GEORGE MORRIS CENTRE

Status and Competitive Impacts of Ethanol Development on Canadian Livestock Industries

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1. Introduction

Attention on ethanol expansion and its impacts on feedgrain prices has been among the leading agricultural stories for 2006-07. This is particularly the case in the US. Many authors have documented the aggressive growth of US ethanol production, and illustrated this growth with data. Perhaps the most powerful indicator that ethanol production is likely to see significant growth in the US for years is that the US President has made repeated reference to it in State of the Union addresses.

Because the Canadian market exists in a free trade situation with the US, as it relates to ethanol, feedgrains, and livestock that consume feedgrains, US ethanol initiatives are an important influence on Canadian agricultural markets. This is particularly the case in Western Canada, where both livestock and feedgrain markets are heavily export-oriented. In addition, Canadian governments have legislated biofuel initiatives which have created ethanol production in Canada. In Western Canada, the impacts of ethanol development are more uncertain because ethanol is primarily made from wheat (rather than corn, which serves as the leading feedstock in most of North America) and because the byproduct distillers' dried grains (DDG) product has some different characteristics compared with DDG derived from corn. Finally, the impact on the costs of feeding livestock in Western Canada resulting from ethanol-driven feed grain prices is unknown.

The purpose of this paper is to provide some context and analysis of the state of ethanol production in Canada and the potential impact on livestock feeding through feedgrain price and DDGS supply effects. Section 2 below provides an overview of ethanol development in Canada, and feedgrain price trends in Western Canada in the period of Canadian and US ethanol expansion. Section 3 introduces the livestock feeding problem confronting western Canadian livestock industries, and develops an empirical model and specific research scenarios with which to measure the apparent impact of ethanol development on western Canadian livestock production. Section 4 places the results of the empirical analysis in context and concludes the paper.

2. Ethanol Development and Feedgrain Pricing in Western Canada

In Canada, fuel is a shared regulatory jurisdiction between the federal and provincial governments. Both levels of government have commitments to renewable fuels; these are summarized in Table 2.1. In addition to a federal biofuels target, three provinces have implemented legislation to mandate renewable fuel content in transportation fuels. Manitoba enacted the Biofuels Act[1] which requires 85% of gasoline sold in the province to have a 10% ethanol blend (Manitoba Government, 2006). In October 2005, Ontario legislated that all gasoline in the province will have an annual average of 5% ethanol content beginning January 2007 (Ontario Ministry of Environment, 2006). Saskatchewan's Ethanol Fuel Act and its regulations require a 7.5% ethanol blend as of January 15, 2007 (Saskatchewan Industry and Resources, 2007).

2.1 Ethanol Production

There are nine commercial ethanol plants in Canada with a total production capacity of 735 million litres per year. As shown in Table 2.2, plants currently planned and/or under construction are expected to just less than double the current capacity. Four of the currently operating Canadian plants use corn as a feedstock and are located in Ontario and Quebec while the remaining five plants produce ethanol using wheat and are located in Manitoba and Saskatchewan (Ethanol Producer Magazine, 2006). Provincial mandates for ethanol create a demand of approximately 1 billion litres (Sanford, 2006) there is therefore still expansion required of the Canadian industry if that demand is going to be met domestically.

2.2 Feedstock Pricing in Western Canada

Feed wheat is the primary feedstock for commercial ethanol production in Western Canada. However, the influence of ethanol development is also relevant on barley pricing because of the arbitrage effect between barley and US corn, and because barley is a latent feedstock for ethanol production.

Figure 2.1 below presents weekly elevator selling prices for feed wheat at Winnipeg, Saskatoon, and Calgary over the period 2000 to the third quarter of 2007. Over the period, feed wheat prices averaged around $Can 133/tonne and $Can 142/tonne, respectively. Some periods of clear deviation around this average are evident. First, severe droughts occurred in Western Canada during the 2001 and 2002 crop year, which resulted in sharply higher price levels. The second significant spike in feed wheat has occurred since the fall of 2006, with recent price quotes ranging over $Can 180/tonne.

[1] The Manitoba Biofuels Act will be proclaimed when there is sufficient ethanol production capacity in the province to meet the demand of a 10% blend.

Table 2.1 Canadian and Provincial biofuels programs and targets

	Target for biofuels volumes/market share	**Tax Reduction for Biofuels**	**Other Initiatives Grants etc**
CANADA (Federal)	• 5% renewable content in gasoline by 2010. • 2% renewable content in diesel by 2012 (intended)	Federal excise tax exemption of 10¢/L of ethanol blended with petrol and 4¢/L for biodiesel. These exemptions will be eliminated April 1, 2008. Federal tax incentives of 10¢/L for gas alternatives such as ethanol and 20¢/L for diesel alternatives such as biodiesel for a total of $1.5 billion over 7 years. The tax incentives will be reduced in three years	-Agricultural Bio-products Innovation Program (R&D) -Capital Formation Assistance Program (for plant construction) -$500 million over 7 years to go to Sustainable Development Technology Canada to aid private companies investing in large-scale 2nd-generation biofuel facilities.
Manitoba	Mandate for 10% ethanol blend and will take effect when local production meets demand i.e. when Husky Energy gets plant online summer/fall 2007.	Eight year sliding scale tax reduction for ethanol produced in the province once act and mandate is proclaimed; Yr1-2 = 20cent/litre Yr3-5 = 15 cent/litre Yr 6-8 = 10cent/litre	
Saskatchewan	7.5% ethanol in provincial gasoline supply mandate to take effect Jan 15th 2007. There is flexibility to blend at any ration under 10% (E10).	Distributors are eligible for a 15 cents/litre grant for ethanol produced and sold in Saskatchewan. This equals the provincial gasoline fuel tax.	
Ontario	Annual average of 5% ethanol in gasoline within the province as of January 1st 2007.	Prior to Jan 1st 2007 ethanol was except from gasoline tax however this has been reversed to fund the Ontario Ethanol Growth Fund	Ontario Ethanol Growth Fund which provides; • Capital assistance for ethanol plant construction • Operating assistance for ethanol plants • Time limited support for independent retailers who have previously sold blended gasoline & may experience loss of market share after Jan 2007. • A R&D fund to develop the industry

Sources: Federal and Provincial Governments

Table 2.2 Ethanol Plants in Canada, as of May 2007

Company	Location	Ownership Type	Feedstock	Annual Capacity (Million Litres)
GreenField Ethanol	Varennes, QC	Private, planning IPO	Corn	120
GreenField Ethanol	Chatham, ON	Private, planning IPO[2]	Corn	185
GreenField Ethanol	Tiverton, ON	Private, planning IPO	Corn	25
St. Clair Ethanol Plant	Sarnia,ON	Publicly traded	Corn	200
Husky Energy	Lloydminster, SK	Publicly traded	Wheat	130
Husky Energy	Minnedosa, MB	Publicly traded	Wheat	10
NorAmera BioEnergy Corp.	Weyburn, SK	Private	Wheat	25
Permolex	Red Deer, SK	Private	Wheat	28
Pound-Maker Agventures Ltd	Lanigan, SK	Private	Wheat	12
Total Capacity				**735**
Under Construction/ Planned				
Collingwood Ethanol LP	Collingwood, ON		Corn	54
GreenField Ethanol	Johnstown, ON	Private, planning IPO	Corn	200
GreenField Ethanol	Hensall, ON	Private, planning IPO	Corn	200
Husky Energy	Minnedosa, MB	Publicly traded	Wheat	130[1]
Terra Grain Fuels Inc.	Belle Plaine, SK		Wheat	150
Total Capacity				**734**

Notes: 1- Expansion of existing plant to reach 130 litres in total: 2- Sanford, 2006
Source: Ethanol Producer Magazine, 2007

Figure 2.1 Western Canadian Feed Wheat Prices, $Can/tonne

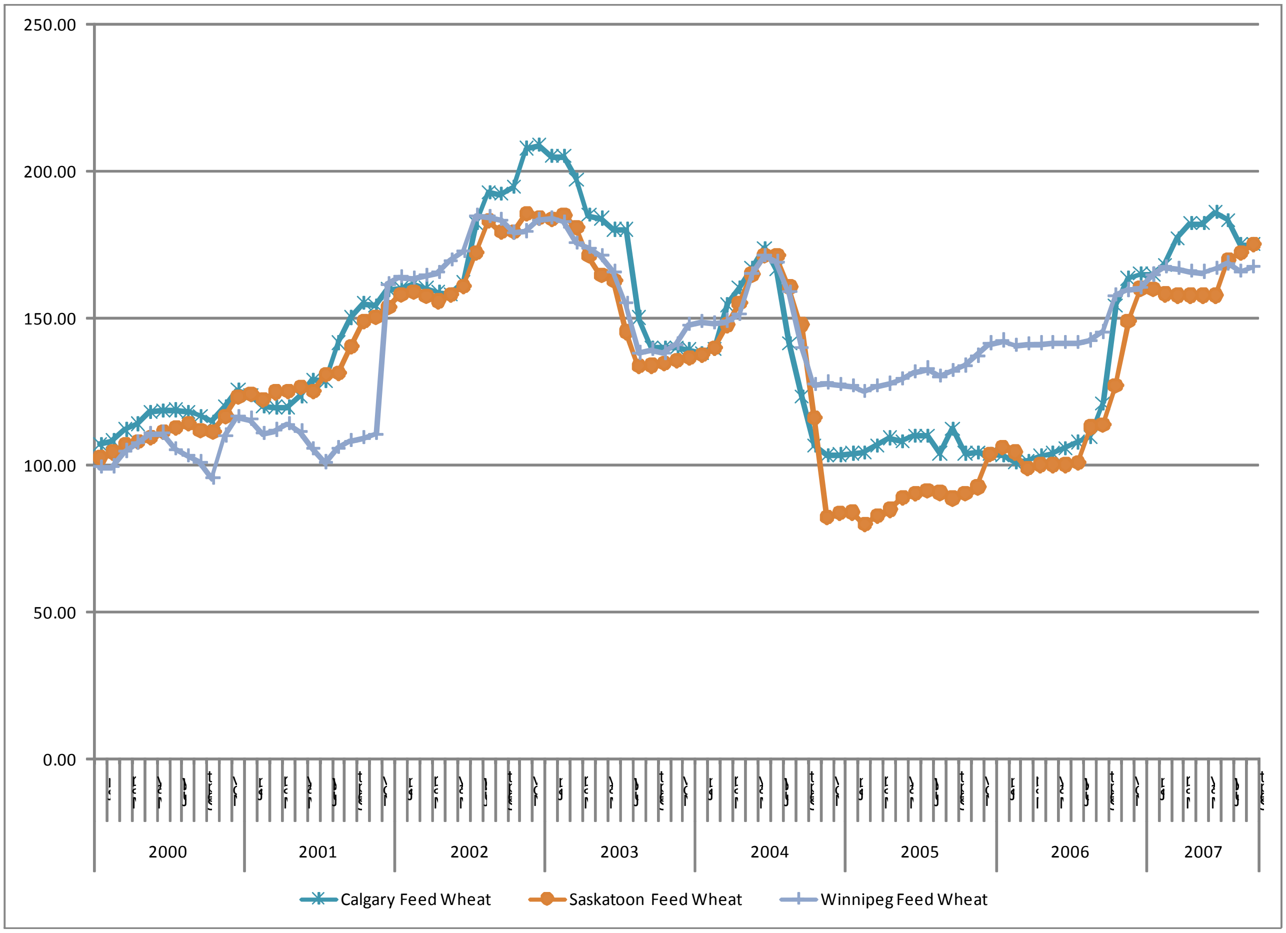


Figure 2.2 presents weekly elevator selling prices for feed barley at Winnipeg, Saskatoon and Calgary over the period 2000 to the third quarter of 2007. Over the period, feed barley prices at Winnipeg and Calgary averaged around $Can 120/tonne to $Can 137/tonne. Many of the same trends observed with feed wheat are also evident in barley. In the fall of 2001, through until the new crop of 2003, barley prices were sharply higher, peaking at almost $Can 200/tonne. In some areas in Western Canada barley processes have returned to this level.

2.3 Protein Feedstuff Pricing

The main protein feedstuffs used in livestock rations in Western Canada are soymeal, canolameal, and field peas. In Western Canada soymeal is imported from the Midwest US. Significant production of canolameal obtained from canola crushing occurs in Western Canada, which is a substitute for soymeal. However, canolameal is used at lower inclusion rates than soymeal, and the practice has generally been such that canolameal is not used to completely replace soymeal. Canolameal is priced directly in correlation with soymeal. Field peas are a feedstuff that provides a balance of energy and protein in a livestock diet, with energy values similar to feedgrains and a protein content of about 27%.

Figure 2.3 presents monthly data for the period 2000-2006 on soymeal prices at Minneapolis, Winnipeg, and Calgary, quoted in Canadian dollars per metric tonne. What is evident is essentially a freight cost relationship in pricing between the locations. In the figure, Minneapolis is the low price point, followed by Winnipeg and Calgary. Over the period, Winnipeg prices averaged about $Can 25/tonne over Minneapolis, and Calgary soymeal averaged $Can 48/tonne over Minneapolis.

Figure 2.4 presents monthly pricing for field peas, Saskatchewan basis. The figure shows that peas have ranged in price between $Can 120/tonne and about $200/tonne. Peas are currently trading just over the $Can 200/tonne level; this most recent spike is more consistent with feedgrain price trends noted in Figure 2.2 than it is with protein feedstuffs.

2.4 Byproduct Pricing in Western Canada

Relatively little information is available on ethanol by-product pricing in Western Canada. Corn-based DDG by-products are thought to be priced at a freight margin over the US Midwest. Monthly estimates of wheat-based distiller's grain by-product prices in Saskatchewan are presented in Figure 2.5 below. These are adapted from the price of canolameal at Vancouver, less $Can 30/tonne, as has been the practice according to industry sources. The figure shows that Saskatchewan wheat DDG prices have generally ranged between just over $Can 100/tonne and $Can 200/tonne, with a downtrend since 2004. Average price for wheat DDG were $Can 168/tonne compared and $Can 153/tonne for corn DDG.

Figure 2.2 Western Canadian Feed Barley Prices, $Can/tonne

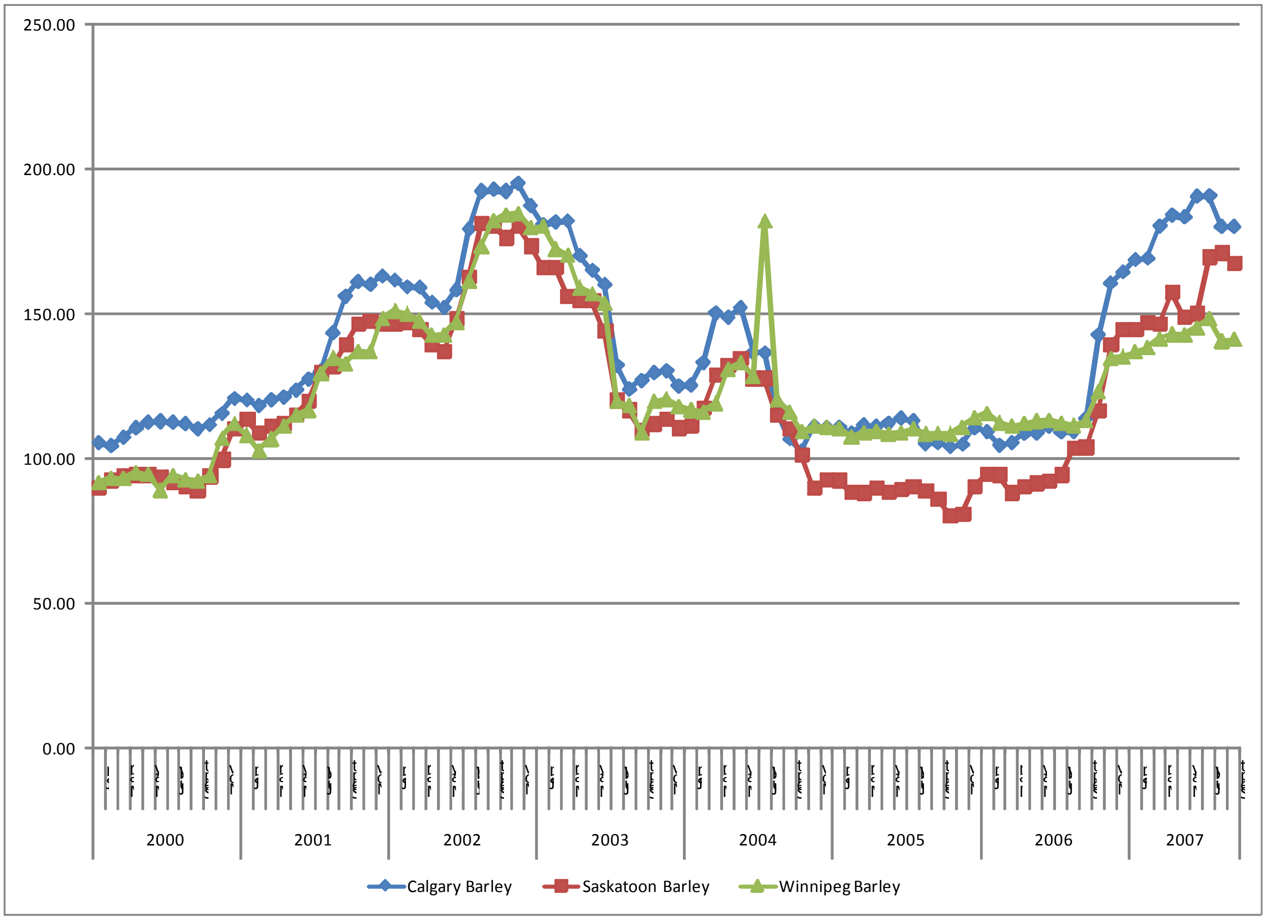


Figure 2.3 Soymeal Prices at Minneapolis, Winnipeg, and Calgary, $Can/tonne

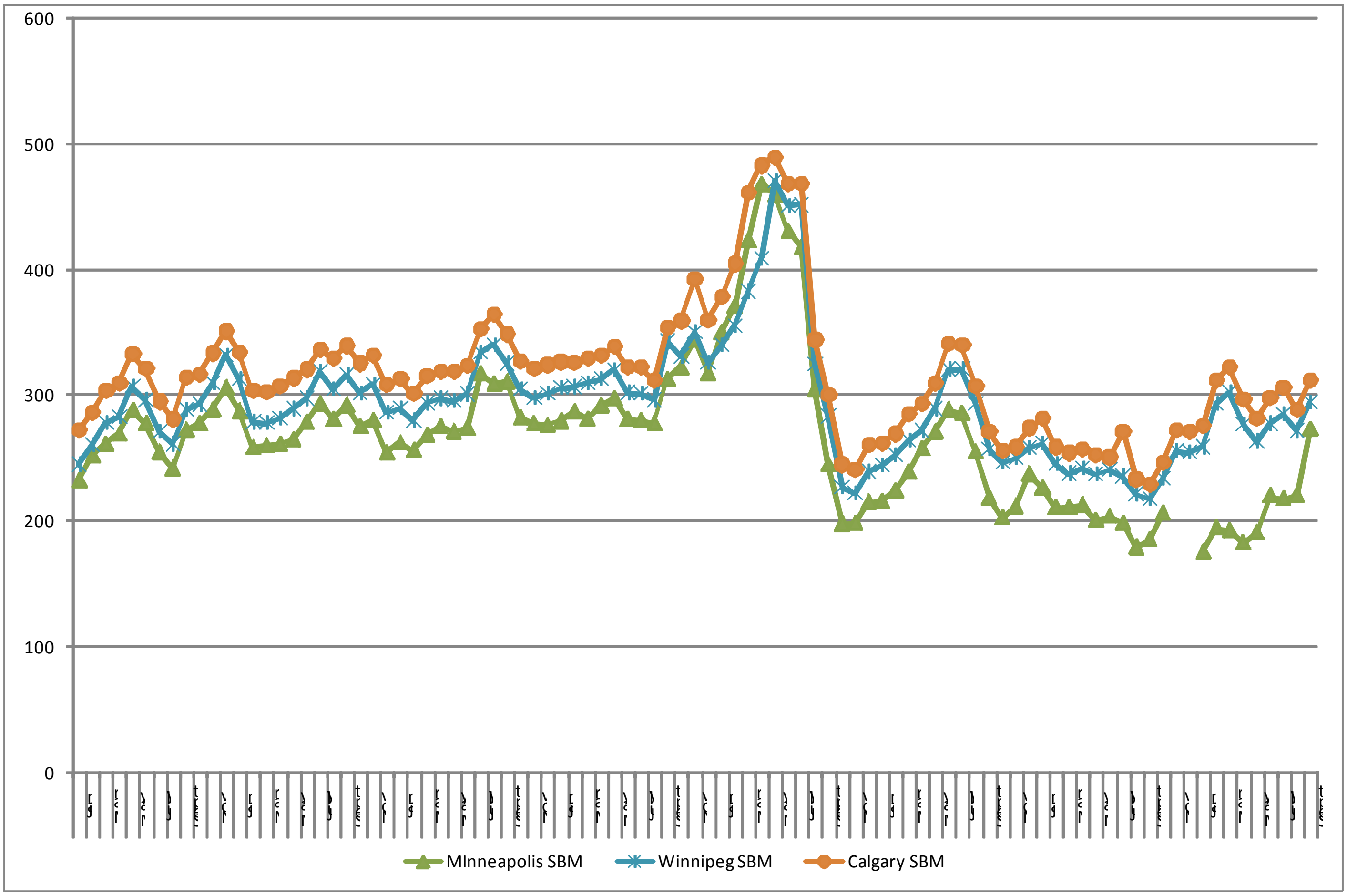


Figure 2.4 Field Pea Prices, Saskatchewan Basis, $Can/tonne

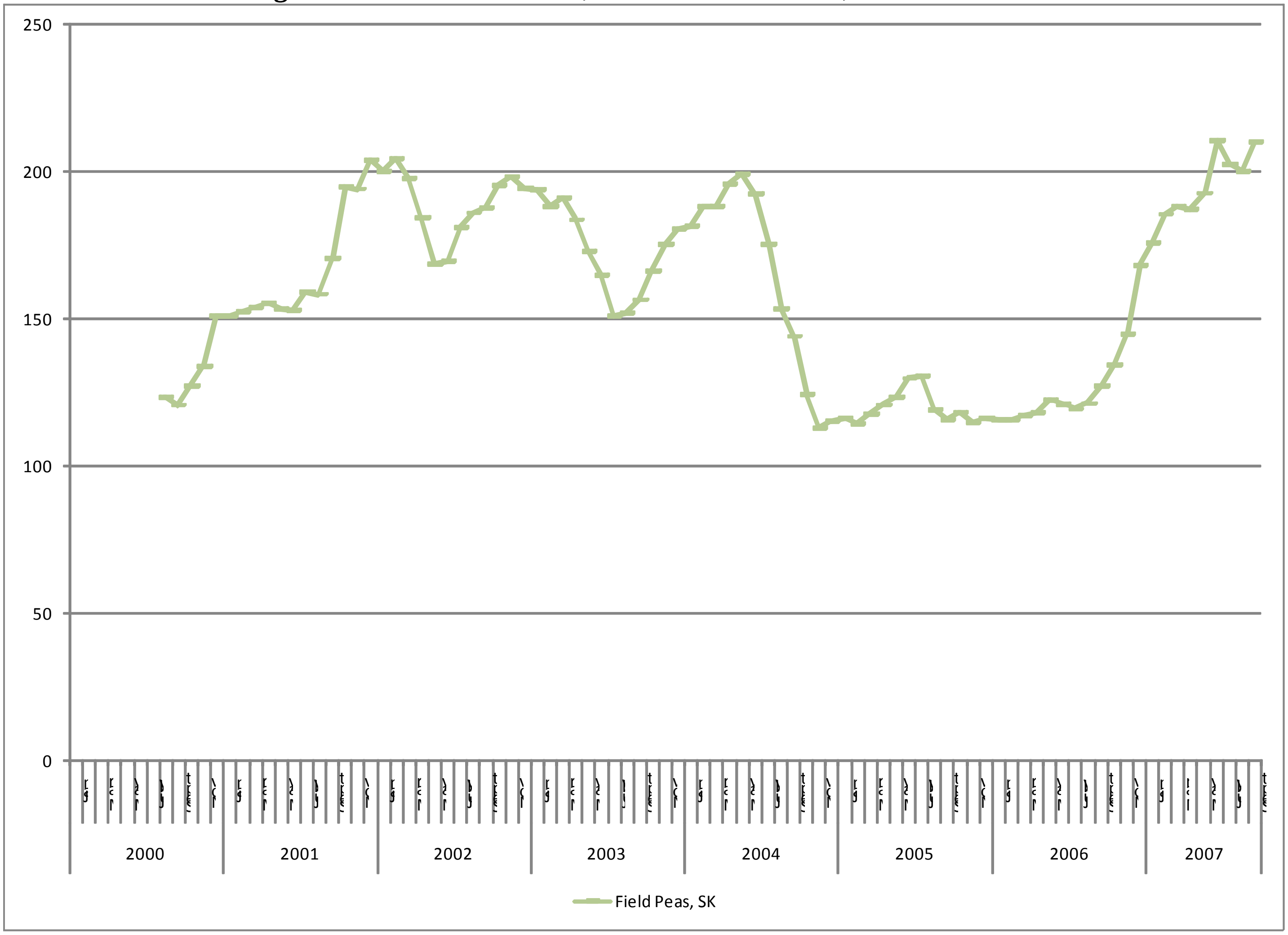
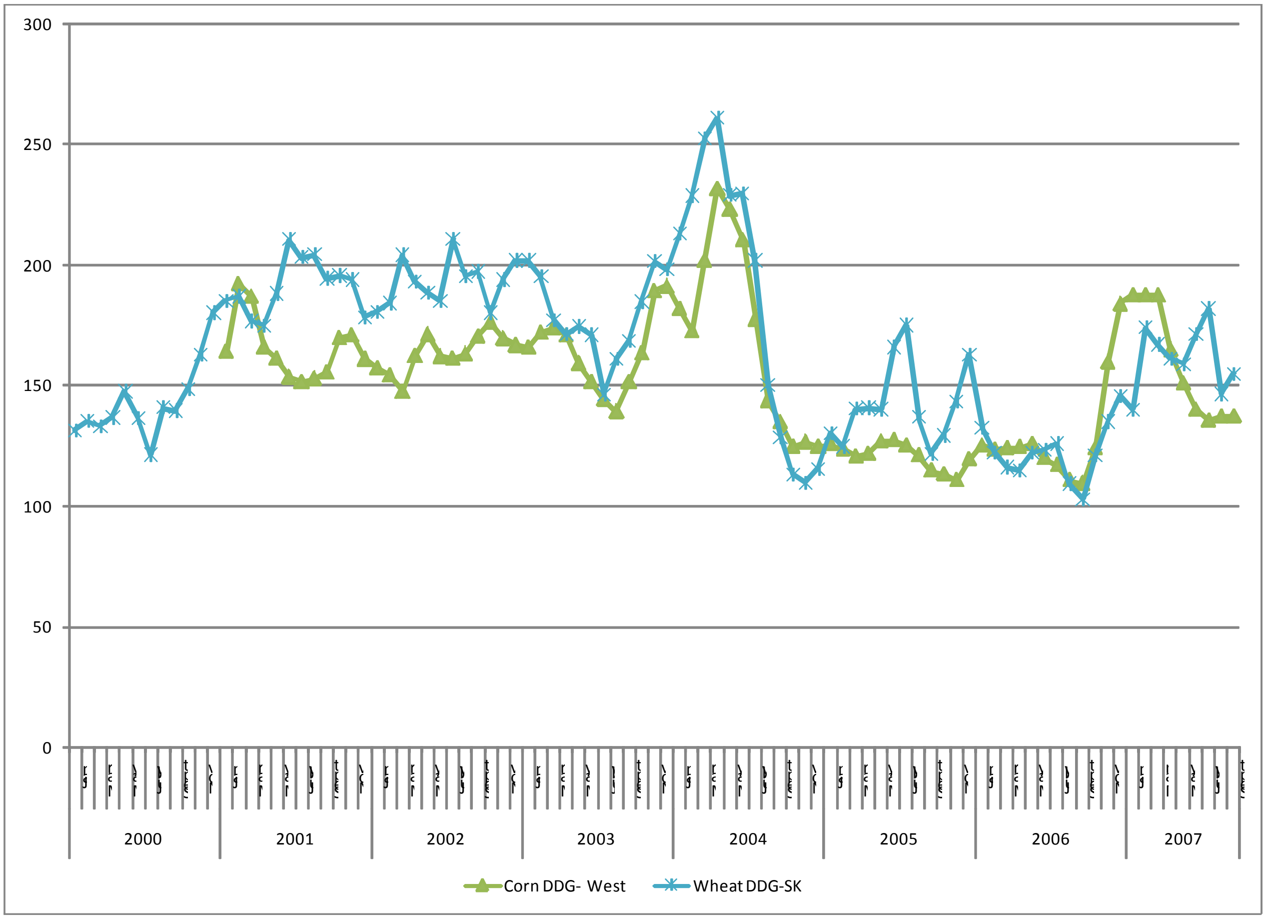


Figure 2.5 Wheat DDG, Saskatchewan Basis, and Corn DDG, Western Canada Basis $Can/tonne



Source: Wheat DDG price constructed from AAFC Vancouver canolameal price less $30/tonne, based on industry sources. Corn DDG price based on Minneapolis DDG price plus $Can 25/tonne

3. Livestock Feeding Impacts of Ethanol Expansion

This section develops an empirical model of livestock feeding in the ethanol-influenced feedgrain market, and in the environment of cross-species competition for feed ingredients. Section 3.1 provides a description of scenarios investigated with the model. Section 3.2 provides a description of the model structure. Section 3.3 describes the data used in the model. The results obtained are presented in Section 3.4.

3.1 Overview of the Empirical Model and the Scenarios Investigated

The analysis of feedgrain price increases and ethanol expansion must incorporate a range of considerations. First, it must be recognized that feed rations are constantly being restructured as the prices of feed ingredients change. This is particularly the case in an environment of increasing feedgrain prices and protein feedstuff prices that are decreasing, at least on a relative basis. Secondly, there is competition for feed ingredients across species. This is due to the differential nutrient requirements that exist across species. Finally, the impact of differences in price levels on feed usage is significant, and includes changes in the structure of rations as well the changes in total feed costs.

To address the above dynamics, a least-cost feed ration model is developed using standard linear programming (LP) techniques. However, where most LP applications are in farm management research with a single enterprise, in this context multiple species are simultaneously considered. This allows for analyses of the allocation of feed ingredients across species, given a range of nutrient requirements and feed ingredient prices. The model minimizes the cost of feeding the annual inventory of hogs, slaughter cattle, dairy cows, and broiler chickens in Alberta, Saskatchewan, and Manitoba given feed ingredient prices, the nutrient content of alternative feed ingredients, and the nutritional requirements of each of the livestock species.

The analysis begins with the assumption that DDG is not used in western Canadian livestock diets, and that historic average feedstuff prices are in place. This provides a form of baseline in terms of historic feed costs and structure. Next, to investigate the initial impact of feedgrain price increases due to ethanol production, current prices are incorporated into the model and it is resolved. To consider the prospect to reduce costs under current feed ingredient prices, the constraints are relaxed to allow DDG inclusion in diets up to maximum levels observed in the literature. Finally, historic long run average prices are used in combination with the availability of DDG at prices discounted relative to history to reflect higher DDG supplies. This allows an assessment of the long run potential for distiller's grains under the assumption that feed ingredient prices may revert back to longer-run averages, but with structurally higher volumes of DDG in the market.

3.2 Empirical Model Structure

The model was structured as a least-cost linear programming model. As such, the objective function was constructed of a vector of feed ingredient prices and feed ingredient quantities. The essential constraints in the model related to the nutritional requirements of the various livestock species and the nutrient contents of feedstuffs. In addition, some additional constraints were added. A maximum proportion of feedgrains in the diet was set at 65% of dry matter for hogs and beef cattle, 40% of dry matter for dairy cows, and the maximum proportion of protein feedstuff ingredients in poultry diets was set at 38%. The maximum proportion of DDG in the ration (dry matter basis) was set at 20% for hogs based on Shurson and Spiehs, 20% for beef and dairy cattle based on Schingoethe *et al*, and 10% for broiler chickens based on Noll. Finally, constraints were placed on the maximum content of canolameal in rations. Based on recommendations by the Saskatchewan Canola Commission, the maximum canolameal proportion of hog rations was set at 16.5%, 20% for chicken rations, and 25% for beef and dairy cattle rations.

3.3 Data

There are three categories of data used in the model:

- Data used to construct nutrient parameters in feed ingredients and nutritional requirements of livestock
- Data on livestock slaughter/inventories
- Data on feedstuff prices

The data used to develop the nutrient makeup of feed ingredients and the nutritional requirements of livestock was obtained from US National Research Council (NRC) specifications and from advice from animal nutritionists. The nutritional parameters reflects the requirements of the grow-finish segment of market hog production, the grow-finish segment of broiler chicken production, the finish segment of beef cattle production (from 750 lbs to 1300 lbs) and for dairy cows in lactation. The specific parameters used of feed ingredients and nutritional requirements are presented in Appendix Tables 1, 2, and 3.

Data on livestock populations were for the 2005-06 slaughter for fed cattle and chickens, the slaughter and exports of live market hogs, and the January 1st inventory of dairy cows. Slaughter data was obtained from Agriculture and Agri-food Canada (AAFC), and the dairy cow inventory data was obtained from Statistics Canada. Live cattle export data was excluded because the US-Canada border was closed to exports for a portion of the 2005-2006 period. The livestock populations are summarized in Appendix Table 4.

Feedstuff selling prices were collected for two periods- the 2003-2006 monthly average period, and for the first five months of 2007. In each case, most of the data was obtained from AAFC as averages of Calgary, Saskatoon, and Winnipeg quotes. Corn DDG quotes were constructed using the USDA Minneapolis price converted to Canadian dollars and metric tons, with $Can 25/tonne added for freight. Wheat distillers DDG were constructed based on the Vancouver canola meal price less $Can 30/tonne, as suggested by industry sources. Barley silage was valued using a formula of the barley price[2]; dicalcium phosphate, haylage, tallow prices were held as fixed over the two time periods. The prices employed in the model are summarized in Appendix Table 5.

3.4 Results- Feed Ration Structure

The above model was solved as a linear programming problem under the four scenarios described above. Section 3.4.1 presents the base run results. Section 3.4.2 presents the results of the scenario assuming no use of DDG and current feedgrain prices. Section 3.4.3 presents the results assuming current feedgrain prices with availability of DDG. Finally, Section 3.4.4 presents the results assuming longer run prices with availability of DDG.

3.4.1 Base Run Results

Table 3.1 presents the base run results, in which long-run feedgrain prices prevail and distiller's dried grains are not used in ration formulations. It is thus broadly representative of history in Western Canada. The table shows that hog diets are structured on barley, field peas, soymeal, and meat and bone meal. Beef rations are structured around barley and barley silage, and dairy rations are based on barley, barley silage, and field peas. Broiler rations are structured around barley, peas, soymeal, and meat and bone meal.

3.4.2 Results- Current Prices Without Access to Distiller's Grains

Table 3.2 presents the least-cost ration results under current price levels assuming that DDG is not widely accessible. The table shows that under current price levels, there is a movement toward substitution of canolameal for peas for in hog, dairy and poultry diets coupled with increased inclusion of barley in hog diets and a switch to feed wheat from barley in broiler diets. In beef and dairy rations, alfalfa silage substitutes for barley silage.

3.4.3 Results- Current Prices With Access to Distiller's Grains

Table 3.3 presents the least-cost ration results under current price levels with availability of DDG. The table shows that access to DDG results in a significant restructuring of rations on a least-cost basis. In hog rations, corn-DDG is used to substitute for peas and some barley, with canolameal inclusion rates increasing. In beef, corn-DDG substitutes for feed barley, with no other feeding adjustments. In dairy rations, corn-DDG substitutes for peas, barley, and canolameal. Broiler rations remain unchanged and there is no inclusion of DDG.

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[2] Barley Silage price/tonne = .272*Barley price/tonne - .001 Source: Manitoba Agriculture, Food, and Rural Initiatives

3.4.4 Results- Historical Average Prices With Access to Distiller's Grains

Table 3.4 presents the least-cost ration results under historic average price levels with greater availability of DDG. The table shows that for hogs, compared with the base results, corn-DDG is used in conjunction with increased utilization of peas, fully replacing canolameal and partially replacing barley. In beef, corn-DDG reduces barley inclusion and shifts forage use to barley silage. With respect to dairy, corn-DDG reduces barley inclusion, fully replaces peas, and shifts to inclusion of barley silage as forage.

3.5 Results- Feed Costs

Table 3.5 below presents the per-tonne costs of feeding the diets presented in section 3.4 above, on an as-fed basis. The table gives the model objective function values at least-cost values, fragmented by species on as as-fed basis, under the alternative scenarios. In interpreting these results it must be observed that the moisture content of the ration varies across species, and that the ration is generally balanced against the grow-finish portion of the animal's diet. For example, the hog ration is 88-90% dry matter and is for the grow-finish portion, while the dairy ration is less than 50% dry matter and spans the lactation.

The results for the base run scenario show that the minimum cost of feeding hogs in Western Canada amounts to about $134/tonne, for beef cattle about $70/tonne, dairy cows about $59/tonne, and $137/tonne for broilers. The columns adjacent to the base run give feed costs under the alternative scenarios, with a column reporting the change relative to base for each alternative scenario. The table shows that, comparing current prices with the base scenario, aggregate western Canadian feed costs increase in aggregate by 27%, with the sharpest increase in costs experienced by beef cattle (28.2% increase).

Under current prices with the availability of distiller's dried grains, the cost increase relative to the base scenario is somewhat mitigated- in aggregate, feed costs increase is about 26% (compared with 27% when distiller's grains are not used). Again, the proportionally largest increase in feed costs occurs with beef cattle (27.1% increase compared with base). Comparing the difference in per tonne feed costs at current prices (Scenario 3 vs. Scenario 2) the most significant cost mitigating effects occur in dairy cows (2.7% decrease in per-tonne cost) followed by hogs (2.4% decrease in cost relative to base).

Table 3.6 considers the economic implications of the inclusion rate constraints imposed on distiller's dried grains. The table gives the change in feed costs that results from an increase in the DDG inclusion rate by 1%. It shows, first, that the inclusion rate constraints bind on hog, beef and dairy rations, and only at current prices- this is evident from the 0 values in the first column in the table. The inclusion rate constraints bind under current prices and historic prices with discounted DDG for hogs, beef cattle, and dairy cows. Secondly, the table shows that the greatest benefit from additional inclusion of DDG is hogs, followed by dairy cows and beef cattle. For hogs, an additional 1%

inclusion would decrease total feed costs by .07-.12%; for dairy and beef cattle the cost decrease is .04-.05%.

3.6 Sensitivity Analysis

Among the more surprising and significant results observed above is that corn DDG is used rather than wheat DDG. This is surprising because corn DDG is essentially a product imported from the US, while wheat DDG is produced locally by western Canadian ethanol plants. To understand the role of wheat DDG in western Canadian feed rations, the following was undertaken. First, wheat-DDG and corn-DDG prices were set equal, and the model resolved under current and historic average price levels to observe inclusion rates. Secondly, because there are differences in their nutrient content, an analysis of the impact of the price spread between corn DDG and wheat DDG on inclusion in rations across species was conducted.

The results are presented in Tables 3.7 and 3.8. In Table 3.7, the least-cost rations are presented under current prices, under the assumption that corn DDG and wheat DDG are both sold at the corn DDG price. Under this scenario, beef and dairy rations shift away from corn DDG to incorporate wheat DDG; hog rations retain corn DDG at the same inclusion rate observed in Table 3.3. Table 3.8 presents results based on wheat-DDG and corn-DDG priced at corn-DDG levels, under historical average prices. Under this scenario, wheat DDG is used in dairy rations, but not at binding constraint levels. Other species do not use either wheat DDG, and corn DDG is used in hog diets.

Table 3.9 presents the results of alternative price spreads between corn-DDG and wheat-DDG. The rows in the table present wheat DDG inclusion rates at alternative levels of corn-DDG price – wheat-DDG price spreads, in $Can 5/tonne increments. The results show that wheat-DDG would need to be priced at par with corn-DDG in order for wheat-DDG to be included in dairy or beef rations. For hogs, wheat-DDG must be priced at a $Can 5 discount to corn in order to be included in the ration. As shown in Section 2.4, it appears as though wheat-DDG has historically been priced at a $Can 13/tonne premium to corn DDG in Western Canada.

Table 3.1 Base Results- Historic Average Prices, No Inclusion of Distiller's Grains

	FEED COMPOSITION, %; HISTORIC PRICES; NO DDGS																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	16.5	0.0	70.3	0.0	8.5	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	42.2	0.0	0.0	0.0	0.0	57.8	0.0	0.0	0.0	0.0	0.0	0.0
Dairy Cattle	100.0	0.0	0.0	5.6	0.0	22.6	0.0	0.0	0.0	0.0	71.8	0.0	0.0	0.0	0.0	0.0	0.0
Broilers	100.0	0.0	0.0	16.0	0.1	64.3	0.0	17.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0

Table 3.2 Results- Current Prices, No Inclusion of Distiller's Grains

	FEED COMPOSITION, %; CURRENT; NO DDGS																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	6.5	0.0	72.3	0.0	16.4	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	43.0	0.0	0.0	57.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dairy Cattle	100.0	0.0	0.0	0.0	0.0	23.1	0.0	5.7	71.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Broilers	100.0	0.0	5.8	11.4	0.3	0.0	60.8	18.8	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0

Table 3.3 Results- Current Prices, With Inclusion of Distiller's Grains

	FEED COMPOSITION, % WEIGHT (AS FED)																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	0.0	0.0	60.6	0.0	15.1	0.0	0.0	0.0	4.8	0.0	0.0	0.0	19.6	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	29.9	0.0	0.0	57.2	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0
Dairy Cattle	100.0	0.0	0.0	0.0	0.0	17.4	0.0	0.0	71.4	0.0	0.0	0.0	0.0	0.0	0.0	11.2	0.0
Broilers	100.0	0.0	5.8	11.4	0.3	0.0	60.8	18.8	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0

Table 3.4 Results- Historic Average Prices, With Anticipated Lower-cost Distiller's Grains

	FEED COMPOSITION, % WEIGHT (AS FED)																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	25.2	0.0	51.6	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	19.5	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	29.3	0.0	0.0	0.0	0.0	58.0	0.0	0.0	0.0	0.0	12.6	0.0
Dairy Cattle	100.0	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0	72.0	0.0	0.0	0.0	0.0	11.0	0.0
Broilers	100.0	0.0	0.0	16.0	0.1	64.3	0.0	17.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0

Table 3.5 Total Feed Costs Per Tonne As-Fed; Price and DDG Scenarios, $

	Base Scenario (Historic Average Price, No DG)	Scenario 2 (Current Prices, No DG)	% Change From Base	Scenario 3 (Current Prices, With DG)	% Change From Base	% Change Scenario 3 vs. Scenario 2	Scenario 4 (Historic Prices, With DG; DG @0.8 Corn)	% Change From Base
Hogs	134	169	25.8%	165	22.8%	-2.37%	129	-3.5%
Beef Cattle	70	90	28.2%	89	27.1%	-1.11%	69	-0.9%
Dairy Cattle	59	74	25.5%	72	21.7%	-2.70%	57	-3.4%
Broilers	137	169	22.9%	169	22.9%	0.00%	137	0.0%
Total	74	94	27.2%	93	25.6%	-1.06%	73	-1.5%

Table 3.6 DDG Inclusion Rate – Feed Cost Elasticities

	CURRENT PRICES	HISTORIC PRICES, WITH DDG AT 80% OF HISTORIC VALUE
Hogs	-0.07	-0.12
Beef Cattle	-0.04	-0.05
Dairy Cattle	-0.05	-0.05
Broilers	0.00	0.00

Figure 3.7 Results- Current Prices, With Inclusion of Distiller's Grains and Corn and Wheat DDG Prices Set Equal

	FEED COMPOSITION, % (AS FED)																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	0.0	0.0	60.6	0.0	15.1	0.0	0.0	0.0	4.8	0.0	0.0	0.0	19.6	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	57.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7
Dairy Cattle	100.0	0.0	0.0	0.0	0.0	17.4	0.0	0.0	71.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1
Broilers	100.0	0.0	5.8	11.4	0.3	0.0	60.8	18.8	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0

Figure 3.8 Results- Historic Average Prices, With Inclusion of Distiller's Grains and Corn and Wheat DDG Prices Set Equal

	FEED COMPOSITION, % (AS FED)																
	Total	Corn Grain	Soybean Meal	Peas	Dicalcium Phosphate (Ca2PO3)	Barley	Feed Wheat	Canola Meal	Alfalfa Silage (Haylage)	Corn Silage	Barley Silage	MBM (Meat Bone Meal)	Pork Meal	Chicken Meal	Fat	Corn DDG	Wheat DDG
Hogs	100.0	0.0	0.0	25.2	0.0	57.9	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	12.2	0.0
Beef Cattle	100.0	0.0	0.0	0.0	0.0	42.2	0.0	0.0	0.0	0.0	57.8	0.0	0.0	0.0	0.0	0.0	0.0
Dairy Cattle	100.0	0.0	0.0	0.0	0.0	22.6	0.0	0.0	0.0	0.0	71.9	0.0	0.0	0.0	0.0	0.0	5.4
Broilers	100.0	0.0	0.0	16.0	0.1	64.3	0.0	17.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0

Figure 3.9 Sensitivity Analysis of Corn DDG - Wheat DDG Prices Spread (Current Prices)

Corn DDG-Wheat DDG Price Spread ($Can/tonne)	Wheat DDGS Inclusion Rate, % (as fed)			
	Hogs	Beef Cattle	Dairy Cattle	Chicken
15	19.4	12.7	11.1	0.0
10	19.4	12.7	11.1	0.0
5	8.6	12.7	11.1	0.0
0	0.0	12.7	11.1	0.0
-5	0.0	0.0	0.0	0.0
-10	0.0	0.0	0.0	0.0
-15	0.0	0.0	0.0	0.0

4. Conclusions and Observations

The trends observed in ethanol suggest that Canadian output will expand from its fairly low base today. The impact of this will be to increase feedgrain prices, and to increase the supply of DDG in the Canadian market as it has in the US. This is consistent with price trends which show DDG decreasing in price as feedgrains are increasing in price. The empirical analysis showed that DDG plays a complex role in this environment, acting as a substitute for both feedgrains and protein across species with sharply different nutritional requirements. These are detailed below.

4.1 Observations

The above presents a complex of results regarding the impact of distiller's dried grains on western Canadian livestock feeding. Current price trends relative to history are such that protein feedstuffs have decreased in price relative to feedgrains. This observation is significant because monogastric species have relatively more of the ration structured around protein feedstuffs like soymeal, canolameal, and peas; in ruminants proteins are supplied in large part by forage, which in Western Canada is priced at its opportunity cost against grain barley. Thus, in the absence of DDG, western ruminant ration costs are more sensitive to increases in feedgrain prices than hogs and broiler chickens, and proportionally greater benefit arises from DDG.

Secondly, the nature of substitution in diets is such that DDG is used mainly in place of feedgrains in the energy component of ruminant diets, while DDG is used mainly in place of protein feedstuffs in monogastric diets. Field peas confound this simplified logic somewhat. Peas are much higher in protein than feedgrains, contain about twice the lysine as most feedgrains, but also contain energy comparable to most feedgrains. Peas thus occupy a position as both a protein and energy feed ingredient. However, peas have increased in price by more than 30% in 2007 compared with history so its pricing behaviour is more consistent with feedgrains. This increase in prices derives a demand for DDG to reduce inclusion of peas. Thus, hog diets derive benefit by using DDG to substitute for peas that is unlike other protein feed ingredients. Given this, surprising results are observed. With regard to hogs, under current prices we observe the ironic result that as corn-DDG substitutes for peas, canolameal inclusion rates increase. In broiler diets, peas are retained in spite of the marked price increase.

Thus, the general observation that can be made on the effect of relatively expensive feedgrains and relatively less expensive protein and DDG feedstuffs is that it has differential impacts across species. It acts as a substitute for feedgrains (primarily) in ruminant diets, and acts as a substitute for protein feedstuffs, especially peas, in hog rations. DDG appears to have little use as a least-cost ingredient in poultry diets, although the literature suggests inclusion at up to 10% of dry matter.

Overall, the distribution of livestock species in Western Canada is oriented toward cattle that depend on diets that are structured around feedgrains, and forages that are priced at their opportunity cost as feedgrains. Thus, the availability of DDG that has decreased in price relative to feedgrains and can serve as a feedgrain substitute is critical.

The results also hint at some challenges for western Canadian livestock competitiveness. Based on the results obtained here, western Canadian corn-DDG is imported from the Midwest US and priced based on a freight margin. This means that livestock users of corn-DDG in Western Canada will be at a cost disadvantage to the US. The results show that in order for wheat-DDG to compete with imported corn-DDG, the two would need to be priced at par, and even then inclusion only occurs in cattle diets. This is surprising, given the significant protein advantage of wheat DDG. Interestingly, in order for wheat DDG to be used in place of corn DDG in hog rations a discount of around $Can 5/tonne must apply on wheat DDG, apparently due to the higher relative lysine content of corn-DDG. Thus, the historic premium to wheat-DDG will need to be offset.

Finally, there are some caveats in interpreting the analysis. Improved information on DDG pricing in Western Canada is needed to better assess implications, particularly given the finding that switching occurs between wheat DDG and corn DDG in a tight price margin. In addition, while the analysis is intended to be illustrative, it is unlikely that sufficient volumes of DDG are currently available in Western Canada to accommodate the volume of demand implied by the results.

4.2 Conclusion

The results suggest that the development of ethanol, feedgrain price effects, and supplies of DDG have potentially significant implications for western Canadian livestock. Based on current information relative to history, this is detrimental to western livestock from a cost perspective. It is also appears to be a negative for Western Canada relative to the US, because imported corn DDG would be used in place of locally supplied wheat DDG.

What is unknown, but requires additional analysis in order to understand the full livestock competitiveness impact, is to what extent western Canadian feedgrain prices will increase relative to US feedgrains as the ethanol industry develops in both countries. If US ethanol production and feedgrain demand grows faster than that in Western Canada, the prospect exists to weaken the feedgrain price spread which would then act to offset the corn-DDG price disadvantage (at least directionally). This is likely to develop in the near future, and as the western Canadian livestock industry evolves the nature of this dynamic will be critical.

References

Ethanol Producers Magazine. (2006). *Plant List* Retrieved November 6, 2006 from http://www.ethanolproducer.com/plant-list.jsp

Manitoba Government. (2006). *10 per cent of provincial vehicles now environmentally friendly*, News Release, May 18 2006 Retrieved October 13, 2006 from http://www.gov.mb.ca/chc/press/top/2006/05/2006-05-18-02.html

Noll, S. 2005. Corn distiller dried grains with solubles for poultry. Prepared for the Minnesota Corn Growers Association. Revised Oct. 2005.

Ontario Ministry of Environment. (2006). *Ontario Regulation 535/05 Ethanol in Gasoline.* Retrieved Oct 13, 2006 from http://www.ene.gov.on.ca/envision/ethanol/index.htm

Sanford, J. (2006). A Growing Concern- Planning to cash in on the ethanol boom? Bank on serendipity *Canadian Business* October 9-22. Retrieved November 8, 2006 from http://www.canadianbusiness.com/markets/commodities/article.jsp?content=20061009_81190_81190#adSkip

Saskatchewan Canola Development Commission. *Recommended Maximum Inclusion Rates for Canolameal. http://www.saskcanola.com/canola/meal.html*

Saskatchewan Industry and Recourses (2007) Personal Communication, Research Officer- Special Projects January 4, 2007.

Schingoethe, D.J., K.F. Kalscheur, and A.D. Garcia. 2002. Distillers grains for dairy cattle. SDSU Extension Extra. ExEx 4022, Aug. 2002. Dairy Science.

Shurson, J. and M. Spiehs. 2002. Feeding recommendations and example diets containing Minnesota-South Dakota produced DDGS for swine. Dept. of Animal Science, University of Minnesota.

Appendix

Table 1 Feed Ingredient Nutrient Values

	MBM	SBM (soybean meal)	Canola meal	Peas	Corn grain	Feed Wheat	Barley	Wheat shorts	Fat, mixed
Metabolizable energy , pigs (kcal/kg)	2760.63830	3797.75281	2933.33333	3606.74157	3842.69663	3606.74157	3269.66292	3133.33333	7777.77778
Metabolizable energy , poultry (kcal/kg)	2110.63830	2724.71910	2100.00000	2922.47191	3839.32584	3450.56180	2973.03371	2940.00000	7161.61616
Metabolizable energy , ruminants-cattle (kcal/kg)	2820.00000	3070.00000	2500.00000	3150.00000	3250.00000	3220.00000	3040.00000	2640.00000	6400.00000
Roughage (fibre)	0.00000	0.00000	0.00000	0.00000	0.02000	0.00000	0.06000	0.00000	0.00000
Protein %	0.54787	0.53371	0.39556	0.25618	0.09326	0.15169	0.12697	0.17778	0.00000
Lysine %	0.02670	0.03393	0.02311	0.01685	0.00292	0.00427	0.00461	0.00778	0.00000
Calcium %	0.10628	0.00382	0.00700	0.00124	0.00034	0.00674	0.00674	0.00100	0.00000
Phosphorus %	0.05266	0.00775	0.01122	0.00438	0.00315	0.00416	0.00393	0.00933	0.00000
Available phosphorus, pigs	0.04766	0.00180	0.00233	0.00180	0.00045	0.00202	0.00118	0.00467	0.00000
Available phosphorus, poultry	0.05266	0.00382	0.00556	0.00202	0.00157	0.00202	0.00191	0.00467	0.00000
Dry matter (DM)	0.94000	0.89000	0.90000	0.89000	0.89000	0.89000	0.89000	0.90000	0.99000

Table 2 Feed Ingredient Nutrient Values

	Alfalfa silage	Grass hay (blue grass + brome)	Barley Silage	Dicalcium Phosphate	Corn Distillers Grain	Wheat Distillers Grain
Metabolizable energy , hogs (kcal/kg)	0.00000	0.00000	1540.00000	0.00000	3814	3790
Metabolizable energy , poultry (kcal/kg)	-	-	1540.00000	0	2576	2315
Metabolizable energy , ruminants-cattle (kcal/kg)	2100.00000	1865.00000	1540.00000	0.00000	2205	2205
Roughage (fibre)	1.00000	1.00000	0.47000	0.00000	0.072	0.072
Protein	0.15500	0.08700	0.12000	0.00000	0.309	0.447
Lysine	0.00000	0.00000		0.00000		
Calcium	0.01350	0.00450	0.00460	0.22000	0.0015	0.0015
Phosphorus	0.00220	0.00250	0.00300	0.18500	0.0078	0.0067
Available phosphorus, pigs	0.00000	0.00000	-	0.00000	.0078	.0067
Available phosphorus, poultry	0.00000	0.00000	-	0.00000	.0078	.0067
Dry matter (DM)	0.36200	0.88000	0.35000	0.00000	0.92	0.93

Table 3 Basic Nutritional Requirements of Livestock Species, Adapted from NRC Estimates

Feed Ingredients	Market Hogs	Broiler Chickens	Beef (growing steer)	Dairy (large frame)
Metabolizable energy (kcal/kg of feed)	3539	0	0	0
Metabolizable energy (kcal/kg of feed)	0	3596	0	0
Metabolizable energy (kcal/kg of feed) ruminants	0	0	2841.409692	2600
Roughage-fibre (per kg of feed)	0	0	0.1	0.5
Protein (per kg of feed)	0	0	0.098	0.18
Lysine (per kg of feed)	0.0011	0.0013	0.0000	0.0000
Calcium (per kg of feed)	0.0074	0.0112	0.0035	0.0090
Phosporus (per kg of feed)	0.0000	0.0000	0.0021	0.0045
Available phosphorus (per kg of feed)	0.0028	0.0039	0.0000	0.0000
Micro mix of vitamins and minerals, monogastrics (per kg of feed)	0.00	0.01	0	0
Micro mix of vitamins and minerals, ruminants (per kg of feed)	0	0	0.002	0.002
Max. meat and bone meal + pork meal + poultry meal (per kg of feed)	0.05	0.05	0.035	0.035
Dry matter intake, kg/day/head	0.75342466	0.008493151	13.62	20.65
Dry matter intake, tons/year/head	0.275	0.0031	4.9713	7.53725
Max. Roughage, percentage DM			0.21	0.21
DM Feed requirements, tonnes/animal/growing period	0.275	0.0031	4.4	9.8185
Max DM (kg//head/day)				20.63

Table 4 Livestock Populations in Western Canada, 2005-06 (Head)

	Market Hog Slaughter and Live Export	Steer and Heifer Slaughter	Dairy Cow Inventory	Chicken Slaughter
British Columbia	84,925			
Alberta	1,694,510			
Saskatchewan	491,506			
Manitoba	2,041,776			
Total Western	4,312,717	2,228,000	229,000	198,582,898