.

Figure 1: Cross-Section View of CREC Bison Research Facility



The feeding/watering areas, runoff ditches, and holding ponds, shown in Figure 2, were also carefully constructed. Pens B1-B4 have a 50% fly ash concrete on the feeding/watering areas. Pens B9-B16 have a flowable mixture of fly ash, bottom ash, cement, and water around the feeding/watering areas.

Figure 2: Ash Treatment and Control Layout



Twelve pens were surfaced with regional ashes and four pens were left untreated for comparative purposes. See Figure 2. Over 140 tons of fly ash was placed at the CREC pens. The ash was incorporated at a 6-8" depth using two different mixing and compaction techniques based on the types of equipment expected to be available to most feedlot operators. Three fly ashes and one bottom ash were used to develop two different ash surfaces. Each of the three fly ashes was used individually as a soil amendment in sets of four pens. The treatments placed and methods of compaction and mixing are listed in Table 2. Fly ash additions ranging from 12-28% were used in order to aid in determining the optimum level of fly ash.

Table 2: Ash Placement Techniques

Pen	% Ash	Mixing	Compaction
1	12	Disk + rototiller	Tractor
2	12	Disk + rototiller	Tractor
3	18	Disk + rototiller	Tractor
4	25	Disk + rototiller	Tractor
5	0	-	-
6	0	-	-
7	0	-	-
8	0	-	-
9	12	Disk	Tractor
10	12	Disk	Rubber-tire compactor
11	16	Disk + rototiller	Rubber-tire compactor
12	22	Disk + rototiller	Tractor
13	14	Disk	Rubber-tire compactor
14	14	Disk	Tractor
15	28	Disk + rototiller	Tractor
16	18	Disk + rototiller	Rubber-tire compactor

Results

Immediately following the ash placement, nuclear density testing indicated compaction was achieved at 89% to >100% of maximum and moisture levels ranged from 5.0% to 9.5%.

After the second ash placement in Pens B13-B16, nuclear density testing indicated compaction was achieved at over 100% of maximum and moisture levels ranged from 5.0% to 9.0%. Strength tests indicated soil blended with coal ash was 3 to 6 times stronger than soil without ash. It is important to note these results are dependent on the source of ash and amounts used and this figure is an average.

The performance of treated and untreated pens appeared to be equivalent during the winter months, however, during spring thaw, the treated pens exhibited significantly improved surfaces as illustrated in Figure 3.

Figure 3: Untreated vs. Treated Soils

Pen B5, left, is a control pen containing no coal ash. Pen B4, right, contains 25% coal ash. Based on visual results, soil in the treated pen appears to perform much better than soil in the untreated pen.

Future Activities

- Engineering performance tests will be performed at regular intervals over the next two years on all ash-based surfaces.
- CREC will evaluate animal performance on treated surfaces and control pens.
- Economic evaluation of lignite ash-based surfaces will be performed.
- Additional field placements will be conducted at commercial feedlots.
- Production of a video entitled "How to Stabilize Feedlots Using Coal Ash" will be produced along with an educational handout outlining the process in detail.
- Standard feedlot surface mixtures and placement techniques will be developed. The project team is working with the North Dakota Department of Health with the goal to develop a rule approving the use of coal ash in feedlot settings.

BISON COW-CALF CASH FLOW PROJECTIONS

Steve Metzger
Carrington Area Farm Business Management Program
Carrington Research Extension Center, NDSU

Abstract

As bison cow-calf producers attempt to work through the current lower prices in the bison market, there is a very real need for information that will help them to stabilize the financial arrangements in their operation. The current drop in the market price of both bison breeding stock and bison calves provides both a financial danger and a financial opportunity for varied producers. A better understanding of how key production and financial elements of the bison industry fit together is essential for the future success of bison cow-calf producers.

Key Words: Investment, Weaning Percentage, Operator Draw, Debt to Asset Ratio

Introduction

With the recent downturn in the market price of both breeding stock and weaned bison calves, many producers are feeling the financial pressure from both decreased asset values on their balance sheets and a decreased ability to provide, from their bison cow-calf enterprise, an adequate cash flow to meet all operating, debt servicing, and operator draws. Both producers and lenders who work with bison producers need to identify a level of profitability that will insure not only the survivability of the producers but also their continued growth and prosperity in the future. Various budget scenarios (n=25) were developed by altering such items as the level of initial investment, total operating expenses, weaning percentages, amount of operator draws, and the value of weaned bull and heifer calves.

Herd Performance and Financial Information

This paper presents several budget or cash flow projection scenarios that are based on bison herd performance and financial data (Metzger and Anderson 1998) that was collected through the Carrington Area Farm Business Management Program. The records detailed the production and financial information for 860 bison cows over a period of four years with four area producers. All records were completed for the entire farming operation and not the bison enterprises alone. A more accurate accounting is possible through the use of total farm financial and production records. In this scenario all farm income and expenses are taken into account as well as the total balance sheet or financial statement.

Bison Cow-Calf Cash Flow Projections

The cash flow projections were completed using borrowed funds, for beginning capital expenditures, of either 50% or 100% at an interest rate of 9 1/2% and amortized over seven years. All annual operating money was also borrowed at the 9 1/2% rate. In addition to the breeding stock values (Table 1, scenarios 1-24) the initial investment also included $60,000 for non-breeding stock assets such as equipment, fencing, facilities, etc. In scenarios 1-23, 5% of the total capital investment for both breeding stock and equipment/facilities was replaced each year while only 1.1% and 1.7% was allowed for capital replacement in scenarios 24 and 25 respectively. Although done for the purpose of projecting profitability, a level of capital replacement at less than 2% may not be possible for many producers.

Breeding stock values reflect not only the value of the cow but also 10% of the value of the breeding bull. Therefore a breeding stock value of $1,200 reflects a cow value of $1,000 per head and a breeding bull value of $2,000 per head. The weaned calf price is based on a 450 pound calf valued at either $1.00, $1.25 or $1.50 per pound. This calculates to weaned calf values of $450, $563 and $675 respectively. Both heifer and bull calves were valued the same. In these projections, all calves were sold at weaning each November. Any replacement or feeding of calves would be kept as separate and distinct enterprises.

Expenses per cow, excluding all interest paid, ranged from $273 to $363 per head. While the $363 figure is most representative of the four year study, various expense levels were used to illustrate the impact of changing expense totals. The operating expenses for the breeding bulls are proportioned among the bison cows. Operator draw also varies from zero to $200 per cow per year. This variation again illustrates the impact of funds exiting the business whether it is for operating expenses or for the operator's labor and potential tax liabilities. One would certainly question the feasibility of any budget projection that has the initial borrowed capital being paid back without any allowance for operator draw to pay for the potential tax liability created by the use of funds for principal debt reduction. One would also fully expect some draws for operator labor to be used for basic family living expenses.

Herd profitability was also calculated under different scenarios using weaning percentages of 85% and 95%. While the 85% figure is closer to figures discussed by local producers, several producers also believe that calf crops of close to 100% are possible once bison have become acclimated to a particular area. To best illustrate the affect of weaning percentage on profitability the factors of 85% and 95% were chosen for these projections.

Measuring Changes in Profitability

Bison cow-calf cash flow projections were constructed to illustrate the impact of various forces; including level of investment, weaned calf value, operating expenses, operator draw, and weaning percentage on the total profitability of the bison cow-calf enterprise over a ten year period, as measured by change in net worth and the ending ten year debt to asset ratio. All projections used the same 9 1/2% interest rate.

In Table 1 scenario 1 illustrates a $1,000 breeding stock investment with $450 per head calves that produced a negative change in net worth of ($1,023) per bison cow and an increase in the debt to asset ratio from 50% to 114% over a ten year period. Scenario 2 shows that by increasing the weaning percentage from 85% to 95% the change in net worth, while still negative, is decreased to a negative ($316) and the ending debt to asset ratio is improved from 114% to 70%. Each increase of one percent in the weaning percentage had the affect of increasing net worth by $71 per cow over the ten year period. The one percent increase also effectively decreased the ending ten year debt to asset ratio by 4.4% When this same increase in weaning percentage was incorporated into scenarios 12 and 14 the results were an increase in net worth of $1,066 per cow or $107 for each single percent increase in weaning percentage. With higher breeding values and weaned calf prices it also moved the ending debt to asset ratio from almost no change at 49% to zero in the ninth year of the cash flow projection.

The affect of changing the amount of beginning capital that is borrowed can be seen by reviewing scenarios 13 and 19. In scenario 19 where 100% of the beginning capital was borrowed versus only 50% in scenario 13, the result was an increase in net worth gained per cow of $1,336 and a change of 124% in the ten year debt to asset ratio as it moved from a high of 137% to a low of 13% at the end of the ten year period.

As shown in scenarios 7 and 15, when the herd is begun at a debt level of 50% and has a projected weaning percentage of 95% an increase in the value of the calves from $563 per head to $675 per head effectively increases net worth $1,584 per cow and decreases the ending debt to asset ratio by 47% allowing all debt to be paid off in the seventh year. Although this comparison is done at a weaning percentage of 95% it is important to note the amount of debt reduction that does take place with the additional $112 of income per weaned calf.

Decreasing expenses per cow had a positive affect on the projections as shown by comparing scenarios 12 and 13. When expenses were decreased $40 per cow there was a positive change in net worth of $648 per cow and the ending ten year debt to asset ratio improved, decreasing from 49% to 13% over the ten year period. This translated into an increase in ending net worth of $162 per cow for each $10 of annual expenses saved.

The affect of operator draw on this business plan can be readily seen when reviewing scenarios 9 and 10. In these two scenarios where the only difference is the $100 per year draw against each bison cow, the result is a decrease of $1,626 per cow in net worth when the draw is taken by the operator. It also more than doubled the ending ten year debt to asset ratio increasing it from 81% to 172%. When this arrangement was repeated in scenarios 17 and 18 with higher valued calves at $675 per head, and the draws taken for $200 and $100 respectively, the result was again a decrease of $1,627 per cow in net worth when the draw was increased by $100 per cow. The ending debt to asset ratio also more than doubled, moving from 79% to 169% over the ten year period.

The last two scenarios, numbers 24 and 25 were designed using greatly decreased rates of replacement for capital items, including breeding stock, equipment, and facilities. While all other scenarios allowed for $5,000 to $6,000 of annual replacement capital, the last two scenarios replaced only $2,000 per year in each year of the ten year projections. Scenario 25 was also constructed with only $20,000 of beginning capital in the form of

equipment and buildings while all other scenarios were constructed with the amount of $60,000 for non-breeding stock capital assets.
Scenario 25 showed an additional increase in net worth of $588 and a very favorable change in the ending debt to asset ratio, moving from 44% to zero in the tenth year of the budget. While the low rate of capital replacement in scenarios 24 and 25 does contribute greatly to a positive change in net worth, $623 in scenario 24 compared to number 18, the continued viability of the total operation must be seriously considered before such a reduction in capital replacement is undertaken. Failure to adequately fund the needed replacement of breeding stock and necessary equipment or facilities, while providing short term financial benefits, may have a serious detrimental effect on the long term and overall success of the operation.

Summary

The continued expansion and success of the bison industry will depend upon a number of factors including the long term success of the bison cow-calf producer. The importance of individual producers being able to determine not only their income and expenses but their entire profitability picture cannot be overstated. Individual differences in such things as beginning debt to asset ratio, cost of breeding stock, expenses per cow, and the amount of operator draw taken from the operation must all be considered when projecting the profitability of any single producer. These cash flow projections, while based on actual farm data, are intended to be used as guidelines for producers to both realize and project the effect of changes they might make to their own production and financial numbers. The challenge for the bison cow-calf producer will be to profitably raise a bison bull or heifer calf that can be sold at a price that reflects the producer's needed profitability while allowing the buyer the opportunity to profitably grow out the bulls and heifers for feeding or breeding. The future of the bison industry is dependent upon all factions of the industry being able to generate profits, including the bison cow-calf producer.

Acknowledgments

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Table 1 Projected Changes in Net Worth with Various Budget Scenarios, per Bison Cow Basis.

	Beg. Debt to Asset Ratio	Breeding Stock Value	Weaned Calf $ per Hd.	Expenses Excluding Interest	Expenses Including Interest	Draw for FL & Taxes	Weaning %	10 Year Change in Net Worth	10 Year Debt to Asset Ratio
1	50%	$1,000	$450	$311	$435	$0	85%	($1,023)	114%
2	50%	$1,000	$450	$311	$409	$0	95%	($316)	70%
3	50%	$1,000	$563	$311	$380	$0	85%	$478	20%
4	50%	$1,000	$563	$311	$351	$0	95%	$1,437	0%
5	50%	$1,200	$563	$313	$370	$0	95%	$1,043	0%
6	50%	$1,200	$563	$313	$435	$100	95%	($603)	84%
7	50%	$1,200	$563	$273	$370	$100	95%	$47	47%
8	50%	$1,200	$563	$313	$467	$100	85%	($1,487)	133%
9	100%	$1,200	$563	$273	$504	$100	95%	($1,291)	172%
10	100%	$1,200	$563	$273	$441	$0	95%	$335	81%
11	50%	$1,200	$563	$273	$402	$100	85%	($836)	97%
12	50%	$1,200	$675	$313	$412	$100	85%	$15	49%
13	50%	$1,200	$675	$273	$347	$100	85%	$663	13%
14	50%	$1,200	$675	$313	$373	$100	95%	$1,081	0%
15	50%	$1,200	$675	$273	$318	$100	95%	$1,631	0%
16	50%	$1,200	$675	$273	$371	$200	95%	$98	45%
17	100%	$1,200	$675	$273	$505	$200	95%	($1,240)	169%
18	100%	$1,200	$675	$273	$443	$100	95%	$387	79%
19	100%	$1,200	$675	$273	$481	$100	85%	($673)	137%
20	100%	$1,200	$675	$313	$508	$100	95%	($262)	115%
21	100%	$1,200	$675	$363	$589	$100	95%	($1,076)	160%
22	100%	$1,200	$675	$363	$526	$0	95%	$550	70%
23	100%	$1,200	$675	$363	$565	$0	85%	($509)	128%
24	100%	$1,200	$675	$273	$420	$100	95%	$1,010	44%

Scenario #24 assumes only a total net replacement figure of $2,000/year for capital replacement.

25	100%	$1,200	$675	$273	$361	$100	95%	$1,598	0%
	Scenario #25 assumes only a net replacement figure of $2,000/year for capital and a beginning equipment and improvements investment of $20,000 versus $60,000 in all other budget scenarios.								

FUTURE BISON RESEARCH

Starch vs. digestible fiber in ruminant diets – applicability to bison and beef
Rumen microbes adapt to either high starch diets or high fiber diets with a no-man's-land environment when rations are relatively even. Some co-products contain digestible fiber levels that may outperform or complement starch sources when fed at intermediate levels. This project will be conducted in both beef and bison to determine animal performance, digestion parameters, and economics of feeding soybean hulls and barley in four reciprocal increments. This trial will start in the fall of 2001 and some grant funds are available for the project.

Feeding bison heifers for meat
Bison heifers have been too valuable, according to prices offered, to feed for meat. Interest is increasing with current market demand. Cull heifers will be fed diets varying in protein, energy, and fiber in order to assess best management practices and characterize meat quality in comparison with bison bulls. No start date has been determined for this study nor are grant funds available at this time.

Optimal integrated bison production systems
Cooperators will be needed for the cow/calf component of investigations into bison productions systems from breeding through butchering. Supplementation of cows, weaning time, feeding regimes, carcass value, and net returns will be some of the items measured in biological terms and modeled for a completely integrated production system. No start date has been determined for this study nor are grant funds available at this time.

Assessing selenium levels and requirements in bison meat
Selenium is an important mineral for maintaining healthy immune systems and high levels of the mineral in meat could increase interest and value for human consumption. Current selenium research at NDSU with beef cattle could assimilate samples from bison for assessment of current status and supplementation effects.