Getting value from your feed dollar with novel, western-Canadian feed ingredients

Eduardo Beltranena[1,2] and Ruurd T. Zijlstra[2]
[1]Agriculture Research Division, Alberta Agriculture and Rural Development
[2]Department of Agriculture, Food and Nutritional Sciences, University of Alberta

Feed prices have come down from the extreme highs seen last year and early in 2008. Nonetheless, western Canadian hog producers continue to face feed competitive challenges. The most relevant factor today is increasing grain demand by ethanol plants. Two other issues impacting competitiveness are grain yield and quality. Our western Canadian grains yield lower than corn and pack less energy per kilogram. Great efforts are under way to enhance crop yield by genetic improvement and agronomic practices. Feed grain quality is also at the forefront of genetic improvement, but addressing these issues will take time. In regards to grain quality, livestock producers also face increasing competition from those who see agricultural commodities as a new source of "green", bio-degradable industrial materials. Therefore, the current reality for livestock producers might be to understand that change is already here. Pork production in the future will not be competitively possible by only feeding traditional grains. Feeding grain co-products and fractions will present good opportunities, but learning about them is imperative. Those who learn and adapt will likely survive and eventually thrive.

The companion paper (D. Beaulieu) addresses getting value from your feed dollar with in barn feed management. This paper addresses getting value from your feed dollar based on recent research feeding novel, non-traditional grains, pulses and oilseed co-products and fractions produced in western Canada.

Feeding Novel Grains

Western Canadian pork production was traditionally based on feeding barley. Our paradigm changed when feeding wheat resulted in faster weight gains. Triticale is a hybrid of rye x wheat that has been around for some time, but there is renewed interest on its feed and bio-industrial applications. The primary driver for us was a 5 – 20% higher yield than wheat in the Brown soils of the dryer southern Prairies. The second driver for us in considering triticale as a feed grain was its potential higher energy content with respect to wheat, closer to corn. However, animal performance data to convince nutritionists and hog producers of the virtues of feeding triticale was scarce. Animal performance data comparing triticale varieties to each other did not exist.

In a four-week nursery trial, we evaluated feeding triticale as a replacement for wheat (HRS or CPS), which has been the western Canadian grain standard in weaner diets. We also compared the performance of weaned pigs offered different triticale varieties. For the overall trial and the first three weeks, replacing wheat with triticale did not affect feed disappearance or weight gain (Table 1). For the last week of the study, pigs offered the HRS, CPS wheat-based or AC Ultima triticale-based diets consumed more feed than those offered the Pronghorn, Bobcat or Pika triticale-based diets. As a result, feed efficiency differed among the diets. Pigs fed the triticale-based diets had better overall feed efficiency than those fed either the HRS or CPS wheat-based diets. A similar response was also seen during the first two weeks of the study. Triticale varieties resulted in similar overall pig performance. AC Ultima was the most comparable triticale variety to CPS and HRS wheat in terms of animal response.

Table 1. Effect of dietary grain on overall growth performance of young pigs fed diets based on either 66% wheat or triticale (7.6 to 22.8 kg liveweight)

	Wheat		Spring Triticale		Winter Triticale		SEM	*P*
	HRS	CPS	Ultima	Pronghorn	Bobcat	Pika		
Feed disappearance, g/d	811	819	798	789	789	786	11.2	0.19
Weight gain, g/d	535	549	541	543	550	546	10.4	0.93
Gain:feed	0.68*a*	0.69*a*	0.72*b*	0.72*b*	0.72*b*	0.72*b*	0.01	<0.05

Beltranena et al. 2008

In terms of nutrient digestibility (percentage of digested nutrients), pigs utilized more energy and retained more protein, calcium and phosphorus from all four varieties of triticale compared to both varieties of wheat. This finding mostly explained the higher overall feed conversion. Excretion of phosphorus, a mineral which soil accumulation creates concerns in lands with heavy manure application, was highest for pigs fed wheat, intermediate for those fed the winter triticale and the least for pigs fed the spring triticale grain varieties. Improved feed conversion efficiency combined with higher grain yield implies that triticale can produce more pork per area of cultivated land than wheat.

Feeding Novel Pulses

Field pea has been the traditional legume fed to hogs. Field pea is and will continue to be the legume of choice for those in the dryer, warmer areas of the southern Prairies. Those farming in the cooler, central and northern Prairies should consider zero-tannin (ZT) fababean, and perhaps, lupin. The primary driver for us in looking at ZT fababean was yield. In years with adequate rainfall, fababean out-yields pea in the Black and Grey Wooded soils zones of central and north-western Alberta. The second driver was air nitrogen fixing. In contrast to pea, dry bean, chickpea and lentil, ZT fababean and lupin allows air nitrogen-fixing beyond blooming until the plant dries. The third driver for us was their high energy and protein content, which may displace imported soybean meal in swine rations.

Table 2. Growth performance of young pigs fed increasing levels of fababean in substitution for soybean meal from 14 – 35 days post-weaning (10 – 23 kg liveweight)[a]

	0% FABA 22.1% SBM	10% FABA 16.6% SBM	20% FABA 11.1% SBM	30% FABA 5.5% SBM	40% FABA 0% SBM	SEM
Feed disappearance, g/d	876	868	857	840	845	19
Weight gain, g/d	579	580	570	572	570	15
Feed:gain	1.50	1.49	1.49	1.47	1.50	0.03

Omogbenigun et al. 2005

Old fababean varieties were limited in their use in swine diets. Their high content of anti-nutritional factors, mainly tannins, limited their dietary inclusion. However, the new zero-tannin white-flowered varieties, such as Snowbird, have much lower tannin content. Although tannins have been reduced, we suspected that there might be other anti-nutritional factors that could hinder digestion in pigs. Legumes, in general, have complex carbohydrates that can cause digestive upset in young animals. We therefore

tested this hypothesis in weaned pigs by offering 0, 10, 20, 30, and 40% ZT fababean. To our surprise, young pigs tolerated well up to 40% without detrimental effects on performance (Table 2). Weaned pigs did not even require an adaptation period to ZT fababean. They performed as well as controls fed soybean meal even for the first week on trial.

We have also evaluated feeding zero-tannin fababean to growing-finishing hogs in substitution for soybean. In an experiment at Prairie Swine Centre Inc, grower pigs were fed either a soybean or faba bean-based diet regimen (Table 3). Over the 35 to 115 kg, feed intake and weight gain did not differ between faba bean and soybean meal. Feed efficiency was 0.02 higher for soybean meal than faba bean in the grower phase. At slaughter, backfat thickness did not differ; however, lean was 4.0 mm thicker for soybean meal than fababean. In summary, zero-tannin fababean has an attractive nutrient profile and does not alter feed intake or growth performance of grower-finisher pigs at inclusion rates up to 30%. The reduced feed efficiency in the grower phase and reduced lean thickness for pigs fed fababean indicate that amino acid supply might have been limiting for the fababean diets early in the study.

Table 3. Growth performance of grower-finisher pigs fed diets based on either faba bean or soybean meal

	Gilt		Barrow		Pooled	*P* value		
	Faba bean	Soybean meal	Faba bean	Soybean meal	SEM	Diet	Gender	Diet x Gender
Feed disappearance, g/d	2.552	2.491	2.922	2.878	0.07	0.45	< 0.01	0.90
Weight gain, g/d	0.977	0.961	1.004	1.017	0.02	0.93	0.04	0.42
Gain:feed	0.388	0.392	0.354	0.365	0.006	0.25	< 0.01	0.59

Zijlstra et al. 2008a

In our PSCI study, no comparison to the locally grown feed pulse standard (field pea) was made. And it was important to follow up effects on carcass traits and pork quality as these could impact producer profitability and might jeopardize Canadian pork exports. In a commercial size study we conducted at Irma, AB 1000 crossbred pigs were offered diets where the supplemental protein sources was ZT fababean, ½ZT fababean:½ soybean meal, field pea or soybean meal. Most hogs were slaughtered at Britco in Langley, BC. Ninety-eight hogs were shipped to Sturgeon Valley Pork for slaughter instead. The half carcasses of the latter group were then shipped to AAFC Lacombe for dissection and pork quality measurements.

For all dietary treatments and irrespective of gender and phase, growth performance was excellent (Table 4). Feed cost per kilo gained averaged $0.39. Gross income after feed cost averaged $56.68. Carcass fat and loin depth averaged 20.5 and 65.2 mm, respectively, resulting in 60.0% separable pork yield, irrespective of gender. There were not treatment effects on primal cuts lean yield, but the pork of fababean and ½ZT fababean:½ soybean meal was a bit darker that field pea and soybean meal fed controls. Drip loss from chops of hogs fed fababean or ½ZT fababean:½ soybean meal was lower than that of pigs fed soybean meal or field pea. The latter findings will be of great interest to packers exporting to Asian markets.

Feed cost per kilo gained was the lowest for hogs fed the pea diet and highest for the hogs fed the soybean meal diet. However, income over feed cost was the same for the fababean, ½ZT fababean:½ soybean meal and field pea treatments. Despite similar hog growth performance compared to pea, higher fababean yield results in more pork produced per area of cultivated land.

Table 4. Growth performance of hogs fed zero-tannin, Snowbird fababean or field pea in substitution for soybean meal (31 – 108 kg liveweight)

	SBM	Faba	Faba/Soy	Pea
Initial weight, kg	31.8	31.0	31.8	30.7
11-wk end weight, kg	108.6	108.6	108.9	107.8
Feed disappearance, kg/d	2.67	2.67	2.70	2.67
Weight gain, kg/d	0.996	1.004	1.001	0.996
Feed:gain	2.68	2.66	2.69	2.67
Feed cost, $/kg gained	0.400	0.396	0.386	0.384
Income over feed cost $/pig	55.8	57.0	57.0	57.0

Gunawardena et al. 2007

Feeding Pulse Fractions

Consistent with the current trends to value-add raw, agricultural commodities and define success by having multiple crop uses (food, feed, bio-industrial), we have pursued the production and feeding of pulse fractions. We have fractionated ZT fababean and field pea into starch and protein and concentrated both fractions at the same time. No high-cost wet separation followed by sophisticated spray-drying is necessary. In this low cost and fast process, we take 28% crude protein ZT fababean to a 65 - 70% crude protein concentrate in minutes. And as expected, the protein content and yield of the protein fraction is substantially higher in ZT fababean compared to field pea. Our hope is that these protein concentrates will find markets in breakfast bars, high-protein snacks, aquaculture and pet foods, and young animal diets. The starch fractions will find markets such as the bakery, paint and paper industry.

Table 5. Effect of dietary protein source on feed disappearance, weight gain, gain:feed and body weight for each weekly period and overall

	Hulled faba protein	Dehulled faba protein	Field pea protein	Control proteins	SEM	*P* value Diet
Feed disappearance, g/d	648	653	685	662	13	0.2475
Weight gain, g/d	483	484	504	486	12	0.5408
Gain:feed	0.758	0.758	0.755	0.740	0.01	0.6709

Gunawardena et al. 2008

In a nursery study, we compared the performance and diet digestibility of weaned pigs offered either ZT faba bean protein or field pea protein in replacement of a blend of imported soy protein concentrate, fishmeal and corn gluten meal. In total, 192 crossbred Hypor pigs (7.5 kg at 27 d) weaned at 21 days of age were offered test diets for a 28 days starting at 7 days post weaning. For the entire study period (Table 5), protein source did not affect daily feed disappearance, weight gain, or gain:feed, indicating that changes in specialty protein sources at the specific dietary inclusion levels did not affect growth performance. In conclusion, fababean and field pea protein fractions are cost effective replacements for specialty protein sources in diets for weaned pigs.

Feeding Grain Co-products

North American governments disrupted the global feed market supply and demand signals. Their mandate of ethanol inclusion in fuels and the provision of subsidies for the construction and operation of bio-fuel plants drove demand and grain prices to the extreme. The consequential increase in the availability of co-products of the ethanol namely distiller's dried grain and solubles (DDGS) potentially represent a low cost feed opportunity for the livestock industry. DDGS are high in dietary fibre and protein. Excess dietary protein contributed by these co-products could also mean greater nitrogen excretion and potentially greater harm to the environment. Variability in DDGS introduced as a result of processing is of great concern to us (Beltranena and Zijlstra 2008, Zijlstra and Beltranena 2008).

In a commercial growing-finishing trial conducted at Irma, AB, Gowans Feed Consulting tested the increasing dietary inclusion of corn DDGS. Their results suggest that good quality corn DDGS can be included in hog diets at levels up to 25% of the diet without reducing feed intake (Table 6).

Table 6. Effect of feeding increasing levels of corn DDGS on hog performance in a commercial facility in Alberta

	Corn DDGS level, %							
	0	5	10	15	20	25	SED	Linear
Feed disappearance ,kg/d	2.33	2.41	2.36	2.29	2.38	2.31	0.029	0.12
Weight gain, kg/d	0.936[a]	0.975[b]	0.964[b]	0.958[ab]	0.972[b]	0.967[b]	0.012	0.05
Feed:gain	2.49[a]	2.47[a]	2.45[a]	2.39[b]	2.45[a]	2.39[b]	0.026	0.01
Feed cost, $/kg gain[e]	0.405	0.405	0.405	0.399	0.413	0.411	0.004	0.08
IOFC, $/pig[f]	39.4	40.7	40.4	40.5	40.2	40.1	0.64	0.58

[a,b,c,d]Means with different superscript letter differ ($P < 0.05$); Average of 8 pens per DDGS level.
[e]Wheat $105, soybean meal $270, peas $130, Canola $120, corn DDGS $123, tallow $470 per tonne
[f]Income over feed cost. Pig price = $1.3 kg dressed
Gowans et al. 2007

Regarding pork quality, high corn DDGS inclusions are a greater concern than high wheat DDGS inclusions would be because corn DDGS contains nearly twice the fat content. Increasing levels of corn DDGS up to 25% did not increase backfat thickness at the grading site (Gowans et al. 2007). Furthermore, the type of fat in corn DDGS is unsaturated. Feeding unsaturated fats to hogs is known to cause soft or "fluffy" bellies. Bacon slabs don't slide well and bacon strips tend to stick together at cooking. The taste and texture of lean pork become oily and mushy at chewing. Sausage quality is compromised, increasing the oily sweat off and reducing wiener firmness. Feeding decreasing levels of DDGS as hogs approach market weight is a strategy that should reduce feed cost and mitigate the negative effects on pork quality. We are currently conducting such study at Irma, including detailed pork quality work at AAFC Lacombe Research Centre.

Feeding Novel Oilseed Co-products

Canola meal has long been fed to hogs in western Canada. It is the co-product of the solvent-extraction of oil for human consumption from canola seed. Recent interest in bio-diesel production from canola has resulted in the appearance of three novel co-products: canola cake, expeller-pressed canola meal (EPCM) and crude glycerol. Canola seed can be easily pressed in small, local facilities using a simple screw press. The resulting co-product is canola cake containing 15 – 20% oil. The concern with this co-product is the variability in residual oil content. Canola cake may not only be difficult to handle at the

on-farm feed mill, but also has not been heated. We therefore expect it to be higher in antinutritional factors compared to solvent-extracted canola meal. In contrast, EPCM is produced in medium-size plants after heating the seed and conducting multiple-pass pressing to remove as much oil as mechanically possible.

In a recent study conducted at Irma, AB, 900 grower pigs in 40 pens were fed four dietary regimes including 0, 7.5, 15, and 22.5% EPCM. For Phases 3 and 4, 22.5% EPCM was reduced to 18% due to reduced feed intake earlier. Overall, weight gain and feed intake decreased and G:F increased quadratically with increasing dietary EPCM level (Table 7). Carcass backfat and loin depth did not differ among dietary regimes. Pigs fed 22.5/18% EPCM reached slaughter weight 3 d later than pigs fed 0% EPCM. In conclusion, EPCM is a valuable energy and AA feedstuff; targeted inclusion levels are required to ensure that pig fed diets containing EPCM reach expected growth performance.

Table 7. Growth performance of hogs fed diets containing 0, 7.5, or 15% expeller-pressed canola meal

	Expeller-pressed canola meal (%)					*P* value	
	0	7.5	15	22.5/18	SEM	Linear	Quadratic
Feed disappearance, kg/d	2.571	2.509	2.380	2.343	0.02	0.01	0.01
Weight gain, kg/d	0.976	0.959	0.920	0.912	0.01	0.01	0.01
Gain:feed	0.366	0.369	0.373	0.378	0.01	0.14	0.03

Seneviratne et al. (2009)

In the production of bio-diesel, cold-pressed or expeller-pressed crude oil is the added of an alcohol and a salt to trigger the separation of glycerol from the oil that is then mixed with regular diesel. Glycerol is a simple sugary gel that pigs can consume in feed as a source of energy, replacing wheat.

In a recent weaner pig trial, we tested the effects of substituting wheat with crude glycerol as a dietary energy source in nursery diets. Seventy-two weaned pigs were fed for four weeks one of three pelleted wheat-based diets containing 0, 4, or 8% glycerol. For day 0 to 28, body weight increased linearly and pigs fed 8% glycerol were 1.11 kg heavier than pigs fed no glycerol (Table 8). Glycerol inclusion tended to increase weigh gain linearly and increased feed intake quadratically without affecting feed efficiency. Feeding up to 8% dietary crude glycerol by substituting wheat enhanced the growth performance of weaned pigs. However, inclusion levels of crude glycerol in mash feed should be limited to prevent difficulties with feed flow in feeders and material handling equipment. Feeding crude glycerol will be subject to CFIA registration due to residual chemicals used in the process.

Table 8. Growth performance of weaned pigs fed diets containing 0, 4, or 8% crude glycerol

	Crude glycerol (%)			Pooled	*P* value	
	0	4	8	SEM	Linear	Quadratic
Feed disappearance, g/d	719	784	754	0.02	0.162	0.037
Weight gain, g/d	516	541	556	0.01	0.066	0.772
Gain:feed	729	715	760	0.02	0.193	0.166

Zijlstra et al. 2008

Conclusions

This paper has highlighted the potential of novel grains (triticale), pulses (fababean, lupin) and introduced the feeding of legume fractions (field pea, fababean), grain (DDGS) and oilseed (expeller-pressed canola meal, glycerol) co-products. We hope that you realize that the way we produce pork and feed hogs has changed. Traditional grains and raw pulses are no longer cheap and abundant. Crops are now seen as "green" and renewable. The bio-industrial use of crops is now in direct competition with the use of crops to feed humans and their animals. It is now clear that we need to learn how to profitably feed crop fractions and co-products. Aggressive research is needed to optimize inclusions and manage fraction and co-product variation in order to obtain consistent, predictable animal performance. How fast we adapt will be critical to regain our global feed competitive advantage.

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