EB-71

Feeding Barley to Sheep

Greg Lardy

Department of Animal and Range Sciences

NDSU Extension Service

North Dakota State University, Fargo, North Dakota

Reviewed March 2010

Introduction

Barley is an energy-rich feed grain grown in the temperate climates of North America and Europe. Sheep operations in these areas, as well as others throughout the world, rely on barley as a source of energy and protein in lamb and ewe diets. This report is intended to review the recent scientific literature related to the use of barley in sheep diets and to give recommendations for its successful use in sheep diets.

Table 1. **Nutrient content of various feed grains** (NRC, 1985; NRC, 1996).

	Barley	Corn	Wheat	Oats	Sorghum
TDN, %	86	87	87	77	86
NE_m, Mcal/kg	2.12	2.15	2.15	1.85	2.12
NE_g, Mcal/kg	1.45	1.48	1.48	1.22	1.45
CP, %	13.5	10.1	16.0	13.3	11.5
UIP, % of CP	27	55	23	17	57
NDF, %	18.1	10.8	11.8	29.3	16.1
ADF, %	5.8	3.3	4.2	14.0	6.4

Energy and Protein Content of Feed Barley

The nutrient content of barley (Table 1) compares favorably with that of corn, oats, wheat, and milo as reported by the National Research Council (NRC, 1996). Barley is used primarily as an energy and protein source in sheep diets. The energy content (TDN, NE_m, NE_g) for barley is slightly lower than the energy value for corn. The lower energy content of barley may be partially attributed to its higher fiber content (NDF, ADF).

The starch in barley ferments rapidly compared to other cereal grains (Figure 1). Grains with more rapid rates of starch digestion require a higher degree of management in high concentrate finishing rations since the occurrence of acidosis and related metabolic disorders is greater with grains that ferment more quickly (Stock and Britton, 1993).

The crude protein content of barley is higher than that of corn and similar to other major feed grains. Protein degradability of barley is similar to other small grains at approximately 20 to 30% undegraded intake protein (UIP). Corn and sorghum have higher UIP values than barley (Table 1).

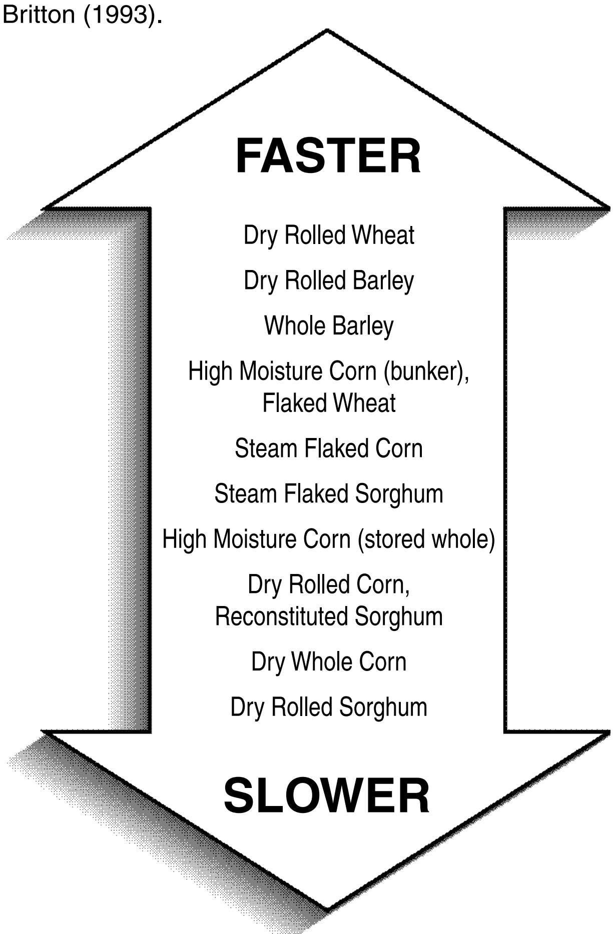
Table 2. **Mineral and vitamin content of major cereal grains** (NRC, 1996).

	Barley	Corn	Wheat	Oats	Sorghum
Calcium, %	0.05	0.03	0.05	0.01	0.04
Phosphorus, %	0.35	0.32	0.44	0.41	0.34
Potassium, %	0.57	0.44	0.40	0.51	0.44
Magnesium, %	0.12	0.12	0.13	0.16	0.17
Sodium, %	0.01	0.01	0.01	0.02	0.01
Sulfur, %	0.15	0.11	0.14	0.21	0.14
Copper, ppm	5.3	2.51	6.48	8.6	4.7
Iron, ppm	59.5	54.5	45.1	94.1	80.8
Manganese, ppm	18.3	7.89	36.6	40.3	15.4
Selenium (ppm)	–	0.14	0.05	0.24	0.46
Zinc (ppm)	13.0	24.2	38.1	40.8	0.99
Cobalt (ppm)	0.35	–	–	0.06	–
Molybdenum (ppm)	1.16	0.60	0.12	1.70	–
Vitamin A (1,000 IU/kg)	3.8	1.0	0.0	0.2	0.05
Vitamin E (1,000 IU/kg)	26.2	25.0	14.4	15.0	12.0

Mineral and Vitamin Content of Feed Barley

Table 2 lists the mineral and vitamin content of feed barley (NRC, 1996). All cereal grains are low in calcium and relatively high in phosphorus, necessitating the use of supplemental calcium in high-grain diets for lambs, especially males. Barley's phosphorus content is similar to corn and sorghum but lower than wheat or oats. Barley is higher in potassium than other feed grains. Barley is higher in vitamin A and Vitamin E than the other major cereal grains.

Figure 1. **Grain sources categorized by rate of ruminal starch digestion.** Adapted from Stock and Britton (1993).



Effect of Barley Processing in Sheep Diets

A companion document to this report, Feeding Barley to Beef Cattle (Lardy and Bauer, 1999), documents the advantages of processing barley for use in beef cattle diets. However, it does not appear that sheep respond to barley processing in the same manner as cattle, perhaps because sheep chew their feedstuffs to a greater degree.

Research at several locations indicates little or no benefit to processing (steam rolling, grinding, pelleting, or dry rolling) when compared to feeding barley whole in forage or concentrate diets for sheep. Table 3 summarizes research trials related to barley processing and the effects on lamb performance.

Research conducted at Washington State University indicated that there was no advantage to steam rolling barley (compared to feeding barley whole) in diets which contained 25 to 50% barley (Morgan et al., 1991). In diets which contained 75 to 85% barley, Hatfield et al. (1993) found that the starch in whole barley had 98% digestibility.

Small increases in diet organic matter digestibility were noted when either .66 or 1.32 lbs of processed barley (rolled or ground) were offered to gestating ewes consuming a forage diet compared to feeding whole barley (Chestnutt, 1992). The author also noted that approximately 20% of the whole barley fed in

Table 3. **Summary of research related to barley processing for sheep fed high grain diets.**

		Processing Method			
Trial	Variable	Whole	Ground	Rolled	Pelleted
Tait and Bryant, 1973	ADG (lb/day)	.64	–	.55	.48
	F/G	3.85	–	4.43	3.98
Erickson et al., 1988a	ADG (lb/day)	.50	.48	–	–
	F/G	5.6	6.26	–	–
Erickson et al., 1989	ADG (lb/day)	.53	.52	–	–
	F/G	6.61	6.61	–	–
Erickson et al., 1987b 40 lb/bushel	ADG (lb/day)	–	.67	–	.86
	F/G	–	5.70	–	5.37
Erickson et al., 1987b 49 lb/bushel	ADG (lb/day)	–	.70	–	.86
	F/G	–	5.63	–	5.32
Hatfield, 1994	ADG (lb/day)	.40	–	–	.37
	F/G	7.53	–	–	7.76

these diets passed through the digestive tract. The authors did not indicate if the barley was intact hulls or viable seed.

Yoon et al. (1986a) found only small differences in the feeding value of whole, rolled, or steam rolled barley when comparing those grains to cracked corn in high concentrate diets (forage to concentrate ratio 23 to 77). Data from that trial indicated that steam rolling barley may increase the efficiency of microbial protein synthesis but had little, if any, effect on other parameters measured. Yoon et al. (1986b) noted that both dry rolled and steam rolled barley had greater ruminal bacterial protein synthesis than whole barley or cracked corn diets. This may be significant in diets where metabolizable protein supply is limiting. It may occur in rapidly growing lambs or with ewes that have high milk production.

Research conducted at the Hettinger Research Extension Center in North Dakota indicates no advantage in lamb performance from feeding ground vs. whole barley (Erickson et al., 1989a). Average daily gain, feed efficiency, and feed intake were not different for the whole barley vs. ground barley treatments. Carcass characteristics were similar for both treatments as well.

Earlier research conducted at the Hettinger Research Extension Center investigated feeding corn or barley in whole or ground forms to finishing lambs (Erickson et al., 1988a). The results of this research showed no significant differences between lamb performance on whole or ground barley diets. Lambs fed whole barley had significantly better feed conversions compared to whole corn. However, lambs fed ground corn had significantly higher average daily gains compared to lambs fed whole corn.

Lambs fed pelleted barley diets gained faster, consumed more feed, and had similar feed efficiencies than lambs fed ground barley diets (Erickson et al., 1987b). Research conducted in Canada (Tait and Bryant, 1973) found that lambs fed whole barley (.64 lb/day) gained faster than lambs fed rolled or pelleted barley (.55 and .48 lb/day, respectively). No differences were noted in feed intakes or feed conversions.

Hatfield (1994) noted no differences in lamb performance when whole or pelleted barley diets were fed. Cost of gain was lower with whole barley diets since no processing cost was necessary in those diets.

Based on these data, it appears that extensive processing of barley is not necessary for optimum utilization in sheep diets.

Use of Barley in Growing and Finishing Lamb Diets

Barley vs. Other Grain Sources in Finishing Diets

A summary of lamb performance (average daily gain and feed efficiency) from several trials in which barley was compared to other cereal grains appears in Table 4.

Barley and soybean meal were used to replace hull-less or naked oats (var. Paul) in diets for finishing lambs. Lambs fed combinations of barley and soybean meal had greater average daily gains, higher final weights, and greater feed intakes than lambs fed increasing levels of hull-less oats ($P < .01$). Feed efficiencies were similar (Poland and Faller, 1997).

Additional research conducted at North Dakota State University compared barley and milo as energy sources in finishing diets for lambs (Erickson et al., 1990a). No differences in average daily gain or feed efficiency were noted. Carcass weights and dressing percentages were higher in lambs fed milo compared to barley. In contrast to research conducted with beef cattle which shows benefits to including mixtures of rapidly and slowly fermenting grains (Bock et al., 1991; Kreikemeier et al., 1987; Stock et al., 1987), no benefits were noted with combinations of barley and milo in diets for finishing lambs.

In another comparison involving milo and barley, feed efficiencies were similar but average daily gains tended to by higher ($P = .053$; Erickson et al., 1990b) for lambs fed milo. Final weights and carcass back fat were higher for lambs fed milo.

Lambs fed ground barley had similar gains compared to lambs fed ground corn and higher gains than lambs fed ground oats (Erickson et al., 1985). Feed efficiencies were similar for all three grains, but feed intakes were lower for barley compared to corn.

Additional trials which compare barley to other feed grains have had mixed results. Barley fed lambs had similar feed efficiencies but consumed less dry matter and gained more slowly than corn fed lambs (Erickson et al., 1988b). Lambs fed barley consumed less feed, had similar feed efficiencies, but gained more slowly than milo fed lambs (Erickson et al., 1989a). Lambs fed barley had lower average daily gains, similar feed intakes, and poorer feed conversions compared to corn fed lambs in additional North Dakota research (Rupprecht et al., 1992). Lambs fed pelleted barley (49.8 lb/bu) had similar gains compared to pelleted or ground corn (56 lb/bu; Erickson et al., 1987b).

Research conducted in Canada compared the energy value of barley and wheat (Tait and Bryant, 1973). No differences were noted in lamb average daily gain, feed intake, and feed conversions. Lamb average daily gains averaged .55 lb/day in this trial.

Hatfield (1994) noted no differences in lamb performance when comparing barley and corn in lamb finishing diets. Cost of gain was lower for barley based diets.

Barley appears to be an effective substitute for corn or other cereal grains in lamb finishing diets. In many cases, barley may be used to lower the cost of gain compared to corn due to the price differential which exists in some markets.

Ionophores in Barley Based Finishing Diets

Ionophores are compounds which improve feed efficiency in ruminants by interfering with ion transport

Table 4. Comparison of barley to other cereal grains as an energy source in diets for finishing lambs.

		Grain Source				
Trial	Variable	Barley	Corn	Oats	Milo	Hull-less Oats
Erickson et al., 1984	ADG (lb/day)	.54	–	.54	–	–
	F/G	7.04	–	7.47	–	–
Erickson et al., 1985	ADG (lb/day)	.66	.72	.49	–	–
	F/G	4.53	5.01	5.30	–	–
Erickson et al., 1988a	ADG (lb/day)	.50	.49	–	–	–
Whole Grains	F/G	5.60	6.71	–	–	–
Erickson et al., 1988a	ADG (lb/day)	.48	.54	–	–	–
Ground Grains	F/G	6.26	6.43	–	–	
–						
Erickson et al., 1988b;	ADG (lb/day)	.76	.84	–	–	–
With DDG[1]	F/G	4.78	4.96	–	–	–
Erickson et al., 1988b;	ADG (lb/day)	.75	.90	–	–	–
With SBM[2]	F/G	4.67	4.44	–	–	–
Erickson et al., 1989a;	ADG (lb/day)	.53	–	–	.57	–
Whole Grains	F/G	6.61	–	–	6.68	–
Erickson et al., 1989a;	ADG (lb/day)	.52	–	–	.55	–
Ground Grains	F/G	6.61	–	–	7.32	–
Erickson et al., 1989b;	ADG (lb/day)	.87	–	–	1.04	–
With DDG[1]	F/G	3.98	–	–	4.03	–
Erickson et al., 1989b;	ADG (lb/day)	.88	–	–	1.00	–
With SBM[2]	F/G	3.79	–	–	3.85	–
Erickson et al., 1990a	ADG (lb/day)	.59	–	–	.60	–
	F/G	7.11	–	–	6.97	–
Erickson et al., 1990b	ADG (lb/day)	.802	–	–	.950	–
	F/G	5.53	–	–	4.97	–
Rupprecht et al., 1992;	ADG (lb/day)	.82	.91	–	–	–
With Lasalocid	F/G	4.29	3.76	–	–	–
Rupprecht et al., 1992;	ADG (lb/day)	.76	.93	–	–	–
W/O Lasalocid	F/G	4.41	3.69	–	–	–
Hatfield, 1994	ADG (lb/day)	.40	.37	–	–	–
Whole Grains	F/G	7.53	7.85	–	–	–
Hatfield, 1994	ADG (lb/day)	.37	.40	–	–	–
Pelleted Diets	F/G	7.76	8.10	–	–	–
Poland and Faller, 1997	ADG (lb/day)	.63	–	–	–	.49
	F/G	6.80	–	–	–	6.64

[1]DDG=Dried Distillers Grains
[2]SBM=Soybean Meal

in certain bacterial species. Ionophores change bacterial populations and provide benefits as a coccidiostat. As expected, the addition of lasalocid (Bovatec®) to barley based lamb finishing diets improved feed efficiency with no changes in average daily gain or daily feed intake (Rupprecht et al., 1992).

Combinations of Barley with Other Energy Sources in Finishing Diets

The addition of 20% beet pulp to either barley or milo based finishing diets for lambs tended to improve average daily gain and feed efficiencies in the barley diets but had the opposite effect in the milo diets (Erickson et al., 1990b). No differences were noted in carcass characteristics.

The addition of 15% beet pulp to barley-based lamb finishing diets improved average daily gains in finishing lambs (Erickson et al., 1991b). Additional increases in the level of beet pulp did not improve performance further. Since barley starch is rapidly fermented, the addition of beet pulp or other highly digestible fiber sources may alleviate subacute acidosis and improve feed conversions.

Average daily gains, feed intakes, and feed efficiencies were similar for lambs fed combinations of barley and oats (100% barley; 67% barley/33% oats; 33% barley/67% oats; and 100% oats; Erickson et al., 1984). There was a numerical tendency for feed efficiencies to improve and feed intakes to drop as barley level in the diet increased.

Effect of Light Test-Weight Barley on Lamb Performance

Average daily gains were similar when light barley (39.8 lb/bu) was compared to heavy barley (49.6 lb/bu; Erickson et al., 1987a). However, feed intake and feed efficiencies were numerically better for the heavy test weight barley.

Forage Levels in Barley-Based Lamb Finishing Diets

Research conducted at the Hettinger Research Center indicates little difference in average daily gains when alfalfa level in barley based finishing diets is increased from five to 45% (Erickson et al., 1993). Feed intakes increased and feed efficiencies decreased as alfalfa level increased. Similar results were also reported with earlier work (Erickson et al., 1991a). Choice of forage level in barley-based lamb finishing diets should be based on the price of feedstuffs and the feeder's ability to manage high concentrate diets.

Using Barley as a Supplemental Energy Source in Ewe Diets

Diets for gestating and lactating ewes are largely forage based in most areas of the world. Depending on the stage of production (gestation vs. lactation) and the nutrient composition of the forage, supplementation is necessary to reach adequate performance. Barley can be used effectively as a source of supplemental energy in ewe diets.

Research conducted at Montana State University compared barley, soybean meal, barley plus blood meal, barley plus feather meal, or control (no supplement) as supplements for gestating ewes grazing dormant native range (Thomas et al., 1992). Non-supplemented ewes lost more weight than ewes fed supplements, ewes fed barley alone had intermediate weight gains, and ewes fed soybean meal, barley plus feather meal, or barley plus blood meal had the highest weight gains. No differences were noted in subsequent reproductive performance, indicating that the economic advantage lies with the low cost supplementation program. Dormant native forages are generally limiting in rumen degradable protein, not energy, which likely explains the differences noted in this research. The supplements which contained barley and rendered byproducts contained 75 to 77% barley, with the remainder being rendered byproducts, minerals, and vitamins.

Similar research, also conducted at Montana State University, compared control (no supplementation), barley, barley/feather meal/blood meal, or barley/feather meal/blood meal/urea (Hatfield et al., 1997). Control ewes lost the most weight, barley supplemented ewes were intermediate, and the ewes fed barley plus rendered byproducts gained a small amount of weight. Ewes receiving no supplement lost the most body condition, while the barley/feather meal/blood meal ewes lost the least condition. The barley and barley/feather meal/blood meal/urea treatments were intermediate in condition score loss. No differences were noted in fleece weight.

Effects of Vomitoxin (DON) Contaminated Barley on Performance of Sheep

Vomitoxin (DON, deoxynivalenol) is a trichothecene mycotoxin produced by Fusarium fungi in scab infected grain. While vomitoxin can cause problems in performance when feeding swine, no evidence exists that sheep are adversely affected.

Research conducted at North Dakota State University suggested that diets containing up to 25 ppm vomitoxin (DON) throughout pregnancy have no effect on weight gain in pregnant ewe lambs, reproductive performance of the ewe lambs, or survivability of the lamb crop (Haugen et al., 1996).

Conclusions

Barley is a useful feedstuff for sheep. It does not require processing when used in sheep diets. Barley contains higher crude protein levels than corn. Consequently, when used as a supplement, lower levels of supplemental protein are required. This should be taken into account when pricing barley.

Vomitoxin does not appear to have any adverse effects on ruminants, including sheep. Vomitoxin level should not be used to discount the value of barley in ruminant diets.

Barley has an energy value similar to corn in high grain lamb finishing rations. Since little or no processing is required and the need for supplemental protein is reduced, barley often results in lower cost of gains when compared with corn.

Literature Cited

Bock, B.J., R.T. Brandt, D.L. Harmon, S.J. Anderson, J.K. Elliot, and T.B. Avery. 1991. Mixtures of wheat and high-moisture corn in finishing diets: feedlot performance and in situ rate of starch digestion in steers. J. Anim. Sci. 69:2703-2710.

Chestnutt, D.M.B. 1992. Effect of processing barley and wheat grain on the digestion of silage-based diets by breeding ewes. Anim. Prod. 54:47-52.

Erickson, D.O., M.R. Light, T.C. Faller, and L. Insley. 1984. Barley, oats and barley/oats combinations for feeder lambs. Proc. 25th Annual Western Dakota Sheep Day. pp. 6-8.

Erickson, D.O., T.C. Faller, and W.D. Slanger. 1985. Comparison of cereal grains for feedlot lambs. Proc. 26th Annual Western Dakota Sheep Day. pp. 24-31.

Erickson, D.O., T.C. Faller, K.A. Ringwall, J.T. Schmidt, W.D. Slanger, M.J. Marchello, and P.T. Berg. 1987a. Barley (light and heavy) compared to corn for feeder lambs. Proc. 28th Annual Western Dakota Sheep Day. pp. 1-6.

Erickson, D.O., B.L. Moore, J.T. Schmidt, and M. Hankel. 1987b. Barley and corn (light and heavy) fed in ground or pelleted form to lambs. Proc. 28th Annual Western Dakota Sheep Day. pp. 7-14.

Erickson, D.O., T.C. Faller, K.A. Ringwall, W.D. Slanger, and P.T. Berg. 1988a. Comparisons of lambs fed barley or corn diets fed in whole or ground form. Proc. 29th Annual Western Dakota Sheep Day. pp. 17-22.

Erickson, D.O., T. Faller, M.J. Marchello, P.T. Berg, J.T. Schmidt, W.D. Slanger, and B.L. Moore. 1988b. Performance and carcass characteristics of lambs fed corn or barley supplemented with soybean meal or distillers dried grains. Proc. 29th Annual Western Dakota Sheep Day. pp. 23-29.

Erickson, D.O., T.C. Faller, K.A. Ringwall, and P.T. Berg. 1989a. Barley or milo fed in whole or ground forms for finishing lambs. Proc. 30th Annual Western Dakota Sheep Day. pp. 1-4.

Erickson, D.O., B.L. Moore, P.T. Berg, and M. Swantek. 1989b. Distillers dried grains compared to soybean meal in barley or milo diets for finishing lambs. Proc. 30th Annual Western Dakota Sheep Day. pp. 6-11.

Erickson, D.O, T.C. Faller, K.A. Ringwall, P.T. Berg, and S. Uriyapongson. 1990a. Finishing lambs with barley or milo or combinations of barley and milo. Proc. 31st Annual Western Dakota Sheep Day. pp. 1-4.

Erickson, D.O., B.L. Moore, P.T. Berg, and S. Uriyapongson. 1990b. Barley and milo with and without beet pulp to lambs. Proc. 31st Annual Western Dakota Sheep Day. pp. 5-9.

Erickson, D.O., T.C. Faller, K.A. Ringwall, P.T. Berg, and S. Uriyapongson. 1991a. Barley fed with varying levels of alfalfa to lambs. Proc. 32nd Annual Western Dakota Sheep Day. pp. 1-4.

Erickson, D.O., B.L. Moore, W. Limesand, P.T. Berg, and S. Uriyapongson. 1991b. Levels of beet pulp fed with barley to early weaned lambs. Proc. 32nd Annual Western Dakota Sheep Day. pp. 5-9.

Erickson, D.O., T.C. Faller, K.A. Ringwall, P.T. Berg, and S. Uriyapongson. 1993. Alfalfa levels in barley based diets for lambs. Proc. 34th Annual Western Dakota Sheep Day. pp. 17-21.

Hatfield, P.G. 1994. Evaluating methods of feeding, type of grain, and form of feed on post-weaning performance and carcass characteristics of wether lambs. Vet. Clin. Nutr. Vol. 1. Number 1.

Hatfield, P.G., V.M. Thomas, and R.W. Kott. 1997. Influence of energy or protein supplementation during midpregnancy on lamb production of ewes grazing winter range. Sheep & Goat Res. J. 13:150-156.

Hatfield, P.G. M.K. Peterson, C.K. Clark, H.A. Glimp, K.J. Hemenway, and W.S. Ramsey. 1993. Effect of barley variety and restricted versus ad libitum intake on rate, site, and extent of digestion by wethers fed a high energy diet. J. Anim. Sci. 71:1390-1392.

Haugen, R.G., T.C. Faller, E.W. Boland, H.H. Casper, and D.V. Dhuyvetter. 1996. The effects of vomitoxin (DON) from scab infested barley on reproductive performance when fed to ewe lambs. Proc. 37th Annual Western Dakota Sheep Day. pp.9-12.

Kreikemeier, R.A. Stock, D.R. Brink, and R.A. Britton. 1987. Feeding combinations of dry corn and wheat to finishing lambs and cattle. J. Anim. Sci. 65:1647-1654.

Lardy, G.P. and M.L. Bauer. 1999. Feeding barley to beef cattle. EB-70. NDSU Extension Service.

Morgan, E.K., M.L. Gibson, M.L. Nelson, and J.R. Males. 1991.Utilization of whole or steamrolled barley fed with forages to wethers and cattle. Anim. Feed Sci. Tech. 33:59-78.

NRC. 1985. Nutrient requirements of sheep (Sixth Ed.). National Academy Press, Washington, D.C.

NRC. 1996. Nutrient requirements of beef cattle (Seventh Ed.). National Academy Press, Washington, D.C.

Poland, W.W. and T.C. Faller. 1997. Whole Paul oat as a feedstuff for sheep. Proc. 38th Annual Western Dakota Sheep Day. pp.1-4.

Rupprecht, D.S., B.L. Moore, and D.O. Erickson. 1992. Effects of lasalocid in barley or corn diets for lambs. Proc. 33rd Annual Western North Dakota Sheep Day. pp. 5-9.

Stock, R.A., D.R. Brink, B.A. Britton, F.K. Goedeken, M.H. Sindt, K.K. Kreikemeier, M.L. Bauer, and K.K. Smith. 1987. Feeding combinations of high moisture corn and dry rolled grain sorghum to finishing steers. J. Anim. Sci. 65:290-302.

Stock, R.A. and B.A. Britton. 1993. Acidosis in feedlot cattle. In: Scientific update on Rumensin/Tylan for the professional feedlot consultant. Elanco Animal Health, Indianapolis, IN. p. B1.

Tait, R.M. and R.G. Bryant. 1973. Influence of energy source and physical form of all-concentrate rations on early weaned lambs. Can. J. Anim. Sci. 53:89-94.

Thomas, V.M., K.J. Soder, R.W. Kott, and C.M Schuldt. 1992. Influence of energy or protein supplementation on the production of pregnant ewes grazing winter range. Proc. West. Sec. Amer. Soc. Anim. Sci. 43:374-376.

Yoon Chil-Surk, Nam-Hyung Lee, and Keun-Ki Jung. 1986a. The effect of corn or barley plus urea and soybean meal on microbial protein production in the rumen of sheep. Korean J. of Anim. Sci. 28:588-596.

Yoon Chil-Surk, Nam-Hyung Lee, and Keun-Ki Jung. 1986a. Quantitative studies of amino acid flow in digestive tract of sheep fed corn and barley diets plus urea and soybean meal. Korean J. Anim. Sci. 28:597-606.

Funding support provided in part by North Dakota Barley Council

Cover barley photo: North Dakota Barley Council
Cover sheep photo: Roger Haugen

The NDSU Extension Service does not endorse commercial products or companies even though reference may be made to tradenames, trademarks or service names.This publication may be copied for noncommercial, educational purposes in its entirety with no changes. Requests to use any portion of the document (including text, graphics or photos) should be sent to NDSU.permission@ndsu.edu. Include exactly what is requested for use and how it will be used.

For more information on this and other topics, see: www.ag.ndsu.edu

County commissions, North Dakota State University and U.S. Department of Agriculture cooperating. North Dakota State University does not discriminate on the basis of race, color, national origin, religion, sex, gender identity, disability, age, status as a U.S. veteran, sexual orientation, marital status, or public assistance status. Direct inquiries to the Vice President for Equity, Diversity and Global Outreach, 205 Old Main, (701) 231-7708. This publication will be made available in alternative formats for people with disabilities upon request, (701) 231-7881.

1M-12-99