Determination of Costs of Harvested Forage Types to Help Reduce Beef Production Costs

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Production costs for beef animals differ little from prices received for live animals. The result is a low profit margin for the beef industry in the Northern Great Plains. A major increase in market prices for beef animals is unlikely because of strong competition from poultry and hogs. The beef production industry therefore requires true reductions in costs to remain competitive. Beef production is the last remaining meat industry to seriously evaluate input costs as a system, and production costs are unnecessarily high in part because the industry relies on many forage management practices that inefficiently capture the nutrients produced on a land base. Viability of the beef production industry depends on the development and implementation of forage management strategies that are biologically efficient and ecologically and economically sound.

Twelve-month forage costs, which include the costs of pasture and harvested feed, are the primary expense for a cow-calf operation, often constituting 60 to 65% of total production costs. The common assumption that the major cause of high beef production costs is the expense of feeding harvested forages has prompted recommendations that beef producers reduce quantities of harvested forages used. Management practices developed in response to these recommendations are generally not properly evaluated and often actually increase the 12-month production costs for a beef animal. Traditionally, beef producers have based evaluations of animal production costs on the rent value per acre for pasture and the production costs per acre or the market value per ton for harvested forages. Calculations using these traditional market values can result in misleading assessments of forage costs. The cost of harvested forage is affected by the efficiency of the harvest strategy and by the quantity of nutrients captured relative to the potential quantity of nutrients produced. Therefore, determination of the profit or loss from forages is more accurately made from calculations based on the costs and returns per unit of nutrients. Total profits from forages and beef animals can be determined from the quantities of nutrients required by the livestock.

The nutrients the beef animal requires are energy, protein, minerals, vitamins, and water. The quantities of each nutrient required by the

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cow depend on the size of animal, level of milk production, and stage in the cow's reproductive cycle. A 1200-pound cow with average milk production and a calf born in mid March and weaned at 8 months of age requires 9,492 lbs of dry matter, 5,223 lbs of energy (TDN), 837 lbs of crude protein, 24 lbs of calcium, and 17 lbs of phosphorus for 12 months. The 12-month forage costs for a cow are equal to the costs for the nutrients that cow requires during a year. Beef producers can reduce production costs for a cow by determining the unit cost of required nutrients and selecting forage types and forage management strategies that supply nutrients at lower costs.

Determination of unit cost of nutrients for forage types is needed to evaluate input costs and to determine beef production costs. All nutrients are important to animal growth, but this report uses only protein and dry matter to express the concepts of using unit cost of nutrients to reduce beef production costs. Major expenses are used to determine average production costs, dry matter biomass costs, and crude protein costs for harvested forage types adapted to the Northern Great Plains. This report is not a crop budget or economic analysis and does not include consideration of operating interest, insurance, or indirect costs. The determinations presented in this report will assist beef producers in the selection of harvested forage types and forage management strategies that reduce beef production costs.

Methods

The North Dakota State University agronomists at the Carrington, Dickinson, Hettinger, Minot, and Williston Research Extension Centers have been conducting investigations on alternative use of cropland for the production of annual forages that can be used as harvested hay or silage. Beef producers should consult annual forage production reports from the Research Extension Center nearest their location. At the Dickinson Research Extension Center, Dr. Pat Carr has been investigating strategies for integration of harvested forage production into crop rotation systems. Data collected on these Dickinson research trials were included in this paper. Test weight and bushel yield per acre for grain production, dry matter yield per acre for forage production, and percent crude protein data for adapted varieties were selected from annual agronomic publications (Carr 1994, 1995, 1996, 1997, 1998, 1999). The same varieties were not included in the research trials each year. Test weight and bushels per acre data for each selected variety were used to determine grain dry matter biomass yield per acre. Annual dry matter biomass and crude protein yield data for selected adapted varieties were combined by forage type and summarized for the years 1995 to 1999, with average and range of production yield reported in pounds per acre. These composite values may not correspond to related reported values because varietal data were maintained separately until the final steps of calculations for this report.

Average production costs per acre for each forage type were determined by adding average custom farm work rates (Beard 1998), average cropland rent per acre, and average seed costs per acre (Swenson and Haugen 1999). Production costs do not include costs of fertilizer, pesticides, or transportation of feed and forages because these costs are highly variable and determining an average value for them is difficult. Even though these costs were not used in this report, they are important and should be considered when individual operations determine their crop and forage production costs. The need for fertilizer and pesticides is greater in grain production than in forage production; therefore, costs for grain biomass yield will be disproportionally increased.

Costs per unit of dry matter (DM) biomass production were determined by dividing average production costs per acre by pounds of dry matter produced per acre. Costs per unit of crude protein (CP) were determined in two stages: first, pounds of dry matter produced per

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acre were multiplied by percentage of crude protein to derive pounds of crude protein per acre; then average production costs per acre were divided by pounds of crude protein per acre. Costs of dry matter biomass and crude protein are reported as cost per hundredweight (CWT). Cost per pound can be calculated by dividing 100 into cost per hundredweight. Cost per ton can be determined by multiplying cost per hundredweight by 20. A standard t-test was used to evaluate the standard deviations of means (Mosteller and Rourke 1973) reported as the range in production yields.

Results

Average grain yields in bushels per acre for the cereals in the research trials at the Dickinson Research Extension Center (table 1) were impressive. Hard red spring wheat, durum wheat, barley, oats, rye, and corn had similar ranges of dry matter grain biomass yields (table 1) when several varieties were combined into forage types across several years (1995-1999). Grain biomass yields of peas and lentils were slightly below those of the cereal grains (table 1). The ranges of pounds of crude protein per acre from grain yields were similar for hard red spring wheat, durum wheat, and barley (table 1).

Average forage dry matter biomass yields (table 2) for barley and oats tended to be greater than average grain dry matter biomass yields (table 1). Most peas and lentils also produced greater forage biomass than grain biomass (table 1 and 2). Average dry matter biomass yield for corn silage (table 2) was considerably greater than average dry matter grain biomass yield for corn (table 1).

Production costs per acre (table 3) were determined from average North Dakota costs (Beard 1998, Swenson and Haugen 1999).

Grain dry matter biomass costs for hard red spring wheat, durum wheat, barley, and oats ranged between $1.40 and $1.80 per hundredweight (table 4). Grain crude protein costs for hard red spring wheat, durum wheat, and barley ranged between $10.10 and $12.60 per hundredweight (table 4). Corn grain biomass costs were just over $2.00 per hundredweight (table 4), and most pea and lentil grain biomass costs ranged between $3.15 and $4.95 per hundredweight (table 4).

Forage dry matter biomass costs for barley, oats, and triticale ranged between $1.25 and $1.50 per hundredweight (table 5). One variety of oat (Paul Naked Oat) had slightly higher costs, at $1.66 per hundredweight (table 5). Forage crude protein costs for barley, oats, and triticale ranged between $11.25 and $23.05 per hundredweight (table 5). Forage dry matter biomass costs ranged between $1.85 and $2.75 per hundredweight for peas and between $1.85 and $4.20 per hundredweight for lentils (table 5). Forage crude protein costs ranged between $11.30 and $15.65 per hundredweight for peas and between $12.55 and $20.40 per hundredweight for lentils (table 5). Forage dry matter biomass costs for cereal/legume mixes ranged between $1.70 and $2.10 per hundredweight (table 5). Forage crude protein costs for cereal/legume mixes ranged between $14.65 and $19.60 per hundredweight (table 5). Forage costs for warm-season annuals ranged between $1.35 and $1.60 per hundredweight for dry matter biomass and between $28.15 and $35.10 per hundredweight for crude protein (table 5). Corn silage cost for dry matter biomass was less than $1.00 per hundredweight (table 5).

Perennial grass hay has been a traditional winter feed for cows in the Northern Great Plains. Harvesting grass when the greatest dry matter biomass per acre could be collected reduced the cost of the dry matter biomass per hundredweight. Crested wheatgrass cut at a

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mature stage yielded about 300 lbs more dry biomass per acre than crested wheatgrass cut at the boot stage (table 6). Dry matter costs for mature hay were about $0.30 per hundredweight ($6.00 per ton DM) lower than dry matter costs for early cut hay (table 6). However, the quantity of crude protein captured per acre in mature hay was only a little more than half the quantity of crude protein captured per acre in hay cut at the boot stage (table 6). In the mature hay, the cost of crude protein per hundredweight was nearly double the cost of crude protein in the early cut hay (table 6).

Winter grazing of native range pastures developed as a common practice during the early settlement period when land was relatively inexpensive and allowing a large land base per animal did not pose an economic problem. Currently, because profit margins are low, the land area required per animal per year has increased importance and must be considered when forage management strategies are evaluated. The cost of crude protein captured from native range pastures that were grazed in December and had rent at $8.76 per acre and an average of 4.8% crude protein was $1.01 per pound ($2020.00 per ton CP). In contrast, the cost of crude protein captured from similar native range pastures that were grazed in July and had rent at $8.76 per acre and an average of 9.6% crude protein was $0.25 per pound ($500.00 per ton CP).

Discussion

Forage management decisions based on bulk cost of harvested forage or production costs per acre will be different from forage management decisions based on per unit cost of nutrients.

Crested wheatgrass cut at a mature stage has per acre production costs of only about $28.00 (table 6). Most of the harvested annual forage types (table 5) have per acre production costs between $60.00 and $100.00, costs considerably greater than those of mature crested wheatgrass hay. However, crude protein costs of mature cut crested wheatgrass are relatively high, at $27.56 per hundredweight ($551.20 per ton CP). Most of the harvested annual forages (table 5) have lower crude protein costs per hundredweight than does mature crested wheatgrass hay (table 6).

Crested wheatgrass cut at the boot stage has a relatively low cost for crude protein, at $14.02 per hundredweight ($280.40 per ton CP) (table 6). However, several annual forages provide crude protein at lower costs (table 5). Forage barley cut at the milk and soft dough stages, oats cut at the milk and soft dough stages, Grande pea forage, Trapper pea forage cut at the middle and late stages, and Indianhead lentil forage cut at the middle and late stages all produce crude protein at lower costs than does early cut crested wheatgrass. Forage barley cut at the milk stage has the lowest cost for crude protein, at $11.26 per hundredweight ($225.20 per ton CP).

Cereals and legumes have sometimes been mixed in efforts to produce a better forage. Annual legumes are included in the mixture as a possible source of nitrogen, and cereals are included in the mixture to improve the effectiveness of harvest of the annual legumes by providing physical support for the plants. The cereal/legume mixes have generally not produced greater dry matter forage biomass or pounds of crude protein per acre than have cereals or legumes seeded separately (table 2). This result occurs primarily because optimum harvest time for cereals differs from that for legumes. Cereals yield greater pounds of crude protein per acre when harvested during early development stages, around the flowering stage to late milk or soft dough stages (table 5). Legumes generally yield greater pounds of

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crude protein per acre when harvested during the middle and late stages of development (table 5). When harvest time for cereal/legume mixes is a compromise between the optimum early harvest for cereals and the late harvest for legumes, quantities of dry matter and crude protein yields are not greater than when these plants are grown separately and harvested during their respective optimum times. A 100-acre field seeded to a mixture of barley/peas and cut when plants are at the soft dough stage captures 63,400 pounds of crude protein at a cost of $0.15 per pound of crude protein. A 100-acre field of which 50 acres are seeded to forage barley and cut when plants are at the milk stage and 50 acres are seeded to forage peas and cut when plants are at the late stage captures 64,550 pounds of crude protein at a cost of $0.12 per pound of crude protein, if harvest technique of sole forage peas is effective.

The effectiveness of forage management strategies in reducing beef production costs can not be properly determined by calculations that rely on dry matter biomass costs or production costs per acre to assess forage costs. The effectiveness of forage management strategies can be accurately determined by calculations that rely on the unit cost of required nutrients to assess forage costs. To illustrate this point we can use examples of forage costs of different management strategies for a cow during one production period. A 1200-pound cow in the 3rd trimester requires a daily intake of 24 lbs dry matter (DM) at 7.8% crude protein (CP) (1.9 lbs CP/day). The examples of forage management strategies are perennial grass hay cut at early and mature growth stages, late season grazing on native range, and harvested annual forage hay cut at an optimum growth stage.

Crested wheatgrass cut at a mature plant stage (table 6) has production costs of $28.11 per acre, dry matter costs of $34.80 per ton, and crude protein costs of $0.28 per pound. This late-cut hay would need to be fed at 30 lbs DM/day to provide 1.9 lbs CP/day. This crested wheatgrass forage would cost $0.52 per day, $47.13 for the 90-day period of the 3rd trimester. Production of this amount of crested wheatgrass hay would require 1.70 acres.

Crested wheatgrass cut early (table 6), at the boot stage, has production costs of $26.50 per acre, dry matter costs of $40.80 per ton, and crude protein costs of $0.14 per pound. This early cut hay would be fed at 13 lbs DM/day to provide 1.9 lbs CP/day. This crested wheatgrass forage would cost $0.27 per day, $23.97 for the 90-day period of the 3rd trimester. Production of this amount of crested wheatgrass hay would require 0.90 acres. An additional 11 lbs of straw per day would be needed to provide the 24 lbs DM/day required.

Rent for native range winter pasture costs $8.76 per acre, available dry matter forage costs $97.33 per ton, and available crude protein costs $1.01 per pound. The available dry matter forage from 4.40 acres of winter native range pasture would be needed to meet the intake requirements of a 1200-pound cow for a month. The crude protein available on 4.40 acres is 1.2 lbs CP/day; therefore, supplementation of 0.7 lbs CP/day would be required. Forage from native range winter pastures would cost $1.26 per day, $113.74 for the 90-day period of the 3rd trimester. Supplemental crude protein would cost $0.88 per day, $78.75 for the 90-day period. Winter pasture forage and supplemental nutrients would cost $192.49 for the 3rd trimester. For the 90-day period, 13.20 acres of native range winter pasture would be required.

Forage barley cut at the milk stage (table 5) has production costs of $68.21 per acre, dry matter costs of $28.80 per ton, and crude protein costs of $0.11 per pound. The forage barley hay would be fed at 14.6 lbs DM/day to provide 1.9 lbs CP/day. This forage barley hay would cost $0.21 per day, $19.25 for the 90-day period of the 3rd trimester. Production of this amount of forage barley hay would require 0.28

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acres. An additional 9.6 lbs of straw per day would be needed to provide the 24 lbs DM/day required.

The forage production costs per acre for the four examples are $8.76, $26.50, $28.11, and $68.21 for winter grazed native range, early cut crested wheat, mature cut crested wheat, and forage barley, respectively. The crude protein costs per pound are $0.11, $0.14, $0.28, and $1.01 for forage barley, early cut crested wheat, mature cut crested wheat, and winter grazed native range, respectively. The 90-day beef production costs are $19.25, $23.97, $47.13, and $192.49 for forage barley, early cut crested wheat, mature cut crested wheat, and winter grazed native range, respectively. The ranking of beef production costs follows the same order as that of crude protein costs but differs from the ranking of the forage production costs and dry matter costs. Forage production costs and forage dry matter costs do not accurately determine beef production costs. Unit cost of nutrients can be used to accurately determine beef production costs.

These simple examples show that when the amount of crude protein harvested per acre increases and standard costs remain constant, the cost per pound of crude protein decreases, the land area needed for forage production per animal decreases, and the cost of feed for an animal during a production period is reduced. The unit cost of nutrients more reliably indicates beef production costs than do forage production costs or forage dry matter costs. Improvements in efficiency of harvest of the nutrients produced on a land base will reduce the cost per unit of nutrient and the land area needed for forage production per animal and offer considerable opportunity for reductions in beef production costs.

Conclusion

The major cause of high 12-month beef production costs is not harvested forage costs but inefficient forage management practices with high per unit cost of nutrients. Most traditional forage management practices used by beef producers in the Northern Great Plains result in high unit costs of nutrients. Harvested annual forages with low unit cost of nutrients are underused as components of low-cost forage management strategies. Beef producers who evaluate their production costs based on unit cost of nutrients and implement strategies that improve the efficiency of nutrient capture can reduce their input costs and improve their profit margin.

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Table 1. Grain dry matter biomass and crude protein yield in lb/ac, Dickinson Research Extension Center. Summary of data from Carr, 1995-1999.

	Number	Average Yield	Average Grain Biomass	Biomass Range	Number	Crude Protein	Average Crude Protein	Crude Protein Range

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	Number of Samples	Yield bu/ac	Biomass lb/ac	Range lb/ac	Number of Samples	Protein %	Protein lb/ac	Range lb/ac
Hard Red Spring Wheat								
Semidwarf	n=14	54.8	3259	3957-2561	n=14	14.8	477	544-410
Medium	n=14	53.4	3209	3748-2670	n=14	14.7	467	526-408
Hard Red Winter Wheat								
Adapted cultivars	n=24	71.9	4375	4711-4039	n=24	13.4	585	631-540
Durum Wheat								
Semidwarf	n=5	50.1	2818	3566-2069	n=5	14.6	406	492-320
Medium	n=13	49.4	2868	3552-2183	n=12	15.7	433	512-354
Tall	n=16	48.9	2848	3524-2173	n=16	15.4	432	512-353
Winter Rye								
Adapted cultivars	n=6	79.1	4017	4582-3451	n=0	------		
Barley								
Six row	n=23	79.0	3596	4321-2871	n=23	13.8	493	582-404
Two row	n=21	74.0	3509	4204-2814	n=21	13.7	481	570-392
Oat								
Grain Oat	n=29	105.5	3564	4144-2985	n=0	------		
Forage Oat	n=11	100.5	3297	3571-2844	n=0	------		
Dumont Oat	n=3	90.8	3019	3877-2161	n=0	------		
Whitestone Oat	n=5	106.8	3567	3984-3150	n=0	------		
Paul Naked Oat	n=5	73.0	2893	3348-2437	n=0	------		

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Corn, 75-99 day								
Corn grain[1]	n=41	66.0	3612	4359-2865	n=0	------		
Pea Grain								
Early Pea	n=11	27.2	1723	2282-1163	n=0	------		
Medium Pea	n=10	38.0	2346	2750-1942	n=0	------		
Late Pea	n=6	29.8	1880	2412-1348	n=0	------		
Forage Pea	n=2	30.0	1833	1862-1803	n=0	------		
Lentil Grain								
Chilean Lentil	n=19	21.6	1302	1693-911	n=0	------		
Persian Lentil	n=4	23.8	1495	1865-1125	n=0	------		
Red Lentil	n=9	20.8	1286	1724-848	n=0	------		
Spanish Brown Lentil	n=4	18.0	1111	1436-787	n=0	------		
Forage Lentil	n=1	25.6	1658		n=0	------		

[1]Includes data from Carr, 1994-1999.

Table 2. Forage dry matter biomass and crude protein yield in lb/ac, Dickinson Research Extension Center. Summary of data from Carr, 1995-1999.

	Growth Stage	Number of Samples	Average Forage Biomass lb/ac	Biomass Range lb/ac	Number of Samples	Crude Protein %	Average Crude Protein lb/ac	Crude Protein Range lb/ac
Barley								
Six row		n=5	4800	7270-2330	n=3	9.5	303	304-303

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Two row		n=6	4800	6584-3016	n=4	9.8	379	492-266
Forage Barley		n=10	5780	7515-4046	n=4	9.0	429	558-299
Horsford Barley	milk	n=3	4733	6065-3402	n=3	13.0	606	748-464
Horsford Barley	soft do.	n=3	5200	6788-3613	n=3	11.3	571	683-459
Horsford Barley	hard do.	n=3	5133	6634-3632	n=3	9.2	468	595-342
Oat								
Grain Oat		n=4	5650	6648-4652	n=2	6.8	323	328-319
Forage Oat		n=10	5700	6860-4541	n=5	8.3	407	531-283
Dumont Oat	milk	n=3	4667	5475-3858	n=3	11.5	535	652-418
Dumont Oat	soft do.	n=3	6000	7744-4256	n=3	9.7	570	692-450
Dumont Oat	hard do.	n=3	5667	6673-4660	n=3	7.8	435	560-309
Whitestone Oat		n=5	5320	6738-3902	n=4	8.7	428	561-294
Paul Naked Oat		n=7	3943	5061-2825	n=5	10.0	388	518-259
Triticale								
Adapted cultivars		n=7	5771	7446-4096	n=4	8.1	372	514-230
Spring Rye								
Adapted cultivars		n=1	3000		n=1	9.6	288	
Pea Forage								
Pea		n=33	3703	5054-2352	n=27	16.8	586	808-364
Arvika Pea		n=2	4400	4966-3834	n=2	13.5	583	647-519
Carneval Pea		n=2	4000	6263-1737	n=2	14.4	534	713-356
Grande Pea		n=3	4333	5752-2914	n=2	17.5	717	986-448
Trapper Pea		n=3	4267	5537-2997	n=3	16.3	718	1023-414
Trapper Pea	early	n=2	2800	3083-2517	n=2	18.9	526	533-518
Trapper Pea	mid	n=2	4200	5049-3352	n=2	16.3	680	777-584

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Trapper Pea	late	n=2	4650	6342-2958	n=5	14.4	685	961-409
Lentil Forage								
Lentil		n=13	2585	3545-1624	n=13	17.7	456	639-274
Chilean Lentil		n=6	2800	3600-2000	n=6	16.9	471	597-345
Red, Crimson Lentil		n=1	1400		n=1	20.4	286	
Spanish Brown Lentil		n=1	1200		n=1	16.2	194	
Forage Lentil								
Indianhead Lentil		n=5	2840	3834-1846	n=5	18.3	525	749-302
Indianhead Lentil	early	n=3	1667	1898-1436	n=3	21.8	361	395-327
Indianhead Lentil	mid	n=3	2733	3039-2428	n=3	18.7	512	582-442
Indianhead Lentil	late	n=3	3867	4283-3450	n=3	14.7	567	627-506
Cereal/legume								
Barley/Pea		n=4	4350	4850-3850	n=4	13.7	590	622-559
Horsford/Trapper	soft do.	n=3	5333	6752-3914	n=3	13.2	634	754-514
Oat/Pea		n=14	5143	6111-4174	n=10	12.5	611	745-478
Dumont/Trapper	soft do.	n=3	5733	7138-4329	n=3	10.8	595	617-573
Dumont/Indianhead	soft do.	n=3	5800	7578-4022	n=3	9.2	506	572-440
Whitestone/Trapper		n=5	5240	6161-4319	n=5	12.5	655	784-526
Paul/Trapper		n=4	4450	5598-3303	n=4	12.6	556	688-424
Triticale/Pea		n=6	5700	6702-4698	n=6	11.5	656	822-491
Warm Season Annual								
Millet, foxtail		n=8	5175	8186-2164	n=2	9.9	247	264-229
Sorghum/Sudan		n=9	5378	8073-2683	n=2	8.6	239	257-221
Corn, 75-99 day								
Corn silage[1]		n=58	8538	10817-6259	n=0	------		

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[1]Includes data from Carr, 1994-1999

Table 3. Custom farm work rates from North Dakota in $/ac, data from North Dakota Agricultural Statistics Service.

	Grain Yield Costs			**Forage Yield Costs**						
	small grain	**legume**	**corn**	**small grain**	**legume**	**cereal legume**	**millet hay**	**sorghum sudan hay**	**corn silage**	**perennial grass hay**
Min. till drill	9.32	9.32	8.50	9.32	9.32	9.32	9.32	8.50	8.50	
Cultivate, 2X			8.54						8.54	
Str. Combine	13.88	19.10	16.26							
Swath/Condition				6.76	6.76	6.76	6.76	6.76		
Swathing										5.31
Chopping									18.69	
Custom Work	23.20	28.40	33.30	16.08	16.08	16.08	16.08	15.26	35.73	5.31
Baling/1000lbs				5.36	5.36	5.36	5.36	5.36		5.36

Seed costs in $/ac, data from NDSU Extension Service.

Spring Wheat	6.25	Pea	23.80
Winter Wheat	4.25	Lentil	12.60
Durum Wheat	5.75	Barley/Pea	28.49
Rye	3.60	Oat/Pea	29.80
Barley	4.69	Triticale/Pea	30.05
Oat	6.00	Millet	3.75
Triticale	6.25	Sorghum/Sudan	9.18
Corn, grain	18.90	Corn, silage	9.18

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Table 4. Grain dry matter biomass and crude protein costs in $/cwt, Dickinson Research Extension Center.							
	Costs/acre						
	Land Rent	Custom Work	Seed Costs	Baling Costs	Production Costs $/ac	Grain Biomass Costs $/cwt	Crude Protein Costs $/cwt
Hard Red Spring Wheat							
Semidwarf	22.07	23.20	6.25		51.52	1.58	10.80
Medium	22.07	23.20	6.25		51.52	1.61	11.03
Hard Red Winter Wheat							
Adapter cultivers	22.07	23.20	4.25		49.52	1.13	8.46
Durum Wheat							
Semidwarf	22.07	23.20	5.75		51.02	1.81	12.57
Medium	22.07	23.20	5.75		51.02	1.78	11.78
Tall	22.07	23.20	5.75		51.02	1.79	11.81
Winter Rye							
Adapted cultivers	22.07	23.20	3.60		48.87	1.22	----
Barley							
Six row	22.07	23.20	4.69		49.96	1.39	10.13
Two row	22.07	23.20	4.69		49.96	1.42	10.39

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Oat							
Grain Oat	22.07	23.20	6.00		51.27	1.44	----
Forage Oat	22.07	23.20	6.00		51.27	1.56	----
Dumont Oat	22.07	23.20	6.00		51.27	1.70	----
Whitestone Oat	22.07	23.20	6.00		51.27	1.44	----
Paul Naked Oat	22.07	23.20	6.00		51.27	1.77	----
Corn, 75-99 day							
Corn grain	22.07	33.30	18.90		74.27	2.06	----
Pea Grain							
Early Pea	22.07	28.42	23.80		74.29	4.31	----
Medium Pea	22.07	28.42	23.80		74.29	3.17	----
Late Pea	22.07	28.42	23.80		74.29	3.95	----
Forage Pea	22.07	28.42	23.80		74.29	4.05	----
Lentil Grain							
Chilean Lentil	22.07	28.42	12.60		63.09	4.85	----
Persian Lentil	22.07	28.42	12.60		63.09	4.22	----
Red Lentil	22.07	28.42	12.60		63.09	4.91	----
Spanish Brown Lentil	22.07	28.42	12.60		63.09	5.68	----
Forage Lentil	22.07	28.42	12.60		63.09	3.81	----

Table 5. (Cont.) Forage dry matter biomass and crude protein costs in $/cwt, Dickinson Research Extension Center.

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		Costs/acre						
	Growth Stage	Land Rent	Custom Work	Seed Costs	Baling Costs	Production Costs $/ac	Forage Biomass Costs $/cwt	Crude Protein Costs $/cwt
Barley								
Six row		22.07	16.08	4.69	25.73	68.57	1.43	22.63
Two row		22.07	16.08	4.69	25.73	68.57	1.43	18.09
Forage Barley		22.07	16.08	4.69	30.98	73.82	1.28	17.21
Horsford Barley	milk	22.07	16.08	4.69	25.37	68.21	1.44	11.26
Horsford Barley	soft do.	22.07	16.08	4.69	27.87	70.71	1.36	12.38
Horsford Barley	hard do.	22.07	16.08	4.69	27.51	70.35	1.37	15.03
Oat								
Grain Oat		22.07	16.08	6.00	30.28	74.43	1.32	23.04
Forage Oat		22.07	16.08	6.00	30.55	74.70	1.31	18.35
Dumont Oat	milk	22.07	16.08	6.00	25.02	69.17	1.48	12.93
Dumont Oat	soft do.	22.07	16.08	6.00	32.16	76.31	1.27	13.39
Dumont Oat	hard do.	22.07	16.08	6.00	30.38	74.53	1.32	17.13
Whitestone Oat		22.07	16.08	6.00	28.52	72.67	1.37	16.98
Paul Naked Oat		22.07	16.08	6.00	21.13	65.28	1.66	16.82
Triticale								
Adapted cultivars		22.07	16.08	6.25	30.93	75.33	1.31	20.25
Spring Rye								
Adapted cultivars		22.07	16.08	3.60	16.08	57.83	1.93	20.08
Cereal/legume								

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Barley/Pea		22.07	16.08	28.49	23.32	89.96	2.07	15.25
Horsford/Trapper	soft do.	22.07	16.08	28.49	28.58	95.22	1.79	15.02
Oat/Pea		22.07	16.08	29.80	27.57	95.52	1.86	15.63
Dumont/Trapper	soft do.	22.07	16.08	29.80	30.73	98.68	1.72	16.58
Dumont/Indianhead	soft do.	22.07	16.08	29.80	31.09	99.04	1.71	19.57
Whitestone/Trapper		22.07	16.08	29.80	28.09	96.04	1.83	14.66
Paul/Trapper		22.07	16.08	29.80	23.85	91.80	2.06	16.51
Triticale/Pea		22.07	16.08	30.05	30.55	98.75	1.73	15.05
Warm Season Annual								
Millet, foxtail		22.07	16.08	3.75	27.74	69.64	1.35	28.19
Sorghum/Sudan		22.07	23.80	9.18	28.83	83.88	1.56	35.10
Corn, 75-99 day								
Corn silage		22.07	35.73	9.18		66.98	0.78	----

Table 6. Forage dry matter biomass and crude protein yield (lb/ac) and costs ($/cwt) for crested wheatgrass hay cut at two growth stages.

	Costs/acre								
Growth Stage	Land Rent	Custom Work	Baling Costs	Production Costs $/ac	Dry Matter Biomass Yield lb/ac	Forage Biomass Costs $/cwt	Crude Protein %	Crude Protein Yield lb/ac	Crude Protein Costs $/cwt
Crested Wheatgrass									
Mature	14.22	5.31	8.58	28.11	1600	1.74	6.4	102	27.56
Bootstage	14.22	5.31	6.97	26.50	1300	2.04	14.5	189	14.02

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[Back to 2001 Annual Report Index] [Back to Grassland Reports]

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