Adding Value and Marketability to North Dakota Feeds and Co-products

V.L. Anderson[1], K. Koch[2], T. Dodd[3], W. Sandberg[4]
[1]NDSU Carrington Research Extension Center, [2]Northern Crops Institute,
[3]Dakota Growers Pasta Company, [4]AgLand Marketing

Summary
North Dakota grain processors produce several different co-products and market them as livestock feed. Each co-product has some physical and nutritional shortfalls that could be improved by combining ingredients and manufacturing a pelleted feed that has superior physical and nutritional characteristics. By developing formulations with different combinations of co-products and grains with complimentary nutritional profiles, compound feeds may be made available in the market place for specific end uses. Proper formulation, manufacturing, and use of "Superfeed" co-product combinations will potentially increase animal performance, shipping and handling characteristics, shelf life, safety, palatability, ease of use, and economic returns for livestock producers in the state, region, continent and possibly for export. This project explored several formulations and commercially manufactured two for use in livestock feeding trials. The positive outcome lends credence to the potential for manufacturing and marketing compound "Superfeeds" from selected manufacturing sites in North Dakota.

Introduction
Feeds with attractive attributes such as palatability, long shelf life, balanced protein for ruminants (appropriate amounts of rumen degradable and undegradable protein), nutrient density (maximum nutrition in minimum volume of product), price point, transportability, and flexible usage are in demand world wide. Most of the feeds developed in this program will be targeted at ruminants (dairy, beef, sheep, goat, bison etc.) with some potential for swine and poultry markets. The geographic areas for marketing these new feed include North Dakota, the Northern Plains Region, and the North American Continent with potential for export to the Pacific Rim.

Many of the feeds considered for these formulations have been studied individually and a good understanding of their uses and shortfalls is known. There are several publications from NDSU that review the storage and use of wheat midds, barley and barley malt, peas and pea chips, corn gluten feed, distillers grains and many other feeds. There is no research on combining these feeds, although there may be some proprietary experience by private feed companies in combining and mixing these products together.

Project Activities:
The trial was coordinated from the Carrington Research Extension Center. Specific tasks included:

- Formulation of multiple compound feeds with wheat midds, distillers grains and peas
- Secure and transport feed ingredients to Northern Crops Institute, Fargo.
- Manufacture pellets of respective formulations monitoring processing parameters
- Test pellet durability of compound feeds
- Analyze the compound feeds for nutrient content
- Select two of the formulations for feeding to feedlot cattle at the Carrington Center and manufacture them at a commercial feed facility
- Feed the two formulations to steers as part of a balanced diet during the winter
- Record feed intake, gain, and calculate feed efficiency
- Record carcass data at slaughter and summarize
- Assess market potential for formulated test products or other products

Materials and Methods

Pelleting Trials

Seven different co-product formulations (Table 1) were developed for testing pelleting manufacturing. The formulations were made with wheat midds, dry distillers grains, and field peas. The planning and formulation of compound feeds was done at the Carrington Center with separate ingredients transported to the Northern Crops Institute, Fargo, ND. The feeds were mixed according to formulations in 500 pound batches and pelleted in a small-scale, commercial California Pellet Mill and cooled and binned as in a commercial facility. Power requirements, production rate, pellet durability, and bulk density were measured. Nutrient analysis was conducted at a commercial laboratory and is reported in Table 2.

Table 1.Equipment and settings for manufacturing compound feeds with North Dakota co-products.

Pelleting equipment:
Pellet mill: CPM Hyflo, 50 hp (37.5 Kw) main drive motor
Die: 1/4" x 2 1/2" (6.4mm x 63.5mm), standard relief
Product: 1/4" (6.4 mm) pellet
The same feeder input setting was used in all feeds.

Base ingredients:
Durum wheat midds (29.6 kg/hl - 368 micron avg particle size)
DDG (51.3 kg/hl - 757 micron avg particle size)
Dry peas, ground (66.5 kg/hl, 536 micron avg. particle size)

Formulations and date run:
Feed #1 - 100% midds - Sep. 8, 2006
Feed #2 - 80% midds, 20% DDG - Oct. 12, 2006
Feed #3 - 70% midds, 30% DDG - Oct. 12, 2006
Feed #4 - 60% midds, 40% DDG - Oct. 12, 2006
Feed #5 - 50% midds, 50% DDG - Sep. 8, 2006
Feed #6 - 50% midds, 30% DDG, 20% peas - Sep. 12, 2006
Feed #7 - 60% midds, 20% DDG, 20% peas - Sep. 12, 2006

Table 2. Results of pellet manufacturing test for feeds.

	Feed #1	Feed #2	Feed #3	Feed #4	Feed #5	Feed #6	Feed #7
	100 Midds	80 Midds 20 DDG	70 Midds 30 DDG	60 Midds 40 DDG	50 Midds 50 DDG	50 Midds 30 DDG 20 Peas	60 Midds 20 DDG 20 Peas
Voltage	458.7	456.7	456	469	452.8	451.3	448.1
Amperage	24.2	28.8	28.5	28	32.7	34.5	33.9
Kw	17.3	21	20.6	20.7	24.4	25.2	24.5
Power Factor	0.9	0.92	0.92	0.92	0.93	0.92	0.92
Prod. Rate (MT/hr)	0.7	0.8	0.8	0.8	0.8	0.9	0.9
kwh/MT	23.8	26	23.9	25	27.5	27.3	26.9
Pellet Durability Index (%)	96.1	96.3	94.4	95	93.3	95.3	96.6
Pellet Bulk Density (kg/hl)	66.6	63.1	63.3	63.3	60	63.6	67.6
Conditioning Temp (°C)	57	72 – 75	68 - 70	68 - 70	53	48 – 50	48 – 50

Table 3. Nutrients in various midds-distillers grains-pea formulations.

Item	Feed #1 100 Midds	Feed #2 80 Midds 20 DDG	Feed #3 70 Midds 30 DDG	Feed #4 60 Midds 40 DDG	Feed #5 50 Midds 50 DDG	Feed #6 50 Midds 30 DDG 20 Peas	Feed #7 60 Midds 20 DDG 20 Peas
Dry Matter, %	90.11	89.2	91.1	90.29	90.74	90.3	90.56
Crude Protein, %	18.7	18.97	20.3	22.02	23.65	21.54	20.74
Acid Det Fiber, %	12	15.07	15.57	16.19	16.6	13.38	13.64
NEm, Mcal/lb	0.89	0.8	0.8	0.79	0.79	0.78	0.82
NEg, Mcal/lb	0.59	0.52	0.52	0.51	0.51	0.53	0.53
Fat, %	4.6	6.38	7.28	8.02	9	6.66	5.5
Calcium, %	0.09	0.12	0.12	0.13	0.12	0.11	0.14
Phosphorus, %	0.92	0.78	0.79	0.77	0.78	0.69	0.69

Feeding Study

Initial full weight of 49 head of steers averaged 799 pounds. Five tons of each of the two products selected for use were manufactured at G & R Grain and Feed in New Rockford, ND. During the first 62-day feeding period, steers were fed the pelleted compound feed that was formulated with 50% midds – 50% DDG (24.33% crude protein, 55 Mcal NEg) in the corn-based diet (Table 3). During the second feeding period, steers were fed the co-product formulation containing 50% midds – 25% DDG, and 25% field pea (23.65% crude protein, 54 Mcal NEg). The percent of field peas was increased in pellets fed compared to the original formulations to increase carcass merit. The two pelleted compound feeds were used in succession as part of balanced corn-based finishing diets (Table 3). The two test feeds made up approximately 28% and 30% of the diet dry matter, respectively, for period 1 and 2 (Table 3). The feeding study was initiated on December 12, 2006, with feed #1 and steers were transitioned to feed #2 on February 12, 2007, with slaughter occurring on April 9, 2007. The diets were balanced to meet or exceed the nutrient requirements for beef feedlot cattle using commercial ration balancing software. Rumen-degradable protein requirements were met by the diets while rumen-undegradable protein exceeded requirements in both diets. The totally-mixed diets were fed to appetite in a fenceline bunks. Feed intake was recorded daily and calves were weighed individually at the start of the trial, when they were transitioned to the different feed product from period 1 to period 2 and just prior to slaughter. Carcass data was collected from steers when they were slaughtered at Barton Meats in Carrington, ND (8 head) and Tyson Fresh Meats (41 head). Feed marketing assessment was done in conjunction with the Dakota Growers Pasta Company. Wayne Sandberg, AgLand Marketing, provided input for marketing potential.

Table 4. Rations fed containing compound co-product feeds.

Diet formulation	Period 1	Period 2
	-- Percent (DM Basis)--	
Dry-rolled corn grain	56.09	55.79
50-50 Midds-DistGr #1	27.61	
50-25-25 Midds-DistGr-Peas #2		30.03
Corn silage	8.88	6.63
Chopped straw	5.15	5.76
Supplement (Ionophore,min, vit)	2.27	1.79
Total	**100**	**100**

Results

Pellet Manufacturing

The base ingredients were durum wheat midds (368 micron average particle size, 29.6 kg/hl, {23 lb/bu} density), DDGS (757 micron average particle size and 51.3 kg/hl, {39.8 lb/bu} density), and ground peas (536 micron average particle size and 66.5 kg/hl, {51.7 lb/bu} density). Durum wheat midds were pelleted to establish baselines for comparisons. DDGS at 20,30,40 and 50% were blended with durum wheat midds and made into pellets. Ground peas were blended at 20% inclusion with either 50% durum wheat midds and 30% DDGS, or 60% durum wheat midds and 20% DDGS. Unpublished data from Kansas State University indicates peas have binding properties that improve pellet quality at up to 20% of the formulation. All the pellets were manufactured using a California Pellet Mill Hyflo model. This is a smaller scale 50 hp (37.5 kW) commercial machine with a direct-drive vertical ring-die and two compression rollers. Die holes were ¼ inch (6.35 mm) with an effective length of 2½ inches (63.5 mm), providing a performance ratio of 10:1 (length/diameter). Die peripheral speed was maintained at 1,200 ft/min (366 m/min) for all the test runs. Prior to pelleting, the feed mix was metered at the same constant rate for each trial, into a longitudinal conditioner equipped with multiple steam ports and a single shaft with adjustable paddles. A speed of 150 rpm with 30 sec. retention time was used in each of the test runs. Conditioning temperatures were adjusted by varying steam addition for optimal operation in each test run. Production parameters were monitored and kWh/mt was calculated for each test run. Final pellet density and Pellet Durability Index (PDI) were also determined.

Blending DDGS with durum wheat midds from 0 to 50% (Table 4) resulted in increased energy use and decreased pellet durability and density. At 50% inclusion DDGS added $.11/mt to production costs, compared to 100% durum wheat midds. Blending 20% ground peas with either 30% DDGS and 50% durum wheat midds, or 20% DDGS and 60% durum wheat midds increased energy use about the same as the 50-50 blend of DDGS and durum wheat midds when compared to 100% durum wheat midds, adding $.09 to $.11/mt to production costs. The 60-20-20 blend had increased pellet durability and density, while the 50-30-20 blend had slightly decreased pellet durability and density compared to durum wheat midds. Both had improved pellet durability and density when compared to the 50-50 blend of DDGS and durum wheat midds.

Table 5. Predicted vs. Actual steer performance.

Steer performance	Period 1	Period 2
Mid-period average wt, lbs.	922	1128
Dry matter intake		
Predicted	19.49	22.71
Actual	21.53	24.31
Daily Gain		
Predicted (Energy)	3.20	3.21
Predicted (Protein)	3.72	4.36
Actual	3.95	2.97
Feed Efficiency (DM per lb. gain)		
Predicted	6.09	7.08
Actual	5.44	8.10

DDGS or ground peas by themselves are difficult to pellet. Blending DDGS with durum wheat midds, or blending ground peas and DDGS with durum wheat midds allowed for increased nutrient density when compared to durum wheat midds alone. The blended and pelleted products provided similar pellet durability and density compared to durum wheat midds, but at an increased cost of production. The question that remains unanswered is, does the value gained through increased nutrient density offset the increased cost of production?

Feeding Study

Commercial feedlot ration software predicted dry matter intake at 19.49 pounds daily using a mid-weight of 922 pounds during period 1. At the predicted intake level, steers were projected to gain 3.20 pounds daily based on energy in the diet and 3.72 based on protein content in the diet. The crude protein in this ration was 13.8% with requirements from NRC established at 12.4%. During the first feeding period, steers actually consumed 21.52 pounds of dry matter and gained 3.95 pounds per day for a conversion of 5.44 pounds of dry matter per pound of live weight gain.

Average mid-weight for steers during the second feeding period was 1128 pounds. The co-product pellet formulation used during this time was 50% midds, 25% DDG, and 25% dry peas. Besides the pellet binding properties, peas were included in the diet during this period to enhance juiciness and tenderness (as proven in other research studies, Anderson et al., 2006) and to increase the rumen degradable protein. A series of inclement weather fronts moved through the region with snow and rain as precipitation creating less than ideal feeding conditions which resulted in wet and cold weather, and muddy pen conditions with significantly reduced gains. Intake was predicted at 22.71 pounds of dry matter for 1128-pound steers during this period. Gains of 3.21 pounds per day were predicted based on the energy content in the diet and 4.36 pounds based on protein. The protein content of this ration was 13.2% and energy was calculated at 63 Mcal NEg per pound. Calves actually consumed 24.31 pounds of dry matter per day, an indication of higher maintenance requirements. Calves gained 2.99 pounds per day during this time frame for an average of 8.10 pounds of dry matter per pound of live weight gain. The significant reduction in gain in spite of the greater intake predicted indicates the significant amount of energy required for maintenance in cold, wet cattle. Over the entire two periods of testing compound feeds, steers averaged 3.50 pounds of gain per day on 22.85 pounds of dry matter for a conversion of 6.56 pounds of dry matter per pound of gain. For British crossbred steer calves fed to finish weight during the fall through late winter season, these numbers are better than typical feedyards in North Dakota experience.

Table 6. Carcass traits for steers fed compound co-product feeds.

Live Wt., lbs.	1200	
Dressing Percent	63.6	
Marbling score[a]	442	(400- 450 = low choice)
Percent Choice	74	
Yield Grade[b]	3.31	
Fat Thickness, in	0.53	
Ribeye area, sq in	12.44	
KPH[c], %	2.46	

[a] Measure of intermuscular fat distribution throughout the ribeye area

[b] Yield Grade is determined based on red meat vs. fat in the carcass, range is 1-5, higher scores = higher fat to lean ratio discounts incurred for scores of 4 and 5

[c] Internal fat measured as a percent of the carcass and referred to as the kidney knob or kidney-pelvic-heart fat

Forty-one head of steers were marketed at Tyson Fresh Meats, Dakota City, NE, and eight head were marketed at Barton Meats, Inc. Carrington, ND. Steers were marketed when it was estimated by visual appraisal that 60% or more would grade USDA Choice. Carcass traits were measured and reported in Table 5. Steers from the CREC herd have traditionally graded at approximately 65% Choice on different rations during several other years of feeding trials. The results in this feeding study indicate excellent qualitative criteria for steers marketed at just over one year of age. Seventy-four percent (74%) of the steers in this feeding trial graded USDA Choice or better.

When cattle are sold on a grid, certain criteria warrant added value and some criteria create discounts. When steers grade USDA Choice vs. USDA Select at the same yield grade and weight criteria, Choice steers were worth $9 to $11 per cwt more during the time these steers were marketed. The increased percentage of Choice carcasses over other years amounts to approximately $19.06 per head. The national average for percent of Choice carcasses at this time of year was 53-55%. The difference between the national average and the steers fed in this demonstration trial is an advantage of $38.11 per head based on carcass grade. No taste panel data was collected on these cattle. If steers can be marketed at a young age, in this case less than 13 months, there is some additional assurance of tenderness. Previous research has supported the improved tenderness and juiciness in ribeye steaks with as little as 10% peas in the diet for 75 days prior to slaughter.

While the protocol of this study did not provide for any side-by-side comparative research on the co-product feed formulation, the experience of feeding these two products was very positive and the carcasses graded very well. There is a need to conduct research that is well designed and provides statistical confidence with larger numbers of animals using different formulations with commercial potential for marketing. The Carrington Center is interested in exploring more formulations in feedlot or cow/calf enterprises. Additional research may include different formulations with barley malt, oilseed meals, beet pulp, soyhulls, and other co-products. Commercialization of various formulations may require consumer experiences for validation and acceptance.

The future commercial development of new compound co-product feed formulations will depend on:

- Identifying markets for respective compound feed product
- Value of compound pelleted feed products relative to use of individual ingredients
- Logistics and cost of shipping ingredients to manufacturing location(s)
- Cost of processing, packaging, and shipment to end user
- Time from purchase agreement to delivery
- Ability to formulate to meet special needs

Support for this project was provided by in-kind contributions of wheat midds from Dakota Growers Pasta Company, Carrington, ND, and by a grant from the North Dakota Agricultural Products Utilization Commission.