Optimum Level of Wheat-Based Dried Distillers Grains for Feedlot Cattle
Interim Report # 2
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Rational:

The western Canadian ethanol industry is undergoing rapid expansion. Husky Oil has recently opened a 130 million liter plant in Lloydminister, Sk. and has plans to expand to a similar size its plant in Minnedosa, Mb. It is well known that profitability of ethanol production is tied not only to production cost and market value of ethanol but also to the value obtained from byproduct sales (i.e. carbon dioxide, feed byproducts). Feed byproducts include wet and dried distiller's grains with or without solubles. The economic sustainability of incorporating ethanol production with cattle and the feeding of wet byproducts is well documented (i.e. Pound-Maker Agventures, Ltd., Lanigan, Sk). However, the size of the Husky Oil ethanol plants plus their competitive advantage with respect to drying costs, dictates that the majority of the distillers grains will be marketed as dried distillers grains with solubles.

There has been extensive research on the feeding value of distiller's byproducts for livestock, with the majority applying to corn byproducts. This research has shown that dried distillers grains is an excellent protein supplement for dairy cows in early lactation and has been sold into this market at a premium. Feeding dried distiller's grain to beef cattle while nutritionally attractive, has not been economically justifiable to this point.

The competitiveness of dried distiller's grains in beef cattle rations is expected to change however, with the continued growth of the North American ethanol industry. In order to market this product at maximum value, new markets will need to be targeted. In western Canada, home to over 4 million beef cows and the 4th largest cattle feeding area in North America, it is logical to target beef cattle feeding enterprises as a potential market for this product. However, little research has been conducted with feeding dried distillers grains to growing and finishing beef cattle, particularly with wheat-based products. Research

with wet distillers byproducts at the University of Saskatchewan (wheat-based) and Nebraska (corn-based) have demonstrated superior performance in cattle fed these byproducts relative to conventional fed cattle. Similar work is required to document the performance of cattle fed wheat-based dried distillers grains. Such work should focus on relative inclusion levels in both backgrounding and finishing diets, impacts on performance and cost of gain as well as on carcass quality.

There is also potential for new domestic and international markets for wheat-based dried distiller's grains. At the University of Saskatchewan, we have a cooperative project with partners in western Canada and Japan to develop a value-added barley-based protein pellet that can be exported to Japan. The non-GMO status of wheat-based dried distillers grains would make it a very attractive protein supplement for this pellet if performance and cost of gain of cattle fed rations based on barley and wheat-based dried distiller's grains rations is equal or superior to that of conventional fed cattle.

The objectives of this trial are to evaluate the feedlot performance of growing and finishing cattle fed incremental levels of wheat-based dried distiller's grains with solubles (DDGS). Performance measures to be evaluated include daily gain, feed efficiency, ultrasound backfat and ribeye area accretion, carcass traits including yield and marbling score and weight.

A. Backgrounding Phase (Winter 2005/06):

Two hundred 200 recently weaned calves (290 kg) were purchased by the Department of Animal & Poultry Science, University of Saskatchewan and fed at the Beef Cattle Research Station. The vaccination and receiving protocol used by the University of Saskatchewan under the direction of the Western College of Veterinary Medicine was used to immunize the cattle against disease. The cattle were randomly assigned to one of 20 pens (10 head per pen). The pens were then randomly assigned to one of 5 backgrounding treatments (4 pens per treatment).

a. Treatment 1: Control (no DDGS);
b. Treatment 2: 5% DDGS;
c. Treatment 3: 10% DDGS;
d. Treatment 4: 15% DDGS;
e. Treatment 5: 20% DDGS.

The control diet consisted of 50% barley silage, 10% grass hay, 10% barley straw, 25% barley grain and 5% protein / mineral supplement (as fed basis). In treatments 2 through 5, DDGS replaced barley gain at 5, 10, 15 and 20% (as fed), respectively. On a dry matter basis, DDGS comprised 8.1, 16.2, 24.2 and 32.1% of the ration for treatments 2 through 5, respectively. All diets were formulated to a net energy of maintenance (NEm) and gain (NEg) content of 1.52 and 0.93 Mcal / kg of diet DM, respectively, based on the assumption that the energy value of DDGS is equal to that of dry rolled barley. The control diet was formulated to contain a minimum of 12% CP (28% rumen undegradable protein (RUP)) for the backgrounding phase (NRC 1996). Treatments 2 through 4 had

formulated CP and RUP levels of 12.8 & 33.7%; 14.84 & 39%; 16.9 & 42.5%; and 18.9 & 45.4%, respectively. Calcium to phosphorus ratios were formulated to range from 1.5:1 to 2:1. All other mineral, vitamin and rumensin levels were formulated to be equal across treatments. Cattle were implanted upon arrival with an estrogen-based implant. The backgrounding phase was designed to target a daily gain of 2.2 to 2.6 lb per day and lasted for 85 days. During this period the cattle were weighed every 2 weeks and were ultrasounded for carcass backfat and ribeye development monthly. Feed samples were taken weekly and have been frozen for future analysis. This phase of the trial lasted from December 14, 2005 through March 9, 2006.

B. Finishing

Following completion of the backgrounding phase, the cattle were maintained on their original treatments and subsequently moved via a step-up program on to a finishing program. The control diet consisted of 15% barley silage, 80% barley grain and 5% mineral vitamin supplement. It was formulated to 13% crude protein and 1.91 and 1.27 Mcal of NEm and NEg, respectively. As in the backgrounding period, treatments 2 through 5 were formulated to the same energy level as the control with DDGS replacing barley grain at 5, 10, 15 and 20% of the diet (as fed basis). On a dry matter basis, DDGS comprised 5.8, 11.7, 17.5 and 23.3% of the ration for treatments 2 through 5, respectively. Estimated RUDP levels varied from 27 to 40% in diets 1 and 5, respectively. Mineral, vitamin and rumensin levels were maintained as in the backgrounding phase.

The target of the finishing phase is to have the cattle gain as fast as possible targeting a slaughter weight (preshrunk) of 1375 lbs.

Performance data collected included animal weights every 2 weeks, daily pen feed intake values, feed efficiency (feed:gain ratios) and ultrasound fat and ribeye area development. All cattle were slaughtered at a commercial packing plant (XL Beef, Moose Jaw. Sk.). Liver abscesses scores were taken at slaughter. Carcass data was collected by Canadian Beef Grading Agency and included: carcass weight, ribeye area, fat thickness and marbling score.

Animal heath data included sickness rate (morbidity) and death loss (mortality). Any animals that died were autopsied by veterinarians of the Western College of Veterinary Medicine.

In addition to the data collected above an overall analysis of performance including both phases was carried out and will encompass an economic comparison between the various treatments.

Preliminary Results:

A. Backgrounding Period:

Cattle fed the control diet gained 2.7 lbs per day during the backgrounding phase. This rate of gain falls within expectations based on formulated energy levels (NRC 1996). Feed dry matter intake was 16.8 lbs per day and feed efficiency (kg feed / kg gain) was 6.35:1 during this period. Cattle fed 5% DDGS had the poorest grains (2.4 lb / day) as well as the lowest intakes (16.0 lbs / day) of all cattle. Cattle fed 10, 15 and 20% DDGS had similar or numerically higher gains than the control cattle (2.6, 2.8 and 2.8 lbs / day respectively). Respective dry matter intakes (kg /day) and feed efficiency (kg feed DM per kg gain) values were 17.0 & 6.64; 17.6 & 6.33; and 17.5 & 6.20 for treatments 3, 4 and 5.

It is not clear why the cattle fed the 5% DDGS level had poorer performance during this period. These cattle consistently exhibited reduced gains from the beginning of backgrounding and it is likely that the poorer gains are associated with the reduced dry matter intakes of these cattle.

B. Finishing Phase:

Performance of all cattle was excellent during the finishing phase, particularly during the first 56 days. The superior performance during the early phase of finishing can in part be attributed to the fact that the cattle had been re-implanted with a TBA implant at the start of the finishing phase. During the first 56 days of finishing, cattle fed increasing levels of DDGS showed a linear increase (P=0.06) in daily gain as inclusion level increased. During this period, dry matter intakes were highest for cattle fed DDGS at the 15 and 20% levels. During the first 56 days of finishing, cattle fed the 5% DDGS level exhibited the most efficient gains. It appears that these cattle were compensating for their reduced performance during backgrounding.

The cattle were on finishing rations for approximately 115 days with cattle fed the 20% DDGS having the lowest days on the finishing program (111vs. 115 or 120 days). This difference however, was not significant (P=0.16). Over the entire finishing period, daily gains of all cattle averaged 4.1 lbs. per day with an average feed conversion efficiency of 6.0:1. Again no statistical differences were noted in the animal's performance over this period (Table 2).

Table 3 shows the performance of the cattle over the entire trial combing both the growing and the finishing periods. During the 200 day feeding period cattle averaged 3.5 (range 3.35 to 3.57) lbs. per day with an average feed conversion efficiency of 6.2:1 (range 6.13 to 6.37). It should be noted that the control rations for both the backgrounding and finishing periods were formulated to meet crude protein needs for the type of cattle fed and expected performance. These results show that the cattle did not respond to the extra crude protein or bypass protein supplied in the rations as DDGS inclusion level increased. The one exception to this may be during the first 56 days of

finishing where a linear increase (P=0.06) in daily gain was noted as DDGS inclusion level increased.

The failure to note a response to supplemental crude protein is not surprising as the cattle fed the control rations were not deficient in this nutrient. What is noteworthy is the fact that as wheat-based DDGS replaced barley in the diets that performance in terms of daily gain, feed dry matter intake and feed conversion efficiencies did not decrease. This indicates that the wheat-based DDGS used in this study has at least the energy density of barley grain which typically ranges from 2.00 to 2.06 Mcal per kg DM of NEm and 1.34 to 1.40 Mcal per kg DM NEg.

C. Carcass Quality:

Cattle were slaughtered when they had reached designated weight of 625 kg. Hot carcass weight averaged 800 lbs with no differences across treatments. This is to be expected as the cattle were targeted for slaughter at a consistent live weight. All measures related to yield grade including fat thickness and ribeye area were similar across treatments, as a result carcass lean yield was not affected by treatment (averaged 61%). Similarly there was no influence of treatment on marbling score or the incidence of dark cutters (Canada B4 grade). While no influence of treatment was found, it is important to note that contrary to some reports with corn distillers' grain, no negative effects of replacing barley grain with wheat-based DDGS were noted on carcass quality.

Conclusions:

It appears from the results presented to date that DDGS can be fed in backgrounding programs at levels of 10 to 20 % as fed (16 to 32 % of the diet dry matter) replacing equal amounts of barley grain with no adverse effects on gain, intake or on fat and ribeye development. When wheat-based DDGS were included in backgrounding rations at 5% of the ration (8% dry matter basis) both gain and feed intake were somewhat depressed. Further work should examine it this is a consistent response to cattle fed DDGS at this level.

Finishing performance of all cattle was excellent. No adverse effects of feeding DDGS at levels up to 23% of the diet dry matter during finishing were detected, in fact through day 56, gains tended (P=0.06) to increase in a linear fashion as DDGS inclusion level increased. These results indicate that for finishing cattle wheat-based DDGS has a net energy of gain value equal to or slightly superior to that of barley grain. No adverse effects of feeding wheat-based DDGS were detected on health of the cattle or on carcass quality.

In summary, the results of this trial show that wheat-based DDGS is an excellent feed for growing and finishing cattle. No adverse effects on overall performance, health or carcass quality were seen when DDGS was included at levels up to 32 and 23 % of diet dry matter in growing and finishing rations, respectively. There was a slight reduction in gain of cattle fed the 5% DDGS-based ration during the backgrounding phase but this effect

did not extend into the finishing period. The results of this study indicate that the energy value of this product is at least equal to that of barley grain for finishing cattle.

When feeding DDGS to growing and finishing cattle, producers should evaluate the impact on the nutrient content of the total mixed diet particularly crude protein and mineral levels such as phosphorus and sulfur. Overfeeding DDGS can elevate protein and phosphorus levels in the diet and ultimately in the manure of cattle. In order to avoid potential environmental problems when this manure is spread, producers should consult a nutritionist to assist them in optimizing DDGS inclusion rates in the diets of their cattle.

Table 1. Effect of wheat-based dried distillers' grains with solubles (DDGS) on performance of weaned calves during an 85 day backgrounding program.

	Level of DDGS, % As Fed**					SE	P Value
	0	5	10	15	20		
Weight (lb)							
Start of Test	640.9	640.3	638.3	639.8	640.4	0.57	NA
End of Backgrounding	866.6ab	844.8c	855.7bc	875.8a	880.5a	6.63	0.01
Average Daily Gain (lb)	2.7ab	2.4c	2.6bc	2.8ab	2.8a	0.08	0.01
Dry matter intake (lb)	16.8a	16.0b	17.0a	17.6a	17.5a	0.30	0.01
Feed efficiency (ADG:DMI)	0.16ab	0.15b	0.15b	0.16ab	0.16a	0.003	0.05
Feed conversion (DMI:ADG)	6.35	6.66	6.64	6.33	6.20	-	-
Backfat, (mm)							
Start of Test	1.80	1.98	1.48	1.85	1.60	0.22	0.51
End of Backgrounding	2.93	2.63	2.45	3.18	2.68	0.24	0.27
Avg daily gain (mm/d)	0.013	0.008	0.012	0.016	0.013	0.003	0.39
Ribeye area, (inches^2)							
Start of Test	8.87	9.15	8.88	8.78	9.05	0.12	0.20
End of Backgrounding	10.90	10.70	11.04	10.85	10.79	0.16	0.62
Avg daily gain (*inches*^{2}/d)	0.024	0.018	0.025	0.024	0.020	0.002	0.07

******Means in the same row with different letters at significantly different.

Table 2. Effect of wheat-based dried distillers' grains with solubles (DDGS) on finishing performance of weaned calves*.

	Level of DDGS, % As Fed**					SE	P Value
	0	5	10	15	20		
Weight (lb)							
Start of Finishing	866.6ab	844.8c	855.7bc	875.8a	880.5a	6.63	0.01
Day 56 of Finishing	1149.4bc	1133.5c	1135.4c	1167.4ab	1177.7a	8.5	0.01
End of Test	1341.7	1336.5	1325.4	1350.2	1338.8	6.19	0.13
*Average Daily Gain (lb***)**							
Day 1 to 56 of Finishing	5.05	5.16	5.00	5.21	5.31	0.08	0.06
Day 56 to End of Finishing	3.26	3.18	2.96	3.13	2.95	0.12	0.29
Day 1 to End of Finishing	4.13	4.10	3.91	4.14	4.14	0.09	0.34
Dry matter intake (lb)							
Day 1 to 56 of Finishing	21.8b	21.4b	21.8b	23.0a	22.8a	0.33	0.01
Day 56 to End of Finishing	25.9	25.8	25.3	26.0	25.6	0.53	0.93
Day 1 to End of Finishing	24.3	24.0	23.9	24.8	24.5	0.31	0.33
Feed efficiency (ADG:DMI)							
Day 1 to 56 of Finishing	0.232a	0.241b	0.229a	0.227a	0.233a	0.003	0.01
Day 56 to End of Finishing	0.126a	0.123ab	0.117bc	0.120abc	0.115c	0.003	0.05
Day 1 to End of Finishing	0.170	0.171	0.164	0.167	0.169	0.002	0.20
Feed conversion (DMI:ADG)							
Day 1 to 56 of Finishing	4.31	4.14	4.36	4.42	4.30	-	-
Day 56 to End of Finishing	7.95	8.12	8.56	8.31	8.67	-	-
Day 1 to End of Finishing	5.88	5.86	6.12	6.00	5.90	-	-

*Day 1 of finishing equates to day 85 of the overall feeding program.

**Means in the same row with different letters are significantly different.

Table 2 Effect of wheat-based dried distillers' grains with solubles (DDGS) on finishing performance of weaned calves* (Continued).

	Level of DDGS, % As Fed					SE	P Value
	0	5	10	15	20		
Days on Finishing Program	115.3	120.0	120.1	115.0	110.7	2.8	0.16
Backfat, (mm)							
Start of Finishing	2.93	2.63	2.45	3.18	2.68	0.24	0.27
End of Test	8.68	8.56	8.23	8.96	8.66	0.46	0.86
Avg daily gain (mm/d)	0.050	0.050	0.048	0.050	0.054	0.003	0.67
Ribeye area, (inches^2)							
Start of Finishing	10.90	10.70	11.04	10.85	10.79	0.16	0.62
End of Test	15.22	15.33	15.32	15.19	15.22	0.21	0.98
Avg daily gain *(inches^2/d)*	0.038	0.039	0.036	0.038	0.040	0.002	0.53

Table 3. Effect of wheat-based dried distillers' grains with solubles (DDGS) on overall performance of weaned calves.

	Level of DDGS, % As Fed					SE	P value
	0	5	10	15	20		
Weight (lb)							
Start of Test	640.9	640.3	638.3	639.8	640.4	0.57	
End of Test	1341.7	1336.5	1325.4	1350.3	1338.8	6.19	0.13
Average Daily Gain (lb)	3.50	3.40	3.35	3.56	3.57	0.07	0.11
Dry matter intake (lb)	21.6abc	21.1c	21.3bc	22.2a	21.9ab	0.25	0.05
Days on Feed	200.3	205.0	205.1	200.0	195.7	2.8	0.16
Feed efficiency (ADG:DMI)	0.162	0.162	0.157	0.160	0.163	0.002	0.35
Feed conversion (DMI:ADG)	6.17	6.19	6.37	6.23	6.13	-	-
Backfat, (mm)							
Start of Test	1.80	1.98	1.48	1.85	1.60	0.22	
End of Test	8.68	8.56	8.23	8.96	8.66	0.46	0.86
Avg daily gain (mm/d)	0.034	0.032	0.033	0.036	0.036	0.002	0.48
Ribeye area, (inches^2)							
Start of Test	8.87	9.15	8.88	8.78	9.05	0.12	0.20
End of Test	15.22	15.33	15.32	15.19	15.22	0.21	0.98
Avg daily gain *(inches^2/d)*	0.032	0.030	0.031	0.032	0.032	0.001	0.61

Table 4. Effect of wheat-based dried distillers' grains with solubles (DDGS) on carcass traits of weaned calves.

	Level of DDGS, % As Fed					SE	P Value
	0	5	10	15	20		
Weight (lb)							
Shipping Weight	1394.7	1392.3	1379.3	1404.7	1394.2	7.1	0.22
Shrunk Weight	1352.9	1350.6	1337.9	1362.5	1352.4	6.9	0.22
Carcass							
Hot Carcass Weight, (lb)	796.9	805.0	797.2	799.4	796.1	4.2	0.58
Dressing %	58.9	59.6	59.6	58.7	58.9	0.33	0.21
Average Backfat, (10^{th} of inch)	3.4	3.4	3.7	3.7	3.6	0.22	0.77
Grader Backfat, (10^{th} of inch)	3.0	2.9	3.1	3.2	2.9	0.25	0.92
Grader Ribeye area, (in^2)	15.4	15.8	15.4	15.4	15.3	0.3	0.81
Ruler Yield, %	61.1	61.2	61.5	61.0	61.4	0.55	0.96
Marbling Scores (% of cattle)							
AAA (Small or >)	18.0	22.5	27.5	27.5	10.0	7.3	0.47
AA (Slight)	71.8	75.0	67.5	70.0	87.5	8.2	0.52
A (Traces)	7.7	0.0	2.5	2.5	0.0	2.04	1.00
Dark Cutters	2.56	2.50	2.50	0.00	2.50	2.04	1.00
*Liver Scores**							
0, % of Cattle	71.0	76.5	83.3	58.1	65.4	9.69	0.43
1, % of Cattle	12.9	14.7	5.6	12.9	0.00	3.57	0.55
2, % of Cattle	12.9	5.9	5.6	12.9	19.2	6.21	0.55
3, % of Cattle	3.2	2.9	5.6	16.1	15.4	5.91	0.41

*Liver abscess scores: 0 = no abscesses; 3 = multiple severe abscesses. Note only 158 of 200 head were scored for livers due to mix-up at packing plant.