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Focus on the Future

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Focus on the Future

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Proceedings of the London Swine Conference
Focus on the Future

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CHAIR'S MESSAGE

10 Years!

In 1999, a small group of people dedicated to Ontario's pork industry assembled at OMAFRA HQ in Guelph and began to plan for the creation of a "world-class annual swine conference in Ontario". The need for such a conference had been felt for some time, but at last this was the push that got it started. It took some ground-breaking work, the building of a partnership between OMAFRA, University of Guelph, and Ontario Pork, generous industry sponsorship, and a lot of planning. In 2001, the London Swine Conference was launched. Internationally renowned speakers mixed with local expertise and active participants provided "a platform to accelerate the implementation of new technologies in commercial pork production in Ontario, and to facilitate the exchange of ideas within the swine industry" – the stated objectives of the conference. For 9 years this proven recipe has helped build the reputation of the London Swine Conference in North America and around the world, and I think those people in Guelph in 1999 must be pleased that their dream has been realized. Thanks to their vision, and to everyone who has supported it, we do indeed have "a world-class annual swine conference in Ontario" – and this is it.

The conference outlook has always been forward rather than backward, and our theme this year is "Focus on the Future". Recognizing the current struggles of the industry while looking to the future can be difficult. Predicting the future is a game of chance, but working towards a desired future through planning and work is vision. That's how this conference came to be. There is a future for the industry and the conference program provides perspective and knowledge that the industry can use to shape its own future within the constraints of national and international events and economic forces.

Industry updates and a look to the future are followed by information to fine-tune all aspects of production, from management and nutrition to animal health and food safety, wrapping up with a grocer's perspective. The break-out sessions provide opportunities to learn and discuss practical, applied topics. It is a well-rounded program that will benefit everyone.

London Swine Conference is a joint effort by staff from Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Ontario Pork, University of Guelph, Ontario Pork Industry Council, and of course the industry sponsorship that makes it possible.

A key aspect of the conference that is not listed on the program is the opportunity to network, meet colleagues and business associates, and engage in discussion. Please come and enjoy all that the 2010 London Swine Conference has to offer.

Jaydee Smith
Chair, Steering Committee
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THE GLOBAL PORK INDUSTRY IN PERSPECTIVE

THE GLOBAL PORK SITUATION – WHERE DOES CANADA FIT?

Ken McEwan
University of Guelph – Ridgetown Campus
120 Main Street East, Ridgetown, Ontario N0P 2C0
E-mail: kmcewan@ridgetownc.uoguelph.ca

ABSTRACT

Pork production is global in nature with trade occurring relatively freely around the world. Most countries now have access to the same genetics and have similar productivity potential. Food safety regulations and health protocols are standard requirements. Industry shocks such as disease (i.e. H1N1) or feed shortages that occur in one country have the ability to affect markets around the world. It is speculated that the main differentiating factors in global pork production are housing standards/animal welfare issues, producer management ability and government policy (i.e. environmental standards, financial support, trade barriers).

Canadian pig producers have faced many challenges during the last few years due to a stronger Canadian dollar, country of origin labelling, feed cost volatility, low market prices, H1N1, and so on. As a result, there has been and will continue to be attrition of producer numbers. Amid these challenging times however it is important to assess the attributes of the Canadian industry, to find light at the end of the tunnel for those with the stamina to remain in the business. What strategies will be needed to set Canada apart from other pork producing countries in the future and to be competitive at a global level?

WORLD PIG INVENTORIES

The pig production industry is global in nature. Table 1 shows beginning inventory numbers for major pig producing countries from 2005 to 2009. China is, by far, the largest producer with nearly 463 million pigs or 59% of the world's pig inventory in 2009. In comparison, the EU-27 countries are reported to have about 19.5% of the world's inventory, the US 8.6% and Canada 1.6% in 2009.

Of the major pig producing countries, Canada experienced the largest decline in pig inventories between 2005 and 2009 (i.e. a decline of 17.8%). The EU-27 declined by 2.6% but China increased by 9.9%, the US increased by 10.1% and Brazil grew by 18.6%.

ESTIMATED PORK COST OF PRODUCTION

Canada has always been viewed as one of the lowest pork production cost regions in the world. Table 2 shows the estimated cost of production in \$/kg carcass weight for Canada and selected countries for 2006 and 2007. The figures have been converted from local currency to Canadian

currency using the Bank of Canada average annual exchange rate between Canada and the specific country.

Table 1. Beginning inventory by country and % change, 2005-2009 ('000 head).

'000 head	2005	2006	2007	2008	2009	% Change 2005 to 2009
China	421,234	433,191	418,504	439,895	462,913	9.9%
EU-27	156,973	159,115	161,526	159,732	152,960	-2.6%
Brazil	32,323	32,938	33,147	32,947	33,892	4.9%
Russia	16,500	16,550	17,180	18,187	19,562	18.6%
Canada	14,810	15,110	14,907	13,810	12,180	-17.8%
Japan	9,600	9,620	9,759	9,745	9,899	3.1%
Mexico	9,068	8,911	9,021	9,401	9,310	2.7%
Others	64,456	67,653	70,566	20,765	16,930	-73.7%
United States	60,982	61,463	62,516	68,177	67,148	10.1%
World Total	785,946	804,551	797,126	772,659	784,794	-0.1%

Source: USDA, FAS

Table 2. Production costs by country, 2006-2007 (\$C/kg carcass weight).

Country	2006	2007	% Change 2006 to 2007
USA	1.44	1.54	6.7%
Brazil	1.30	1.62	24.8%
Canada	1.42	1.74	22.5%
Denmark	1.85	2.01	8.7%
Netherlands	1.81	2.16	19.4%
France	1.92	2.22	15.4%
Belgium	1.82	2.23	22.5%
Spain	2.02	2.31	14.1%
Germany	2.08	2.34	12.4%
Britain	2.28	2.62	15.1%

Source: Pig International, March/April 2009 adapted from InterPig reports. University of Guelph-Ridgetown Campus calculations.

Table 2 shows that, of the countries listed, the US had the lowest estimated cost in 2007 at \$1.54/kg. The next lowest cost country was Brazil at \$1.62 followed by Canada at \$1.74. The European countries listed in the table all had costs higher than \$2.00/kg ranging from Denmark at \$2.01/kg to Britain at \$2.62/kg. It should be noted that in 2006, Canada ranked second behind Brazil for the lowest cost of production.

The table also shows the % change between the two years which is positive for all of the countries listed as a result of increased feed costs. The change figures shown account for both changes in the cost of production within the specific country and any change in the currency conversion between Canada and the specific country from 2006 to 2007. The change in costs

from 2006 to 2007 showed Canada had the second largest increase at 22.5% after Brazil's increase of 24.8%. The US had the lowest increase at 6.7%. When the changes in the currency conversion between Canada and the specific country are removed, Canada had the largest change in production costs based on local currency at 22.5%. The country with the smallest change was Denmark at 5.3%.

For comparison purposes, China, the world's largest pork producing country had an estimated cost of production as of mid-2007 ranging from \$45-\$52 per hundred pounds while US production costs were just under \$50 per hundred pounds (\$US). These costs would convert to approximately \$1.44-\$1.67/kg for China (i.e. \$1.55/kg average) and just under \$1.60/kg for the US (all figures in \$C/kg carcass weight). The US figure is higher but comparable to that for 2007 in Table 2 above while the estimated average of \$1.55/kg for China would place it between the US and Brazil for 2007.

In summary, Canada is still among the world's lowest cost pork producing regions. A comparison between Canada and selected countries showed that, in 2006, Canada ranked 2nd behind Brazil and in 2007, Canada ranked 3rd behind the US and Brazil in terms of cost of production in \$C/kg carcass weight of pork. From 2006 to 2007, Canada's production costs increased 22.5% but costs increased in the other countries in the comparison as well. This allowed Canada to maintain its relative standing as a low production cost region.

GLOBAL TRADE

Table 3 provides information on the top 4 pork exporters. In 2009, these 4 countries represented 90% of global pork exports and the US accounted for 35% of all exports. The US has had significant growth in its pork exports increasing by 56.1% from 2005 to 2009. The EU-27 and Canada increased at much more modest rates while Brazil decreased from 2005 levels.

Table 3. Top 4 pork exporting countries ('000 tonnes).

Exports	2005 (‘000 t)	2009 (‘000 t)	% Change 2005-09	% of World Exports 2009
1. US	1,209	1,887	56.1%	35%
2. EU-27	1,143	1,250	9.4%	23%
3. Canada	1,084	1,130	4.2%	21%
4. Brazil	761	645	-15.2%	12%
Top 4	4,197	4,912	17.0%	90%

Source: USDA – FAS. Ranked according to 2009 data.

Table 4 shows the top 4 importing countries. Japan is the largest pork importer accounting for 23% of world imports in 2009. The top 4 countries represented 55% of all imports. Mexico reported the largest increase in imports (i.e. 42.9%) between 2005 and 2009 while Japan and Russia decreased by 7.9% and 0.3% respectively.

Table 4. Top 4 pork importing countries ('000 tonnes).

Imports	2005 (‘000 t)	2009 (‘000 t)	% Change 2005-09	% of World Imports 2009
1. Japan	1,314	1,210	-7.9%	23%
2. Russia	752	750	-0.3%	14%
3. Mexico	420	600	42.9%	11%
4. S Korea	345	375	8.7%	7%
Top 4	2,831	2,935	3.7%	55%

Source: USDA - FAS. Ranked according to 2009 data.

GLOBAL PORK CONSUMPTION PATTERNS

It is expected that pork demand worldwide will grow in the future as incomes rise in developing countries and populations increase. The U.N. Food & Agriculture Organization (FAO) recently released “The State of Food & Agriculture 2009” report which shows per capita consumption of meat in 2050 compared to 2000. This is shown in Table 5 along with the % change. Significant growth is anticipated in East and South Asia and the Pacific where the increase is believed to be 82.1%, from 28 to 51 kg/person/yr. Meat consumption is expected to double in sub-Saharan Africa although the beginning value in 2000 is quite low. It is difficult to know how pork consumption in particular fits in the projection but it is believed that pork consumption will increase similarly.

Table 5. Worldwide per capita meat consumption levels, 2000 versus 2050 and % change.

	2000	2050	% Change 2000-2050
Central & West Asia & North Africa	20	33	65.0%
East & South Asia & the Pacific	28	51	82.1%
Latin America & the Caribbean	58	77	32.8%
North America & Europe	83	89	7.2%
Sub-Saharan Africa	11	22	100.0%

Source: U.N. Food & Agriculture Organization, “State of Food & Agriculture”, 2009.

In terms of historical per capita consumption of pork, Table 6 shows pork consumption by country between 2005 and 2009. Hong Kong, EU-27 and Taiwan reported the highest per capita consumption of pork in 2009 at 65.1 kg, 42.3 kg, and 41.7 kg/person/yr. Canada was similar to the US, South Korea and Russia at 24.9 kg/person/year. Russia has experienced the most growth in consumption increasing by 21.8% from 17 kg/person in 2005 to 20.7 kg/person in 2009. Hong Kong and South Korea also reported strong growth with increases of 9.2% and 7.0% respectively.

Table 6. Per capita consumption of pork by country (kg/person/yr) and % change 2005 to 2009.

	2005	2006	2007	2008	2009	% Change 2005-09
Canada	25.0	25.2	26.6	25.5	24.9	-0.4%
China	34.6	35.0	32.3	34.9	36.1	4.3%
EU-27	42.2	42.1	43.9	42.8	42.3	0.2%
Hong Kong	59.6	60.4	61.5	65.0	65.1	9.2%
Japan	19.7	19.2	19.4	19.5	19.6	-0.5%
Korea South	27.3	29.5	31.1	31.4	29.2	7.0%
Mexico	14.7	14.3	14.0	14.6	15.0	2.0%
Russia	17.0	18.2	19.4	21.7	20.7	21.8%
Taiwan	41.6	40.7	40.5	41.2	41.7	0.2%
United States	29.3	29	29.8	29	29.1	-0.7%

Source: USDA – FAS

CONCENTRATION IN THE GLOBAL AND NORTH AMERICAN FOOD SYSTEM

The many participants in the Canadian pork industry supply chain include producers, processors and retailers. The largest Canadian pork processor in Canada is Maple Leaf Foods and the largest food retailer is the Loblaw Companies. As a participant in the global food system, the Canadian pork industry is affected by the intense competitive factors that Canadian based processors and retailers like Maple Leaf and Loblaw face from large international competitors.

Global Retailers

Table 7 shows the largest food retailers in the world ranked by 2008 sales in \$US billions. The US based Wal-Mart is far and away the world leader at \$401.2 billion and has a large presence in Canada. Ranked number eight in the world is US based Costco with sales of \$71 billion. Costco also has stores throughout Canada. Canada's Loblaw Companies rank number 24 in the world with sales of \$28.9 billion.

North American Retailers

If the focus shifts to North America, the food retail sector is dominated by US based companies. Table 8 shows the largest North American food retailers and wholesalers ranked by estimated 2009 sales in \$US billions. Total sales includes both food and non-food merchandise in North America. The top 75 companies are estimated to have had \$891.4 billion in total sales in 2009, which is down 0.2% from 2008. Wal-Mart is the dominant market leader with North American sales of \$262.0 billion or 29% of the total for the top 75. The ten largest companies on the list represented \$606 billion in sales or 68% of total sales of the top 75 companies. The top 20 companies accounted for \$727 billion in sales or 81.6%.

Table 7. Largest global food retailers, 2008.

Rank	Company	2008 Sales (\$US billions)	Number of Stores
1	Wal-Mart Stores (USA)	401.2	7,873
2	Carrefour (France)	117.3	15,430
3	Tesco (UK)	99.7	4,300
4	Metro Group (Germany)	98.6	2,195
5	Schwarz Group (Germany)	80.9	9,300
6	Kroger (USA)	76.0	3,637
7	Rewe (Germany)	73.4	13,000
8	Costco (USA)	71.0	544
9	Aldi (Germany)	65.7	9,000
10	Auchan (France)	57.8	2,777
24	Loblaw (Canada)	28.9	1,036

Source: SupermarketNews.com.

Table 8. Largest North American food retailers and wholesalers, 2009.

Rank	Company	Estimated 2009 Sales (\$US billions)	Corporate Stores
1	Wal-Mart Stores (USA)	262.0	4,624
2	Kroger (USA)	76.0	3,634
3	Costco (USA)	71.4	527
4	Supervalu (USA)	41.3	2,450
5	Safeway (USA)	40.8	1,730
6	Loblaw (Canada)	29.9	1,036
7	Publix Super Markets (USA)	24.3	1,018
8	Ahold USA (USA)	22.3	707
9	C&S Wholesale Grocers (USA)	19.0	n.a.
10	Delhaize America (USA)	19.0	1,608
14	Sobeys (Canada)	12.7	1,325
17	Metro (Canada)	10.7	747
46	Overwaitea Food Group (Canada)	2.7	123

Source: SupermarketNews.com. Note: n.a. – not available.

Canadian Retailers

The Loblaw Companies ranked number six in North America at \$29.9 billion in sales or 3.4% of the top 75 total. The next largest Canadian based companies are Sobeys with \$12.7 billion, Metro at \$10.7 billion, and the Overwaitea Food Group with \$2.7 billion in sales. They are ranked number 14, 17 and 46 respectively. The four Canadian companies combined accounted for \$56 billion in sales or 6.3% of the top 75 total.

Research done by Ipsos Reid in Canada in 2008 found that 70% of pork purchases in Canada (in kg) were from Loblaw, Sobeys and Metro stores. The vast majority of pork is purchased at mainstream or discount grocery chains. Loblaw, Metro, Wal-Mart and Costco all buy nationally and combined accounted for 65% of meat buying decisions. In Ontario, these four retailers accounted for 75% of meat buying decisions.

North American Processors

Shifting to the largest North American food processors, we again see US based companies dominating the market. Table 9 shows the largest North American food processors ranked by 2008 food sales in \$US billions. Of specific interest in the list are companies with a significant presence in the North American retail pork sector. These include Tyson Foods (#2), Smithfield Foods (#8), JBS USA (#13), Sara Lee (#16), Hormel Foods (#17), and Cargill (#21). These six US based companies accounted for \$64.134 billion in food sales and \$193.04 billion in total company sales in 2008. By comparison, the largest Canadian based processing company with a pork product presence is Maple Leaf Foods ranked number 23 with \$5.2 billion in food and total company sales.

Table 9. Largest North American food processors, 2008.

Rank	Company	2008 Food Sales (\$US billions)	2008 Total Company Sales (\$US billions)	Food Sales/ Total Sales (%)
1	Nestle	26.477	102.962	26
2	Tyson Foods	26.325	26.862	98
3	Pepsico	25.346	43.251	59
4	Kraft Foods	23.956	42.201	57
5	Anheuser-Busch InBev	15.571	39.158	40
6	Dean Foods	12.455	12.455	100
7	General Mills	12.100	14.691	82
8	Smithfield Foods	10.726	12.488	86
9	Kellogg	8.457	12.822	66
10	Coca-Cola	8.205	31.944	26
11	ConAgra Foods	8.031	12.731	63
12	Pilgrim's Pride	8.025	8.525	94
13	JBS USA	8.000	13.284	60
16	Sara Lee	6.828	13.212	52
17	Hormel Foods	6.755	6.755	100
19	Saputo	5.793	n.a.	n.a.
21	Cargill	5.500	120.439	5
23	Maple Leaf Foods	5.243	5.243	100

Source: FoodProcessing.com. Note: n.a. – not available.

In summary, participants in the Canadian pork industry supply chain face stiff competition from international companies, particularly US based companies. Wal-Mart is the leader in both North American and global food retailing. Canada's largest retailer, Loblaw Companies, ranks 6th in

North America and 24th in the world in retail sales. In terms of food processors, Canada's largest company with a significant pork product presence is Maple Leaf Foods which ranks 23rd in North America. Six US based companies with significant pork product presence in the North American retail market are all larger than Maple Leaf in terms of food sales. This fierce competition at the retail and processing level creates a lot of pressure on the Canadian pork industry supply chain to continually search for advantages in costs, quality, innovation and relationship management.

GLOBAL ISSUES

As shown in the previous discussion the pork industry is a global business. As such, events in one part of the world often have the ability to affect production in other countries. Disease is a prime example of this. When the H1N1 virus was found on a pig farm in Mexico in April 2009, pork markets worldwide suffered as countries closed their borders to imports and consumers lost confidence in the pork supply. University of Guelph - Ridgetown Campus estimated that losses to the Ontario industry alone were approximately \$7 million for the 3 weeks immediately following the announcement of H1N1 in Mexico.

Feed costs are another issue that affect pig production. Feed represented approximately 64% of the cost to raise a market hog from birth in 2009 (Richards). Table 10 shows US corn supply and demand figures as of February 2010. This information is important because Ontario corn prices are based off US prices and are then adjusted for local factors. Table 10 indicates that prices at this time are projected to be lower in the coming year compared to the previous 2 years due largely to record yields.

Table 10. US corn supply and demand.

	2007/08	2008/09	2009/10 Feb*	2009/10 Mar*
Beginning Stocks	1,304	1,624	1,673	1,673
Production	13,038	12,092	13,151	13,131
Imports	20	14	10	10
Total Supply	14,362	13,729	14,834	14,814
Feed & residual	5,913	5,246	5,550	5,550
Food, seed, industrial	4,387	4,953	5,565	5,565
Ethanol – fuel	3,049	3,677	4,300	4,300
Exports	2,437	1,858	2,000	1,900
Total Use	12,737	12,056	13,115	13,015
Ending Stocks	1,624	1,673	1,719	1,799
Avg Price (\$/bu)	4.20	4.06	3.45-3.95	3.45-3.75

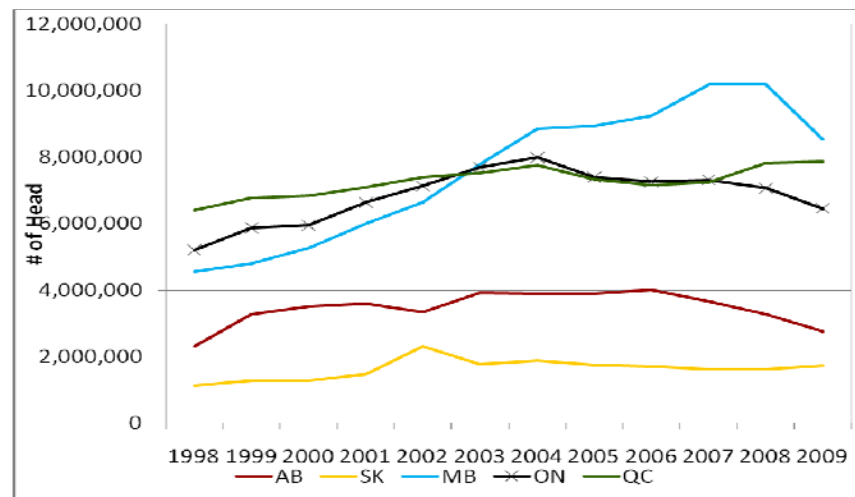
Source: USDA, WASDE, March 2010. * Projections. Numbers may not add due to rounding.

Trade is another challenge for the pork industry. Trade barriers such as country of origin labelling and food safety regulations in other countries can be significant impediments to trade while exchange rate affects price competitiveness in export markets.

CANADIAN PIG PRODUCTION AND TRADE

Total pig production for the major pig producing provinces is displayed in Figure 1. Manitoba increased pig production from approximately 4.6 million pigs produced in 1998 to the peak of 10.2 million in 2007. Canada's total production grew from 20.5 million in 1998 to a high of 31.2 million in 2004 before declining to 27.8 million in 2009.

Figure 1. Total pig production by province.



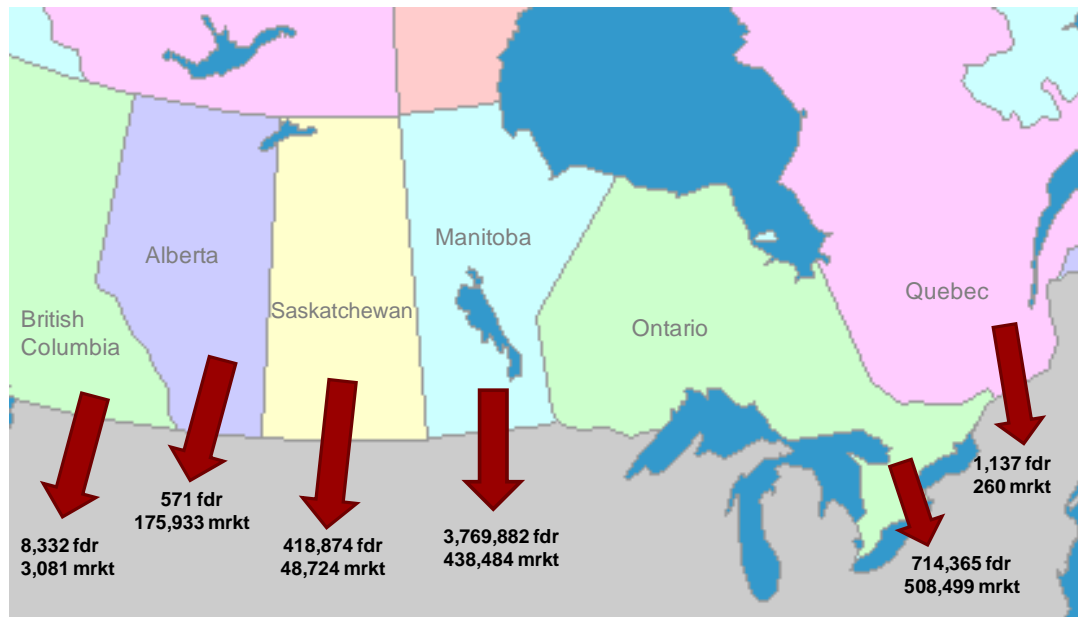
Source: USDA, APHIS; CFIA & provincial governments. Pig production = province of origin hogs slaughtered + weaner exports + market hog exports.

Canada has been heavily reliant on exporting feeder pigs and market hogs to the US. Movement of these pigs by province in 2009 is shown in Map 1. Live exports have decreased in 2009 to 6.2 million pigs (i.e. 5 million feeder pigs + 1.2 million market hogs) from approximately 9.7 million in 2007 (i.e. 6.5 million feeder pigs + 3.2 million market hogs).

Table 11 provides an indication of how reliant on exporting the Canadian pork industry is. In 2008 approximately 62.7% of production was exported as live pigs or pork compared to 57.9% in 2009. Much of the change in export % can be attributed to the decline in total live pig exports which decreased by 32% from 2008 to 2009. The decrease in live exports is largely due to country of origin labelling regulations in the US which has reduced the flow of pigs from Canada.

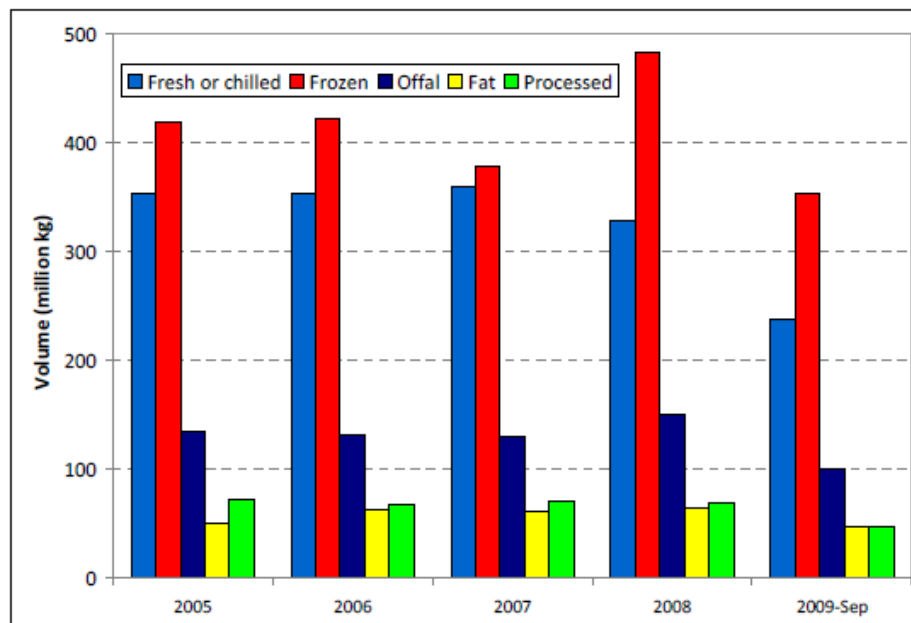
As stated previously, the pork industry in Canada is heavily reliant on the export market. There are 5 categories of export products including: fresh and chilled; frozen; offals; pig fat; and processed. The largest category by volume from 2005 to 2009 is frozen pork which ranged from 379 million kg in 2007 to 483 million kg in 2008 as shown in Figure 2. This represented 42% of all pork exports on average. Fresh or chilled pork ranged from 329 million in 2008 to 359 million in 2007 and represented on average 33% of all pork exports. When combined, the frozen and fresh or chilled pork categories accounted for 75% of total Canadian pork exports by volume.

Map 1. Feeder pig and market hog exports to US, 2009.



Source: USDA, APHIS.

Figure 2. Total volume of pork exports by category, 2005-2009.



Source: AAFC Agri-Food Trade Service. 2009 data is for January to September.

Table 11. Canadian hog production.

	Pig #s	
	2009	2008
i) Hogs		
Number Slaughtered*	21,642,151	21,521,403
ii) Pork Trade		
Processed Pork Exported (kg)	1,075,180,822	1,094,500,865
Processed Pork Imported (kg)	169,740,222	174,271,744
Net Processed Pork Trade (kg)	905,440,600	920,229,121
Conversion of net pork exports to live hog equivalents ¹	9,841,746	10,002,490
iii) Consumption		
Consumption (Hogs slaughtered – live hog equivalent of net pork exports)	11,800,405	11,518,913
iv) Live Pig Exports (to all countries)		
Exports – Feeder Pigs	5,221,664	7,036,388
Exports – Live Hogs	1,142,671	2,308,368
Total Live Pig Exports	6,364,335	9,344,756
A. Net Pork and Live Pig Exports	16,206,081	19,347,246
B. Total Production (slaughtered + live pig exports)	28,006,486	30,866,159
C. % of Production Exported as Pork or Live Pigs (C=A/B)	57.9%	62.7%

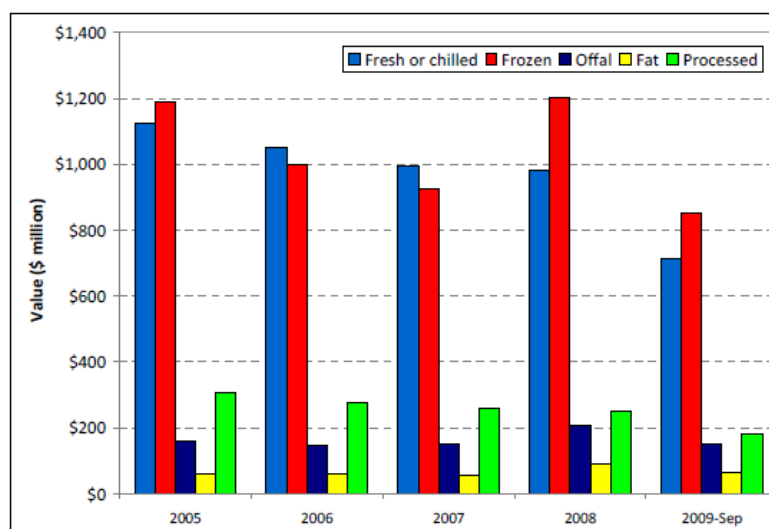
Source: Statistics Canada; ¹ Live hog equivalent = net pork trade/average carcass weight. Carcass weight = 92 kg.

* Province of origin slaughtered pigs - hogs that are slaughtered within Canada.

Frozen pork is also the largest category in terms of total value. This is shown in Figure 3. This category ranged from \$926 million in 2007 to \$1.2 million in 2008. On average the frozen pork category represented 41% of the total value of pork exports. The category fresh or chilled pork was the next largest and ranged from \$981 million in 2008 to \$1.1 billion in 2005. An average of 39% of the value of all pork exports was attributed to fresh or chilled pork. Therefore, 80% of total export value is from fresh, chilled or frozen products. In comparison, 10% is from processed products, 7% from offals and 3% from pig fat.

Japan and the US are the two leading countries that Canada exports to. Japan and the US represented 33% and 32% respectively of the total pork export value however the US represented 31% of the total export volume compared to 21% of Japan. Together, the US and Japan account for 65% of pork exports by value and 52% of exports by volume. The top 5 countries for 2009 by value and volume are shown in Table 12.

Figure 3. Total value of pork exports by category, 2005-2009.



Source: AAFC Agri-Food Trade Service. 2009 data is for January to September.

Table 12. Top 5 destination countries for Canadian pork exports by value and volume, 2009.

Rank	Country	Value (\$C mil)	% of Total	Rank	Country	Volume (mil kg)	% of Total
1	Japan	865	33	1	US	329	31
2	US	834	32	2	Japan	227	21
3	Australia	140	5	3	Hong Kong	79	7
4	South Korea	126	5	4	South Korea	64	6
5	Hong Kong	118	4	5	Russia	59	5
	Total, all countries	2,602			Total, all countries	1,075	

Source: Statistics Canada, AAFC Agri-Food Trade Service. Figures have been rounded. Countries have been ranked according to 2009 export data.

The value per kilogram for exports is broken down by country in Table 13. The 5 countries shown are the countries that had the highest total value of exports in 2009. The highest average values from 2005 to 2009 were realized on products sold to Japan and Australia. The average prices to these two countries were \$3.65/kg and \$3.20/kg respectively. The average price to the US was \$2.75/kg. The average value for all pork exports during the 2005 to 2009 time period was \$2.50/kg.

Table 13. Value of exports for top 5 destination countries (\$/kg), 2005-2009.

	2005	2006	2007	2008	2009	Average
Japan	3.81	3.45	3.44	3.72	3.81	3.65
US	3.06	2.85	2.60	2.71	2.54	2.75
Australia	3.55	3.15	3.30	3.18	2.83	3.20
S Korea	1.67	1.78	1.94	2.15	1.97	1.90
Hong Kong	1.34	1.39	1.36	1.40	1.49	1.40
Total	2.76	2.44	2.40	2.50	2.42	2.50

Source: Statistics Canada, AAFC Agri-Food Trade Service. Figures have been rounded. Top 5 countries determined by value of 2009 exports.

SUMMARY

In summary, pork production is a global business. Pork producers are affected by issues that occur around the world and they must be able to adjust quickly as a result. Canadian producers have been making adjustments as a result of a strengthening Canadian dollar, country of origin labelling, variable feed costs and so on. The industry has relied heavily on the export market for live pigs and pork. Given Canada's current production capacity and "pork for the world" marketing philosophy, it is expected that the export market will continue to be very important in the future.

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A HOLISTIC VIEW OF THE FUTURE

Dennis DiPietre
KnowledgeVentures, LLC
1802 E. Whisenhunt Rd., Columbia, Missouri 65201
E-mail: hogs2denis@aol.com

INTRODUCTION

In the early 1980's, I co-authored an undergraduate Farm Management text with the title: "Farm Business Management: *Successful Decisions in a Changing Environment*"; if I only knew! To say we are now in a period of rapid change and it will continue is nothing short of a tautology. Humanity, however, is facing some very serious questions about global sustainability as the world transitions out of the "wild west" mode of undiscovered areas of abundant natural resources just over the horizon, to the stark reality that population continues to expand while available resources are getting more expensive to find and utilize.

This was the muse of Thomas Robert Malthus who wrote in the mid 1700's that humanity would constantly challenge, through expanding population, the globe's ability to produce sufficient food to sustain it. His forecast of tripartite doom through disease, aggression and, of special interest to this group, famine, as the necessary cure for overpopulation is still in the forefront of policy makers minds whether they know of his work or not.

Norman Borlaug, whose recent passing we note, led nothing short of a global transformation of agriculture beginning in the mid 20th century, primarily by applying the science of plant genetics to overcome localized growing issues and to make a class of plants that could sustain large yielding heads of grain, for instance, without lodging. Borlaug was the last of the traditional agriculturalists that seemed to depend on more and better fertilizers coupled with better quality genetics.

Environmentalists have reinterpreted his work, which literally saved millions from starvation, in a negative light and have succeeded in gaining control of the various government and private funding agency agendas to cease subsidizing this pathway in the future. Borlaug himself believed that only a few areas of the world remained to be developed for crops, mainly the Russian steppe and parts of South America and Indonesia and then, some serious checks on population would need to appear, either through private decision or public policy.

Trying to understand the emerging "holistic" nature of the swine industry of the future cannot be divorced from this reality, as its most recent transformation from "pigs in mud puddles" to the current production systems of the developed world escaped the mud only to become newly mired in a development model that policy makers, currently in the ascendancy, would like to retire.

DEVELOPMENT MODELS

One of the biggest issues facing both the global swine industry and all of agriculture is the politicization of almost everything, but perhaps most important science. The role of scientists as “dispassionate purveyors of value free information” has all too often given way to a politicized class of agenda-driven researchers who often operate their craft in the mode of “conclusions seeking evidence”. The recent e-mail imbroglio of the East Anglia University just illustrates the current state of affairs at major and minor universities.

To understand this, I think you begin with the issue that many universities must rely on government research aid (local, state, country, global such as the United Nations) to survive and many, more than specialize in it. And it has become a source of funds which has shown that it can be and often is now as corrupting and corrupt as any accusation which could in the past be leveled at private company research sponsorship, regarding bias. Gaining access to government funding in highly politicized areas of research (such as anything related to the environment) seems to require something far more than a *tabula rasa* of preconceptions for the proposals to be successful. This leads to the “in-crowd” of dependable researchers who will reach dependably supporting conclusions in the dependably accepting refereed journals while challengers are apparently now systematically refused both funds and publication venues. Whether or not this situation is corrected will largely determine the unfolding future of global agriculture and its methods. My personal opinion is that the demands for food will eventually force the truth on everyone.

The underlying falsehood of this current model described above is based in the following *modus*. A consensus conclusion is reached regarding the truth of an issue and then researchers excuse themselves from rigorous scientific research, the principles of doubt which undergird true research, and “spurious” data and results which at times do not support the conclusion are discarded. This is done because the stakes are too high with regard to the environment to let any other conclusions or evidence delay the full implementation of the consensus fix(es).

ACTUAL THREATS OR DISTRUST OF SCALE?

If you make a list of the current criticisms which are leveled at modern agriculture by not only major policy makers, but by NGOs, interest groups, the media and the arts (witness a veritable cottage industry erupting in anti-modern, food production and processing films) you are left wondering something important. Are the criticisms real problems or are they a reflection of the East Anglia problem? Namely, that a distrust of modern agriculture has developed, based on a number of preconceptions and belief systems which include, among other things, distrust of corporations and the likelihood of corporate responsibility, distrust for concentration and the scale it normally entails, and certain beliefs about rural justice and the social contract issues surrounding the transitioning of agriculture from small-scale family plots to agribusinesses. Conclusions in these areas seem to spin up the supporting “research”, funding, and eventual policy creation and implementation.

Activists discovered that attempts to inject their influence in modern agriculture by seeking governmental restraints and prohibitions were often countered by the multi-national character of corporations which could escape government regulations by transferring their business to other, less regulated countries. This resulted in a two part strategy to enforce conformity by attacking the brand of these companies (which has global revenue ramifications) and by appealing to global governance bodies like the United Nations hoping to enforce global restrictions and taxes. The former has been much more successful than the latter as the Global Warming meetings held recently in Copenhagen illustrate.

POPULATION GROWTH AND INCOME

Regardless of the political, corporate and individual influences that shape the future of the swine industry and production agriculture in general, I believe there are some things which will be relatively inescapable and will be manifest in magnitude only depending on which group or points of view gain ascendancy and when. There is no doubt that the population of the world is growing and there is further no doubt that the quickest pace is in areas of the world which are the poorest. Many factors contribute to shape global and regional population growth but the most effective thing in slowing down rates of growth is increases in per capita income. As nations and regions become more prosperous, their rates of growth diminish (and the opposite is also true at least by correlation). Large family strategies can be related to religion and other motives but survival drives this strategy in the poorest of the poor nations. Current efforts to restrict, tax and prohibit growth, if successful, seem likely to restrain the growth of per capita income and thereby exacerbate the population problem. A politically enforced “one-child” policy is the strategy employed where per capita income growth cannot increase at a rate fast enough to naturally restrain population growth.

PRECISION AGRICULTURE

Rising demand for food from the people least able to both organize to produce it and afford to pay for it is the challenge of the next 25 to 50 years. The global poor tend to consume mostly coarse grains and some vegetables so the demand for meat will be conditioned on increases in per capita income or population growth in areas where per capita income supports significant meat consumption. The demand for arable land, global and regional water resources, and global and regional energy resources will eventually become constraining unless technological (including plant and animal genetics) solutions outpace the growing demand. You bet against technological advance at your own peril but governmental policy constraints on technological solutions may limit the speed of progress.

What this means is that the future will likely be more volatile than the past along a host of important dimensions. Our course within agriculture and within the swine industry in general will need to become more precise. Those who are successful will find ways to live and thrive within a much smaller range of the full volatility that will be served up over the next decade. With volatility comes opportunity, so while we may have to trade off some of the future “average” to buy the protection of a risk-reduced strategy, that average should be larger than in

the past. Failure to define a strategy which escapes the turbulence to smoother air will result in chronic liquidity crises and the failure to secure adequate financing.

Precision agriculture, which is a moniker developed primarily in crop agriculture, refers to the ability to measure variation in the production process and intervene with highly targeted solutions prior to harvest as well as prescribing interventions for the next cycle. The ability to effectively monitor a production process for variance from intention and intervene to restore intention is the key to operating within this “narrower” band of variance which the market and “conditions” of various kinds will increasingly serve up.

Following a more precise biological production strategy will result in increased efficiency, since the root cause of high cost systems is almost always traceable to high variance production. Resource use and therefore effluent produced per hundredweight are minimized as standard deviation of production is lowered. Most modern swine production systems produce standard deviations of finished liveweights in the range of 10-12 kg. Since most data sets of weights of animals sold are usually normally distributed, it takes a range of 40-50 kg to contain 96% of the production outcomes. This is unacceptable in the future and can be markedly reduced on a consistent basis where a knowledge based approach with the proper incentives is employed.

By the same token, managing the cost of input purchases, especially feedstuffs and the sale prices of finished animals in conjunction with each other (that is, managing variation in margin) is the corollary to reducing production variance. Those who hope in the long run to survive by accepting the day to day average price of feed and animal prices will face increasingly wrenching swings in net income which will make acquisition of capital difficult even if the farm survives by other income strategies (such as off-farm employment). Managing the so-called “crush” will be more important than achieving a “high” hog price, which has lost all meaning since input costs are capable of rendering record high hog prices into a financial loss.

CHANGE IS ON THE HORIZON

MILK PRODUCTION AND NUTRITIONAL REQUIREMENTS OF MODERN SOWS

**Casey Neill and Noel Williams
PIC North America**

100 Bluegrass Commons Blvd. Suite 2200, Hendersonville, Tennessee 37075

E-mail: casey.neill@pic.com

INTRODUCTION

The modern white line sow has been selected for large litters and milk production and the evidence is clear on sow farms. Many sow farms have been increasing total born and weaning large litters with heavier pigs. With litter size continuing to improve and lactation length increasing to around 21 days, the demand for milk production must continue to increase to meet the increasing demand of heavier pigs. Modern sows can produce 10 to 12 kg milk/day (Aherne, 2007) with day 21 of lactation being the peak of production. In fact, sows can produce more milk per kg of body weight than cows. If a 182 kg sow produces 11 kg of milk/day that would be 0.06 kg of milk per kg of body weight. A 909 kg cow can produce 45.5 kg of milk/day that would be 0.05 kg of milk per kg of body weight (Goodband, personal communication).

Milk production by the mammary glands is influenced by genetics and nutrition (Tri-State Swine Nutrition Guide, 1998). To maximize milk production in sows, it takes many factors besides genetics and nutrition. Other factors include feed intake (frequency of feeding), environment (farrowing house temperature), length of lactation, body condition and water intake. One example of management that decreases milk production is restricting feed intake which will decrease milk production in gilts and sows (Pluske et al., 2009).

With the correct selection of genetics, the right environment and management there can be an increase in milk production and therefore heavier weaning weights.

POTENTIAL FOR MILK PRODUCTION IN COMMERCIAL UNITS

As sows have been selected for greater milk production and productivity levels have been improved in commercial units, both milk production and litter weaning weights have increased substantially. In USA, there are examples of units where sows are weaning total litter weaning weights of over 76 kg on 20 day lactation (Table 1). With increased potential for milk production, management and nutritional factors must be changed to meet these demands for lactation.

NUTRITIONAL REQUIREMENTS FOR OPTIMUM MILK PRODUCTION

Sows can achieve and maintain high levels of milk production throughout their productive life if given adequate levels of energy and nutrients. The most critical nutrients for maintaining

optimum lifetime milk productivity are energy and amino acids. Table 2 shows the predicted lysine needs of prolific first litter sows based on current estimated milk production potential.

Table 1. Commercial production for milk production (January – June 2007)^a.

Trait	Response
Number of Sows Farrowed	3029
Total Pigs Born	12.5
Total Pigs Born Alive	11.6
Litter Birth Weight, kg	20.9
Pre-Wean Mortality, %	7.0 %
Pigs Weaned/Litter	10.8
Weaning Age, Days	20.2
Litter Weaning Weight, kg	76.4
Litter Weight Gain, kg/d	2.74
Milk Production, kg/day ^b	10.99

^aPIC Commercial Camborough 1070 Females located in Midwest USA.

^bAssumes 4 g milk per gram of piglet growth.

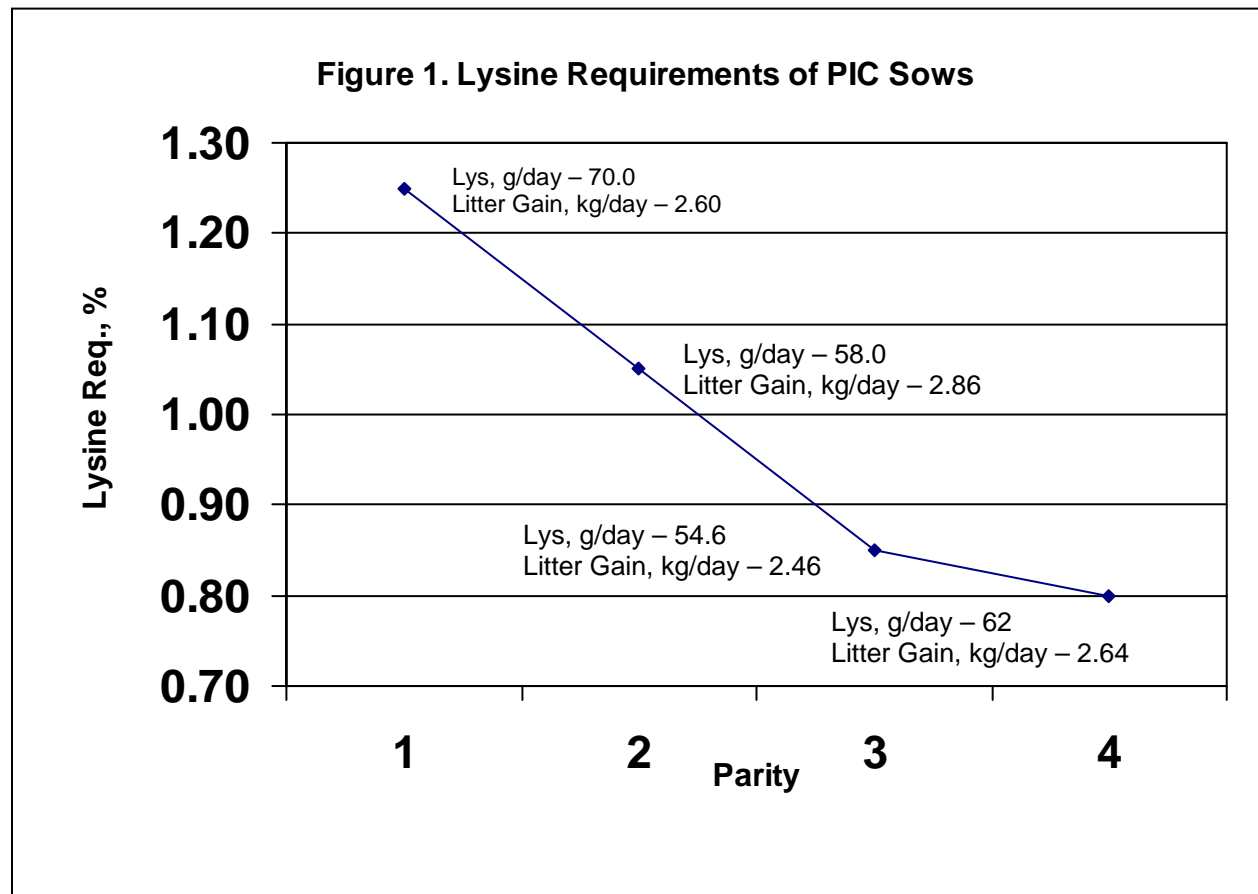
Table 2. Predicted lysine need for first parity sows^a.

Trait	Response
Body Weight at Farrowing, kg	182
Body Weight at Weaning, kg	163
Weight Loss, kg	11.1
Estimated Protein Loss, %	10
Litter Gain, kg/d	2.74
Lysine Needs, g/d	
Maintenance ^b	2.5
Milk Production ^b	73.4
Total	75.9
Lysine Supplied g/d	
Protein Mobilization, g/d	2.5
Diet, g/d	73.4
Feed Intake, kg/d	5.0
Total Lysine Requirement, %	1.22

^{a,b}Adapted from Boyd et al., 2002 and Pettigrew, 1993.

These estimates for lysine needs have been validated in a series of studies designed to validate amino acid needs of PIC sows in commercial research conditions (Srichana et al., 2007). In these studies, PIC C-22 sows in parities 1 through 4 were fed isocaloric (3.46 Mcal ME/kg) corn soybean meal lactation diets ranging from 0.95 % to 1.35 % total lysine. Diets were given to sows from day 112 of pregnancy throughout the 19 day lactation period. Feed intake was recorded with a computerized feeding system that insured ad-libitum feed intake. Figure 1 demonstrates the estimated lysine requirement (% and g/day) and milk production (kg/day) for PIC C-22 sows in parities 1 through 4.

Figure 1. Lysine requirements of PIC sows.



In summary of these sets of experiments, total lysine intakes of 70 g/day or 62 grams of SID lysine/day optimize reproductive and milk production performance in PIC sows.

Because gilts eat 10 to 15% less than sows the percent SID lysine in the lactation must increase compared to a mature sow herd. Because we target 62 grams of SID lysine/day we must formulate based on feed intake and not only percent SID lysine. To prevent a Parity 2 dip, we must feed the gilt properly and allow full feed after farrowing. First, the gilt loses more than 10% of her body weight during lactation, then the subsequent litter will suffer with low production. Refer to Figures 2, 3 and 4.

Figure 2. Impact of body weight loss on subsequent performance (Parity 1 gilts).

PIC

Impact of Body Weight Loss on Subsequent Performance (Parity 1 Gilts)

	Body Weight Loss			P-value
Criteria	> 10 %	0 -10 %	Gained Wt.	
Number of Sows	31	191	66	
WEI, d	7.04	6.58	5.32	.21
Sows bred by day 7, %	67.4 ^a	79.5 ^b	86.3 ^b	<.10
Total Born	11.17 ^a	12.57 ^b	13.04 ^b	.07

^{abc}Means within a row without a common superscript differ (P <.05)

NEVER STOP IMPROVING

Figure 3. Effect of dietary lysine intake on piglet ADG (g/d) of gilt litters.

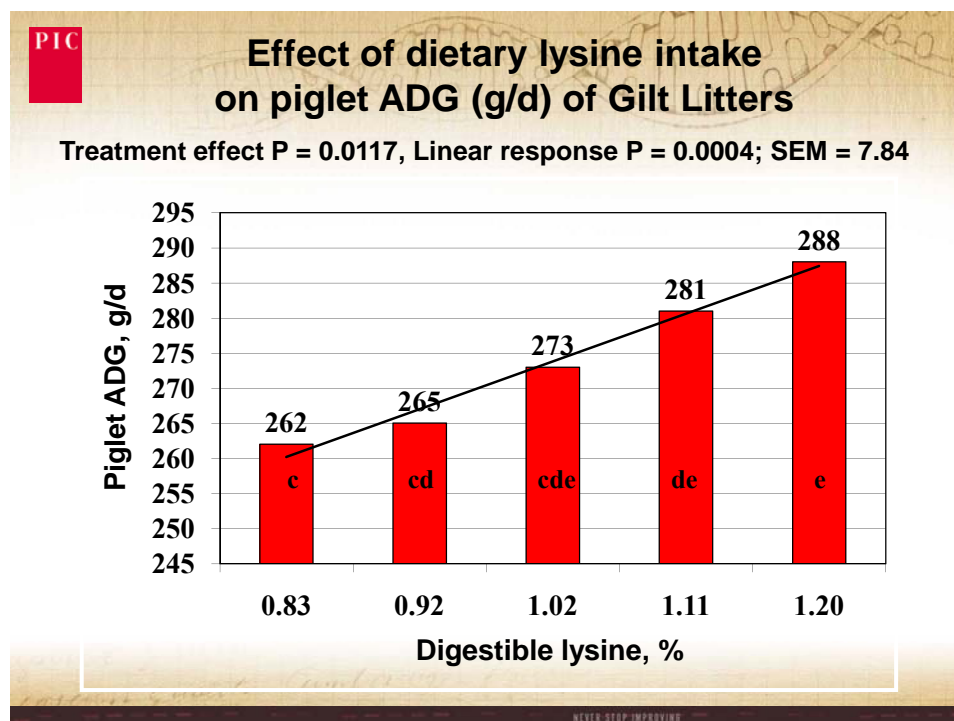
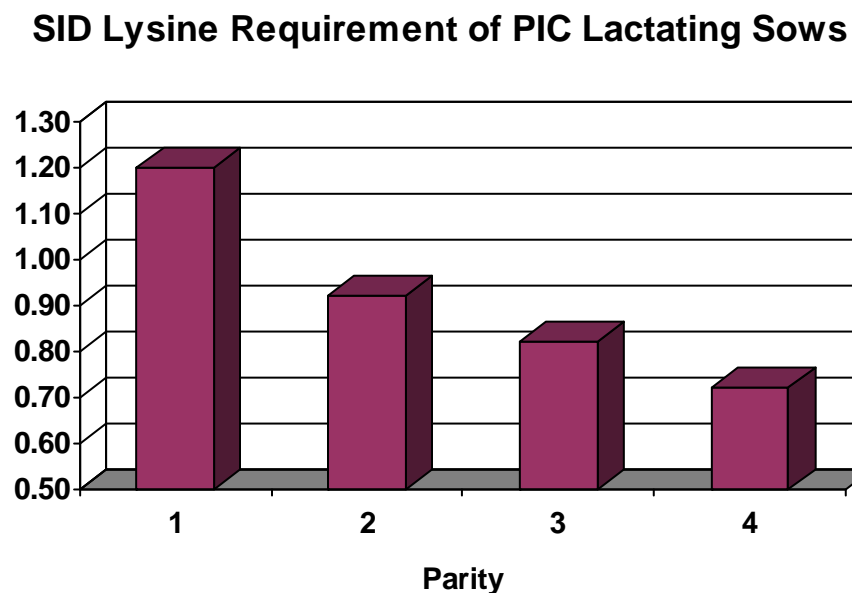


Figure 4. SID lysine requirement of PIC lactating sows.



In addition to lysine requirements, the maximum amount of synthetic lysine in lactation diets and the ideal ratios of other amino acids have recently been validated (Shrichana et al., 2007). Not only will this improve performance but lower diet cost. Table 3 shows reproductive and milk production response to increasing levels of dietary synthetic lysine.

Table 3. Maximum use of crystalline amino acids in lactating sows^a.

L-lysine-HCL, %	0.000	.075	.150	.225	.300
Sow Body Wt Change, kg	1.4	2.9	3.0	4.6	4.4
Litter Gain, kg/d	2.27	2.29	2.38	2.23	2.41
WEI, d	7.1	6.4	5.5	5.9	5.5
Subsequent Reproductive Performance					
Total Born, pig	11.75	12.52	12.45	12.05	12.48
Born Alive, pig	10.95	11.47	11.41	11.42	11.62

^aShrichana et al., 2007. 283 Primiparous PIC C22 Sows. Total Amino acid ratios used in diets: Methionine+Cystine: Lysine, 58%; Threonine:Lysine, Tryptophan:Lysine, 18%; Valine:Lysine, 71%.

These studies indicate that up to 0.30 % synthetic lysine can be added to primiparous sow diets without deleteriously affecting reproductive or milk production performance. This response has also been validated in older parity sows (Allee, 2007 personal communication).

With updated nutrition requirements we have included updated SID amino acid ratios (Table 4).

Table 4. SID amino acid ratios.

SID Amino Acid Ratio	Gestation	Lactation	
	Herd	Gilt	Herd
Lysine	100	100	100
Methionine + Cystine	70	50	50
Threonine	76	64	64
Tryptophan	18	18	18
Valine	68	75	75
Isoleucine	58	56	56

FEEDING MANAGEMENT REQUIREMENTS FOR OPTIMUM MILK PRODUCTION

In addition to amino acid intake, proper energy intake is essential for maximizing milk production in sows. Both the amount of and type of energy can influence milk production. Several ways to increase feed intake have been evaluated in commercial sow production. Basic feeder design and feeding pattern have recently been evaluated in commercial conditions to evaluate methods to maximize feed intake and thus milk production.

Recently in the United States, various forms of self feeders have been evaluated in order to maximize feed intake. PIC has collaborated on various trials to determine the efficacy of newly designed self feeders in commercial systems. Although there exists various options within the industry, we have most extensively evaluated the INTaK Ad-Lib Lactation Feeding System (<http://www.automatedproduction.com/english/swine/swine.htm>). Commercial field research has demonstrated an improvement of 7 percent in feed intake compared with hand feeding systems, along with less labor required for feeding. Figure 5 represents an illustration of an automated feeder.

In addition to evaluation of self feeders, we have evaluated optimum feeding pattern for maximizing lactation intake in commercial systems. In a recent study, the following feeding patterns were evaluated with self feeding systems (Tables 5 and 6 - Kummer, PIC Symposium 2007).

Data from Tables 5 and 6, demonstrate the mild restriction for 3 days followed by full feeding from day 4 through the end of lactation resulted in increased feed intake and reduced body weight loss. Based on these data, the recommendation for feeding PIC sows is to scale feed at 1.8, 1.8, and 2.7 kg for days 0,1, and 2, respectively of lactation followed by ad-libitum access to feed. These data also more fully illustrate the potential for feed intake and milk production for PIC females in parities 1 and 2.

Figure 5. Illustration of self feeder.

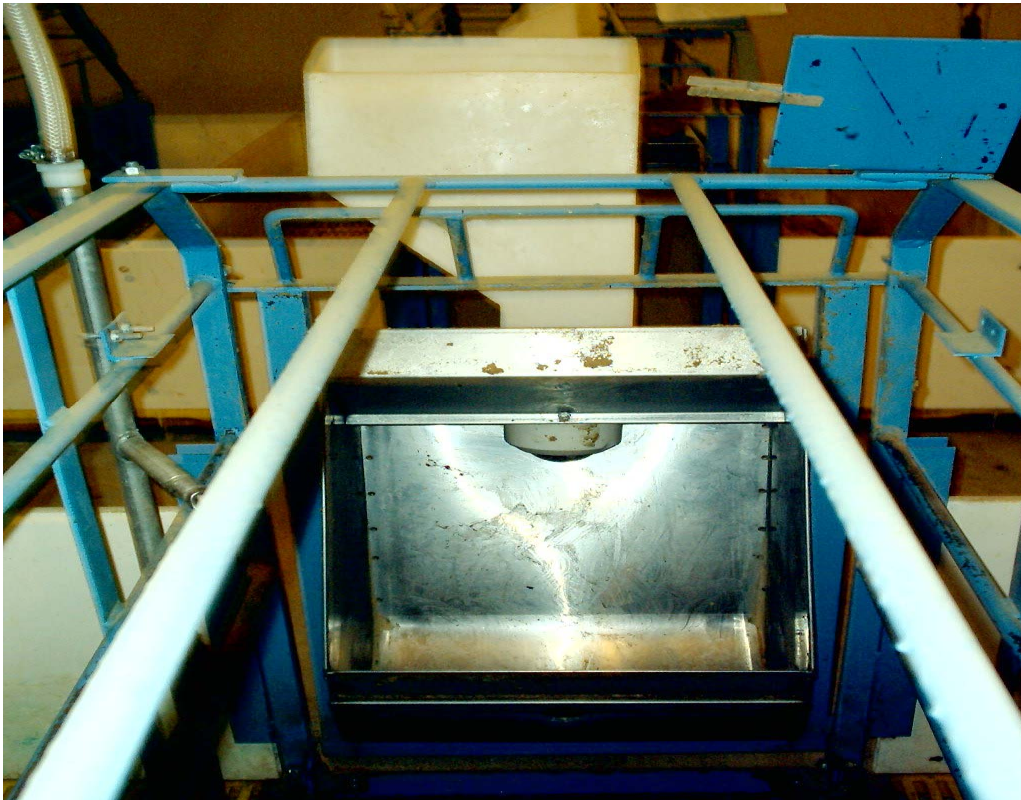


Table 5. Evaluations of various lactation feeding patterns^a.

Feeding Treatment	Day of Lactation								
	0	1	2	3	4	5	6	7	8+
1, kg fed	1.8	1.8	2.7	2.7	3.6	3.6	4.5	4.5	Full
2, kg fed	1.8	.9	1.4	1.8	2.3	2.7	3.2	3.6	Full
3, kg fed	1.8	1.8	2.7	2.7	Full	Full	Full	Full	Full

Table 6. Response to lactation feeding patterns^a.

	<u>Feeding Curve</u>		
	1	2	3
Sow Performance			
Post Farrow Wt, kg	216	216	216
Wean Wt, kg	210	206	211
Weight Loss, kg	6.8 ^b	9.3 ^c	6.1 ^b
Feed Intake			
0-10 Days	4.16	3.39	4.39
1-19 Days	5.17 ^b	4.75 ^c	5.28 ^b
Litter Performance			
Piglets Started/Sow	11.7	11.7	11.7
Piglets Weaned/Sow	10.82	10.72	10.82
Piglet Weight Initial, kg	1.63	1.66	1.66
Piglet Weaning Weight, kg	6.06	6.01	6.2
Litter Gain/kg/day	2.52	2.45	2.58

^aAdapted from Kummer, 2007. 200 PIC Camborough P1 and P2 sows.

^{b,c}Means with different superscripts differ, P<.05

BUMP FEEDING IN LATE GESTATION

There is limited research data on increasing feed in late gestation. However it is common practice to increase feed by 0.5 to 1.0 kg the last 2 to 3 weeks of gestation to support the increased litter growth. When sows are in proper body condition, bump feeding is recommended. However, if sows and gilts are over condition, bump feeding is not recommended. With the increase in feed costs, many producers are questioning the importance of bump feeding as it could save \$3.00 to \$5.00 per sow in feed costs.

A recent trial conducted by Shelton et al. (2009), used 108 PIC Camborough gilt and sows for a bump feeding trial. The researchers increased feed by 0.90 kg at day 90 of gestation or did not increase feed. The birth weight of pigs from gilt litters that were bump fed had increased ($P < 0.01$, Feed Level) weights. However there were no differences in birth weight from sows that were fed increased levels. The researchers concluded little response to bump feeding.

One area to point out is the amount of feed that was fed from day 35 to 90 of gestation. Table 7 shows that the sows were fed 2.60 kg per day of a corn-soybean meal diet. In most production systems sows are fed 2.0 kg from day 35 to 90 of a lower energy diet with wheat midds, soy hulls or DDGS. This may have caused some over conditioning.

If sows and gilts are being fed 1.8 to 2.0 kg per day in gestation, then the recommendation is to bump feed at day 90. If gilts and sows are over conditioned then do not bump feed.

More research is needed to better obtain a conclusion.

Table 7. Bump feeding in late gestation.

	Gilt		Sow		P < Level x Parity
	Normal	+ 0.90 KG	Normal	+ 0.90 KG	
Gestation Feed Intake, d 35	2.1	2.1	2.6	2.6	-
Gestation Feed Intake, d 90	2.1	3.0	2.6	3.5	-
Total Gestation Feed Intake, kg	237.5	260.8	299.0	321.9	0.99
Gestation Feed Cost, \$	50.85	55.82	64.01	68.91	0.99
Total Born	14.6	14.0	11.9	12.9	0.20
Pig Birth Weight, kg	1.41	1.49	1.53	1.42	0.04
Overall Litter Weight Gain, kg	51.2	51.5	47.7	46.8	0.72

ADDED FAT IN LACTATION

This is another area of limited research. An abstract from the 2010 Midwest Animal Science meetings by Rosero et al. (2010) used 337 sows (PIC Camborough) in Oklahoma during the months of July to September with added fat levels of 0, 2, 4, and 6%. The fat source was an animal-vegetable blend.

The researchers reported that when caloric intake was increased there were no beneficial effects on any measured criteria, except for improved litter gain in P3+ sows.

Another internal research trial was conducted with 1,020 PIC gilts and sows with two treatment levels of 0 and 5% added fat. The weaning weight from pigs that nursed from gilts and sows fed 5% added fat were 0.18 kg heavier ($P < 0.001$). However the difference in weight was not maintained at 22 weeks after weaning. There were no differences in sow performance reported.

CONCLUSIONS

The modern sow has a tremendous capacity for milk production given proper nutrition and feeding management. Milk production levels of over 11 kg/day can be achieved in commercial situations. To achieve these levels, specific needs for lysine and energy intake must be achieved. These levels are well defined for PIC females and are supported by commercial research. This paper serves as a guide for nutritional and feeding management for PIC sows.

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PRECISION MANAGEMENT: WHAT TOP PRODUCERS ARE DOING TO BE PROFITABLE

Hans Rotto
Innovative Agricultural Solutions LLC
Ames, Iowa 50010
E-mail: rotto.hans@gmail.com

ABSTRACT

The most economically stable swine producers today have implemented management practices that directly impact the profitability of their enterprise. They commit to clear expectations and protocols which allow people to meet their goals. They use objective measurements to monitor progress. Management through farm level employees is part of continual evaluation of the system and is connected to improvement and changes. Daily execution is a given and prioritization is driven off of the expectations.

INTRODUCTION

The lower profit margins in today's pork industry put tremendous pressure on producers' profitability. Costs and inputs have been scrutinized more closely than ever before. If you are trying to go from "Good to Great" on an "Earth that is Flat" and the current economics are "Freakonomics" to you, the potential of a "Fall from Greatness" is frightening. Currently, there are some common points that stand out in big and small production systems that make them better than others. No individual company is doing everything perfectly, but many have implemented a number of management practices that provide a way to continually improve.

CLEAR EXPECTATIONS

Successful swine production systems / farms can clearly state goals and the processes to attain those goals. They are recorded in concise protocols. These written protocols address **how** to do things and **when** to do things. The best protocols and expectations also clearly and concisely state **why** these expectations are important. An example could be the washing of farrowing crates and farrowing rooms post weaning. There is a logical step-wise process from breaking down the room, pre-soaking etc. The **how** and **when** are sequential logical methods to achieve the expected levels of cleanliness. If you have never done this task before, it is not so logical and may not make sense. Protocols with an explanation on **why** washing the crate from ceiling to floor to prevent re-washing and re-contamination helps people learn the logic and reasons in the written protocols. This leads to the achievement of the expectation and an inspected clean farrowing crate and room.

OBJECTIVE MEASUREMENTS

If expectations are clear and people understand **why** they are performing a task, it enables the process of measurement. Clear expectations should detail an outcome or goal that is understood, can be objectively measured and is in the control of the people responsible for the work. There is alignment of measurements and accountability. The best objective measures are either YES or NO or could be viewed as PASS or FAIL. A farrowing crate is clean or needs to be re-cleaned. The best operations view unmet expectations as opportunities to improve and provide ongoing training and clarification of the expectations. They are constantly trying to fill the gaps in a positive pro-active manner. They do not waver. They consistently re-visit and reference the written protocols and invest in the time and resources necessary for training. Ultimately, they understand more quickly when an individual is either incapable of performing the expectations or is making a choice not to meet expectations. At the same time the best companies are always evaluating the expectations outlined. Can they be improved? Streamlined? Are they realistic? Are they practical and achievable?

INCLUSIVE

As these companies are asking themselves these questions, they are engaging the people at all levels of the organization in the “self” evaluation. Generally, there is a semi-formal process where the on-farm and management input comes together. This input is reviewed and either changes are made or there is a re-commitment to what is currently expected. The best companies review the expectations and written protocols annually. They do not wait for failures or problems to occur in an area to review it. They look for opportunities to improve.

EVOLVING / CHANGING / ADAPTING

Highly successful and productive swine businesses are undergoing continuous improvement. Even though clear expectations are an absolute, these companies are challenging the **how**, **when** and **what** at all times. They have the ability to focus on measureable outcomes and do not get lost in the cloud of natural variation in a biological system. They re-set the expectations, re-train the processes and continuously evolve. People in these systems expect to change, they do not fear it. They are engaged in it and feel ownership in it at all levels of the organization. They are willingly and openly trying new technologies. They carefully measure these advances with a formal process of evaluation and are quick to adapt positive innovations. They are equally quick to dump things that do not work. It is important to realize that most of these organizations do not get caught up in the “flavor of the month” mentality. Nor do they get caught up in the paralysis of analysis of everything measurable. Too often, so many things are measured and analyzed that people within the organization lose sight of what is important. The risk is that eventually nothing seems important and prioritization becomes confusing.

KEY MEASUREMENTS

Successful swine production organizations are sharing and reviewing key indicators in real-time through-out the organization. Few days pass before a missed expectation is reviewed, investigated and plans put into place to correct it. These key indicators in the production system are very sensitive to the bottom line. If breed target is a key indicator and it is missed, the **what**, **why** and **how** are known, discussed and communicated openly. This assessment leads the conversation to other components of the key measurement. Did the farm breed the expected number of gilts? Did they miss target on wean sows, opportunity sows, etc...? This type of analysis requires open communication at the owner/management level to the farm level. For example, the breeding crews cannot control the fact that the gilts showed up 70 lbs lighter than expected. They can identify the missed expectation when it happens. They are responsible to plan accordingly to meet breed targets in any given week. If breeding target is missed two months later because the gilts were light, an opportunity was missed. It was a known “missed expectation” by the gilt supplier when the gilts arrived. The best organizations are immediately putting plans in place to make breed target when these gilts were expected to be available to breed. They are also working on correcting the gilt weight issue. Lastly, they are considering and working on plans to avoid over-breeding when the slug of gilts comes through the breeding herd. Management at all levels is in lock-step to anticipate the consequence of a missed expectation and minimize its impact on profitability. They are also sensitive and realistic about what people can control and do to minimize risks to profitability. These same companies use these issues to continuously improve their processes and protocols to meet expectations.

EXECUTION

Every day of the week, the execution of processes and protocols to meet the expectations on the farm are done with diligence, patience and care. There is no rushing through work on week-ends. Clock-watchers are not filling their day to match their task list. Work is not disrupted by a feed-line motor not working or someone not able to work due to illness. Execution of the most important processes is done well daily. This means that some days, some things such as washing a hallway or organizing the med shelves are postponed to a later date. The **key measurements** and **clear expectations** drive the prioritization of work at the farm level and managers/employees habitually focus on what is most important to the results.

CONCLUSIONS

The best companies use clear expectations, communicate change effectively and inclusively, and measure in real-time the key indicators to profitability. This re-enforces the importance of daily execution which can be tangible change to the bottom line and future of an organization.

ACKNOWLEDGEMENTS

Thank you to all the swine producers who allow me to learn and grow through providing support services to them.

PRODUCTION AND COST MANAGEMENT

PERFORMANCE VERSUS COST

Robert Morrison
University of Minnesota Swine Group
385 Animal Science / Veterinary Medicine
1988 Fitch Avenue, St. Paul, Minnesota 55108
E-mail: bobm@umn.edu

ABSTRACT

Canadian pork producers have had a quadruple whammy in recent years: corn going into ethanol driving up corn price, a global economic depression, nH1N1 influenza, and the Canadian / US exchange rate. Is maintaining top performance cost effective? What strategies should producers take in good and bad times? What tools are available to help make these business decisions? In this paper, we review the importance of having financial records to supplement production records. We need financial records for reporting and monitoring our financial well-being, for managing our costs and profitability and for making decisions that will impact the business. In the presentation, we will review cost of production and examples of effective decision making. The message is to first, know your cost of production, benchmark and look for ways to keep it low. Secondly, be an efficient top producer. Thirdly, manage your margin through effective hedging. And fourthly, maintain a strong balance sheet.

INTRODUCTION

A herd could be weaning 30 pigs / sow / year for an entire year and go broke. How? It could be a lack of inventory control, and therefore, too few sows bred, too few pigs weaned and fixed costs are spread over too few pigs. That is, the cost of production is too high. This is an example of a commonly accepted performance measure being overly simplistic and by itself, inadequate. We have adopted a second biologic measure to account for this inadequacy, and that is pigs weaned per week. We calculate the capacity of a sow facility and set a goal for throughput. This is a definite improvement. But I am guessing we all know farms where they are meeting throughput goals and yet are in financial trouble. In such a case, the problem may rest in the balance sheet, but might be made worse by income statement problems. That is, the cost of production could be too high and / or income too low, thereby increasing indebtedness on the balance sheet. So, while performance records are important to understand the biologic operation of the farm, financial records and their use in making decisions represent the “bottom line”.

FINANCIAL ACCOUNTING

Financial statements serve three important economic functions:

- They provide information to the owners and creditors of the farm about the current status and past financial performance.

- They provide a convenient way for owners and creditors to set performance targets and impose restrictions on the managers of the farm.
- They provide convenient templates for financial planning.

Chart of Accounts is used to classify data as it is accumulated in the general ledger for all financial reporting. The National Pork Board (NPB) recommends that producers keep at least the first level of accounts that include major income, expenses assets, liabilities and equity categories. The chart of accounts can be taken to three basic levels of production – breeding / gestation, nursery, finishing.

Balance Sheet

The balance sheet (BS) presents a snapshot at a point in time.

- Assets – items that have the ability or potential to provide future benefits to the firm. For example, cash, inventory and equipment.
 - Current = cash and convertible within 1 year
 - Non current = Property, plant & equipment (PPE)
= original cost – cumulative depreciation
- Liabilities – creditors’ claims on the assets of the firm
 - Current – due within 1 year
 - Noncurrent
- Equity or net worth – is the difference
 - Paid in capital – funds invested by shareholders for an ownership interest
 - Retained earnings – earnings realized by the firm; assets reinvested in the firm
- $\text{Assets} = \text{Liabilities} + \text{Shareholders' equity}$

Market Value vs. Book (cost) Value. Farm financial statements will generally give both cost and market value for long term assets. Cost represents the purchase price minus accumulated depreciation. Market value is the value of the asset on the open market minus any selling commissions and potential taxes due to capital gains.

Inventory can be valued as “cost” or “value”. NPB recommends using cost of production as value. Costs associated with inventory should be carried on the balance sheet as pig inventory asset. Home raised corn inventory can be valued at market price. After transfer to production, it should be valued at cost.

Regarding depreciation, breeding stock should be depreciated over the estimated life of the animal; 2-2.5 years for sows and 2 yrs for boars at straight line. Salvage value is cull value. First-in, first-out cost flow. Buildings are 15 year at declining balance (150%) until straight line is greater. Salvage value for shell and concrete if at all. Equipment is depreciated over the useful life with declining balance method. Salvage value is scrap value.

Income Statement

The income statement (IS) has three parts:

- Revenue (pig sales and other pork revenues)
- Expenses (feed, labor, utilities, vet, etc),
- Profit (production profit, operating profit and net income)

The IS represents the results of operating activities for a period of time. The IS links the BS at the beginning to the BS at the end of the period of time. Net income usually does not equal net cash flow.

Accounts can be kept as accrual (recorded as production occurs or as expenses are committed) as or cash (recorded when received or paid, except for machinery, equipment of breeding stock which can be depreciated over time). Accrual more accurately reflects income generated during the period.

Cash Flow Statement

This statement shows cash flow into and out of the farm during a period of time. It is a useful supplement to the IS because it focuses attention on the farm's cash position, and does not require judgment on what is a revenue item versus an expense (only cash flow). It shows how operations affected cash for the period. It has 3 sections:

- Operating activities
 - Cash inflows – cash outflows
- Investing activities
- Financing activities
 - Dividends, new loans

ANALYZE PERFORMANCE USING FINANCIAL RATIOS

Analysts use financial ratios as one mode of analysis to better understand the farm's strengths and weaknesses, whether its fortunes are improving, and what its prospects are. These ratios are often compared with the ratios of a comparable set of companies and to ratios of recent past periods. The five types of ratios are profitability, turnover, financial leverage, liquidity, and market value ratios. Finally, it is helpful to organize the analysis of these ratios in a way that reveals the logical connections among them and their relation to the underlying operations of the firm.

5 measures of a farm's performance:

1. Profitability
 - use assets or equity as the denominator; use average of beginning and ending value for denominator.

- $ROA = \text{Earnings Before Interest Taxes} / \text{Total Assets (avg)}$
 - $ROE = \text{Net income} / \text{Equity (avg)}$
2. Asset performance
 - farm's ability to use the assets
 - $\text{Asset turnover} = \text{Sales} / \text{Avg Total Assets}$
 3. Financial leverage (solvency)
 - a farm's capital structure and debt burden
 - $\text{Debt ratio} = \text{Total debt} / \text{Total assets}$
 - $\text{Interest Coverage} = \text{EBIT} / \text{Interest expense}$
 4. Liquidity
 - a farm's ability to meet short term obligations and remain solvent
 - $\text{Current ratio} = \text{current assets} / \text{current liabilities}$
 - $\text{Quick or Acid test} = (\text{Cash} + \text{receivables}) / \text{Current liabilities}$
 - $\text{Working capital} = \text{CA} - \text{CL}$
 5. Market value ratios
 - Used for publicly traded firms.
 - $\text{PE} = \text{Price per share} / \text{earnings per share}$
 - $\text{Market to Book} = \text{Price per share} / \text{Book value per share}$

Return on equity (ROE) is the ultimate measure of economic return of an investment. This is because ROE reflects the financial return on the amount the owners have invested. ROE can be compared to other potential investments of similar risk to determine if the return is adequate.

Return on Equity (ROE) has three determinants:

- Return on invested capital (composed of net fixed assets + working capital)
- Use of financial leverage (Interest Bearing Debt / Equity)
 - relative amount of debt
 - interest rate
- Tax policy

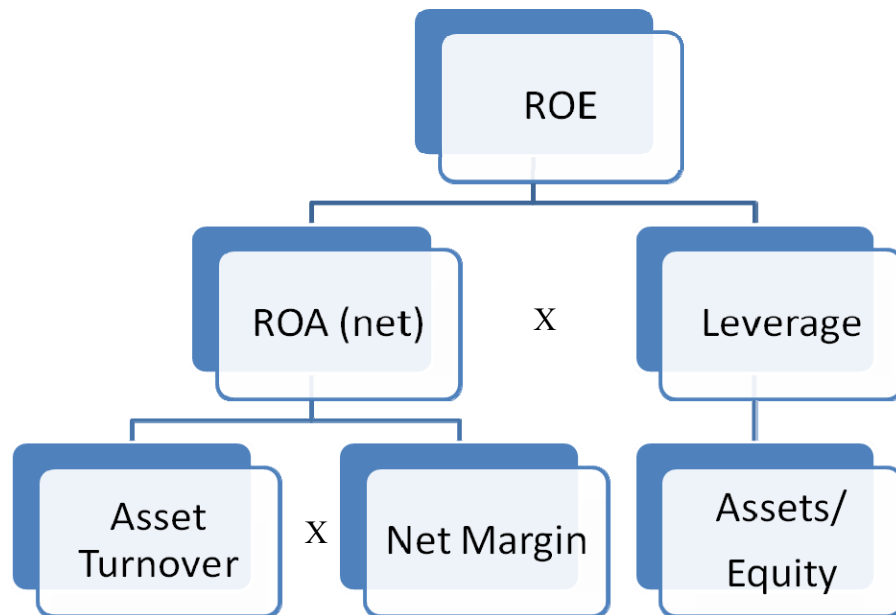
Note that effective use of leverage occurs when return on invested capital exceeds cost of debt (interest rate). There is a balance between increased risk when using debt financing and increased potential profitability.

Return on Assets (ROA) is a measure of how well the business is functioning independent of how it is financed. Use of debt (leverage) is a function of how one chooses to finance the business.

The ROE model was first developed and used in the early 1920s at the DuPont Corporation as a tool to help them manage their business. Accordingly, it is often referred to as the DuPont

formula or the DuPont system of financial management (Figure 1). Since its early use at DuPont, it has become a commonly used tool in the non-agricultural business arena.

Figure 1. DuPont formula.



The goal is to maximize ROA by effectively managing and balancing profit margin and asset turnover. Consider a farm with annual sales of \$1,000,000, asset value of \$500,000, and a net profit margin after tax of 7%. This would give the business a ROA for the year of 14%.

$$\begin{aligned}\text{ROA (net)} &= \text{asset turnover} \times \text{net profit margin} \\ &= (\text{total sales} / \text{asset value}) \times \text{net profit margin} \\ &= (\$1,000,000 / \$500,000) \times 7\% \\ &= 14\%\end{aligned}$$

The strength of the model is that it helps the owner understand the importance of managing profit margin at the same time as asset turnover (throughput). The manager can also appreciate that it is possible to trade margin for turnover and maintain the same ROA (Figure 2; Table 1). Pork producers intuitively use the DuPont formula when making management decisions. Examples include changing wean age, feeding strategy and market weight.

To improve ROA, the manager needs to improve margin, turnover or both. Margin can be improved by:

- cutting costs, both variable and fixed,
- increasing per unit sales price (e.g. quality or quantity premium, futures).

Figure 2. Asset turnover and net profit margin of 14% ROA.

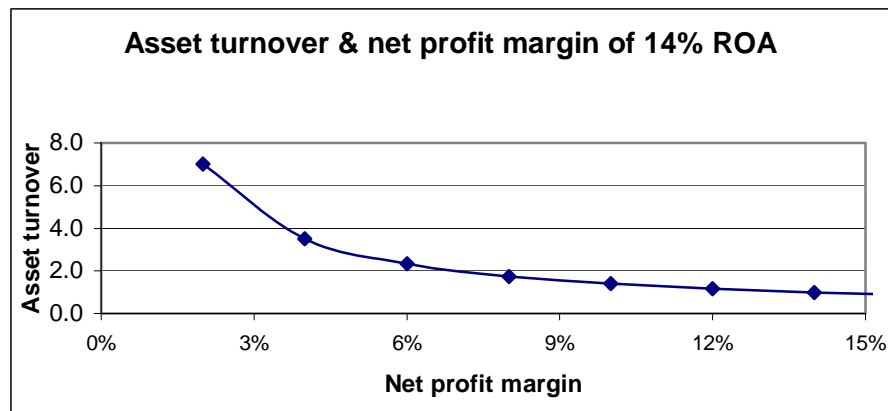


Table 1. Effect of net profit margin (%) and asset turnover on return on assets (%).

Margin	Asset Turnover Ratio							
	0.25	0.5	0.75	1	1.25	1.5	1.75	2
2%	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%
4%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%
6%	1.5%	3.0%	4.5%	6.0%	7.5%	9.0%	10.5%	12.0%
8%	2.0%	4.0%	6.0%	8.0%	10.0%	12.0%	14.0%	16.0%
10%	2.5%	5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	20.0%
12%	3.0%	6.0%	9.0%	12.0%	15.0%	18.0%	21.0%	24.0%
14%	3.5%	7.0%	10.5%	14.0%	17.5%	21.0%	24.5%	28.0%
16%	4.0%	8.0%	12.0%	16.0%	20.0%	24.0%	28.0%	32.0%
18%	4.5%	9.0%	13.5%	18.0%	22.5%	27.0%	31.5%	36.0%
20%	5.0%	10.0%	15.0%	20.0%	25.0%	30.0%	35.0%	40.0%

Turnover can be increased by:

- increasing sales volume,
- disposing of obsolete or unneeded inventory,
- identifying and dispose unused fixed assets, and
- speeding up collection of receivables; evaluate credit terms.

ROE is a function of three major drivers; return on assets, use of debt (leverage) and taxes. A firm may also increase ROE by increasing ROA, but also by increasing the percentage of total assets financed by debt. This third component of the ROE tree is sometimes referred to as the equity multiplier (assets / equity). Increasing debt will increase the ROE as long as the gross ROA exceeds the cost of the debt. However, as debt increases, the risk position of the enterprise also increases.

Effective use of financial leverage is a management practice that many producers, and their lenders, have not mastered. In agriculture, the commodity risk that results from large variance in cash flow and profitability typically causes the belief that use of debt is not conducive to

profitability. Agricultural lenders tend to be more conservative than non-agricultural lenders because of this large variance in producers' cash flows.

It is important to understand that use of debt, up to a point, is, in fact, conducive to profitability. But the proper measure of profitability should be in terms of ROE, which is where the DuPont Model again becomes very useful. Also, what makes debt conducive to profitability is that debt is a cheaper form of capital than equity. But again, up to a point. All capital is either debt capital or equity capital. And debt capital is cheaper (all else being equal) because the interest payments on debt are tax deductible. Also, payments on debt take priority over payments on equity so risk to the lender is typically less than the risk to the owner.

Therefore, use of debt is cheaper than equity as long as the risks to the lender are not so great that the lender requires a premium (higher rates to generate higher returns) to have the incentive to make the loan. This is the risk - reward trade-off. But if the debt levels are too high and/or profitability is highly volatile (and there is a correlation between low equity and volatile profitability), the lender begins to take on the same risks as the owner. In reality, if the lender perceives the risks as high, the loan is not made at any rate because the lender does not want to take the same risks as the owner even with premiums.

In agriculture, the commodity risks tend to dictate that financial leverage needs to be low to keep the risks to the lender satisfactory without causing the lender to require a premium. However, if the producer implements proper risk management measures, the risks to the lender are reduced and the lender can allow higher leverage. Proper risk management measures stabilize profitability. When this is done properly, the risks taken by the lender due to the higher leverage are more than offset by the risk management measures implemented by the producer. Therefore, the lender allows higher leverage without requiring a premium. The higher leverage then can result in a higher ROE.

Table 2. Underwriting guidelines (from Lee Fuchs at AgStar).

	All owned	Contract barn
Equity / Asset	>50%	>25%
Current assets / current liabilities	>1.3	>1.0
Loan / Appraised value	<65%	<80%

BUDGETING & COST CONTROL

Dr. Gary Dial describes a 6-step approach to controlling costs:

- Set performance budgets that accurately project throughput,
- Establish unit-use budgets to predict line-item costs for all inputs for the income statement,
- Identify cost variances (differences in budgeted vs. actual) as they occur,
- Use compliance reports to identify input wastage,
- Link production and line-item variances to identify financial opportunities,
- Empower farm staff to drive out costs.

Forecasting sales is relatively easy to do if we understand our farm. Suppose we want to forecast sales 10 months from now. We know the number of sows in lactation that are to be weaned next week. Knowing our historical cull rate, gilts available, and farrowing rate, we can forecast farrowings 4 months from now. If we have reasonable data on growth and mortality, we can estimate pigs available for sale in 6 months. Add consecutive weeks of data and we have the beginnings of an annual budget.

To quote Dr. Dial, *“for cost management to be effective, a ‘low-cost culture’ must be created. This usually requires that biological endpoints, at least initially, be de-emphasized at the expense of financial endpoints.”* What is your break-even cost? Or, what is your cost / weaned pig? And just as important, where are your opportunities for decreasing this cost?

Production costs are usually classified as **fixed or variable**. Fixed costs do not change with the level of output and typically include depreciation, taxes, insurance, and interest. Variable costs change with output and include feed, propane, veterinary and health expenses. As the planning horizon lengthens, more costs become variable such that in the long run, all costs are variable.

Only variable costs should be considered in deciding how much to produce in the short run. A production function expresses the relationship between use of inputs and products produced. It will show the **marginal productivity** as inputs are increased. The optimum production level is where marginal cost equals the marginal value of product (where $MOVC = \$0$).

We strike a balance between shooting for maximum productivity and achieving low cost. The decisions involved in achieving optimum performance can be difficult. For example, how does the cost of feed and market price influence our decision to euthanize some pigs because they are noncompetitive and will cost substantially more to grow out than we will earn? Should we cut back the sow herd so that we can increase wean age by 10%? What is the optimum slaughter weight for a farm? Should we feed growth promotants in the nursery to improve feed efficiency? When prices are particularly low, at what point should we not breed sows? The answers will vary across farms, but all farms could benefit by analyzing these questions.

Prices have been incredibly volatile over the last 12-18 months. This makes benchmarking difficult because differences among farms may reflect productivity and/or effectiveness of managing the input costs and margin. Prairie Swine Center recently published some cost and productivity numbers to use for benchmarking.

This newsletter was originally published on January 29, 2010 and is reprinted below with permission.

Productivity and Cost of Production

Last week at Banff Pork Seminar the productivity awards sponsored by PIC recognized Kyle Colony in Saskatchewan with 30.3 pigs weaned per mated female. This is a tremendous accomplishment and a reminder of how our industry has ramped up productivity consistently over the past quarter century. All too often the complexity of benchmarking cost of production, the next natural step in comparing production units, does not receive the same attention as productivity. There is good reason for this since the age of assets, debt load, labour costs and accounting practices make comparisons difficult if not impossible. That however shouldn't dissuade us from trying to benchmark cost of production, because the power of having that information is indeed worth the effort.

Take for example a survey of western Canadian mid-sized farrow to finish producers that was recently shared with me. The top 10% of producers demonstrated significant productivity measure improvements over the average and bottom 10% for key measures such as:

	Top 10%	Avg	Bottom 10%
Sow mortality rate	4.40%	6.70%	10.50%
Marketed / mated female / yr	24.0	22.3	20.6
Whole herd FCR	2.98	3.25	3.44
Revenue / hog marketed	\$154.75	\$145.28	\$134.47
Margin over recorded cost *	\$34.74	\$25.62	\$12.75

* note that labour, depreciation, interest removed to allow for comparison of variable costs only

Although the variation is impressive and motivational to try to raise the productivity bar, it pales in comparison to the variation in financial performance seen between these same farms (all financial measures taken for same time period as productivity data above).

Accepting the inaccuracies that come with such comparisons there is significant opportunity to improve productivity and profitability through comparison (benchmarking) to other similar farms.

Below are a few articles to assist in our pursuit of improved profitability, and one article that encourages the use of statistical control charts to detect changes in herd productivity.

Profit Sensitivities to Feed Price and Pig Price with Varying Production Levels (Banff Pork Seminar 2009)

<http://www.prairieswine.com/database/details.php?id=39200>
 Top 10 Cost Cutters and Revenue Generators (Centred on Swine, 2004)
<http://www.prairieswine.com/database/details.php?id=1847>
 Control charts applied to simulated sow herd datasets (Germany, 2009)
<http://www.prairieswine.com/database/details.php?id=39056>

Lee Whittington BSc (Agr), MBA, PAg
 President/CEO

Prairie Swine Centre Inc.
 P.O. Box 21057, 2105 - 8th St East
 Saskatoon, SK
 S7H 5N9

(P) 306-667-7447

Table 3. Goals for economic and production measures (Lee Fuchs, 2009).

Farm performance	Very good
Asset turnover	> 0.9
Feed cost / cwt	< \$28
Non feed cost / cwt	< \$9
Fixed costs / cwt	< \$11
Breakeven / cwt	< \$48
Production measures	
Pig weaned / litter	> 11
P/S/Y	> 25
Nursery FCR	< 1.6
Nursery ADG	> 0.9
Nursery mortality	< 3%
Finish FCR	< 2.75
Finish ADG	> 1.75
Finish mortality	< 4%
W-F FCR	< 2.55
W-F ADG	> 1.7
W-F mortality	< 6%

And currently, Lee says that their strongest clients have good liquidity, control volatility, low cost and a strong balance sheet.

MAKING DECISIONS

Some decisions are major with an impact for many years and involving major investment and often capital expenditures. For example, should we construct a gilt development barn? Or,

should we sell the pigs at weaning on contract or construct facilities to market them ourselves? On the other hand, many decisions are relatively narrow in impact and short term in nature. For example, should we hire another person for farrowing? Or, should we vaccinate for influenza? A partial budget is an economic analytic method for simple decisions where the time period is relatively short term and the outcome does not have a high degree of uncertainty. Partial budgets are relatively simple because they are restricted to estimating the change or **incremental** effect of the decision.

Every partial budget uses the same basic equation:

$$\begin{aligned} & \text{increased revenues associated with the decision} \\ & + \text{decreased costs} \\ & - \text{increased costs} \\ & - \text{decreased revenues} \\ & = \text{change in revenue} \end{aligned}$$

For example, should we pay a bonus to staff if they achieve certain levels of performance? Some think of this as a profit share and others as an incentive. Regardless, a frequent example is to pay a bonus for quality pigs weaned above standard expectation. Aside from the economic considerations, there are strong feelings on both sides of the “bonus” issue.

Another example is whether to vaccinate pigs for PCV-2 to reduce the mortality. As we work through this example, we need to first understand how to quantify cost of mortality. We might see the cost of mortality reported as:

- income not received. This approach will over estimate the true cost.
- costs incurred in the pig before it died. This approach will likely underestimate the true cost.
- income not received for that pig (that died), minus the variable costs that it didn't incur because it died. This is the best method and is also referred to as the margin over variable costs.

The analysis (below) might be conservative as no advantage was attributed to feed efficiency (could not be measured with trial design). If feed efficiency is improved, this would be included as reduced total feed cost in the vaccinated group. Improved average daily gain is slightly more complex because the economic benefit depends on which of two space / time capacity scenarios is present at the farm. If the farm has limited finishing space or time and the reduced average daily gain (ADG) results in having to sell the pigs at a lighter weight, then the cost of reduced ADG is lower income / pig. If, on the other hand, ample space and time is available, then the producer can wait until the pigs achieve the desired weight and the cost of reduced ADG is only the time value of money (not getting paid as soon) plus the possibility that one of the pigs may die or get sick in the added days needed to reach market weight. Estimating the value of reduced variability in weight gain is more complex and beyond this presentation, but can have substantial impact. Finally, if carcass attributes are affected such as % lean, this would be fairly easy to include – however, there is little data on impact of vaccination on carcass quality. Whereas King et al. (2009) detected a difference when comparing carcass composition of PCV-2 vaccinated vs.

non-vaccinated controls, Venegas-Vargas et al. (2009 - Leman Swine Conference Proceedings) did not.

Table 4. Effects of PCV-2 vaccination on growing pig performance (King et al., 2009 – Proceedings, AASV).

	Vaccinated	Control	P value
Number pigs	600	600	
d0 starting weights, lbs	11.66	11.78	0.48
d0-131 ADG, lbs/day	1.57	1.52	< 0.0001
Nursery & finish mortality, %	5.18	7.07	0.19
Finishing cull rate, %	5.16	10.24	0.001
Pigs assessed at slaughter	509	474	0.09
Hot carcass weight, lbs	194.23	190.76	0.01
Economic assumptions			
> 255 live base price / cwt	\$51.00	\$51.00	
≤ 255 live base price / cwt	\$31.00	\$31.00	
Yield, %	74	74	
Income / pig target market	\$133.86	\$131.47	
Live weight of light pigs	180	180	
Income / pig light market	\$55.80	\$55.80	
Income good pigs	\$70,012	\$65,227	
Income cull pigs	\$1,728	\$3,428	
Total income	\$73,740	\$68,656	
Feed consumed	\$43,775	\$41,635	
Margin over variable costs	\$29,964	\$27,021	
Difference		\$2,943	
Benefit / pig placed		\$4.91	
Cost to vaccinate		\$1.12	
Benefit / cost ratio		4.38	

Sensitivity analysis is a tool that allows us to assess the impact of the model's assumptions on the outcome. In a sensitivity analysis, we change one parameter (such as price) over a possible range of values while holding the rest of the variables in the analysis constant. In so doing, we explore the robustness of a partial budget outcome--i.e., how sensitive are the results of partial budgets to the assumptions in the analysis?

MANAGING THE MARGIN

John Lawrence (Iowa State University) does a nice job explaining what is meant by managing the crush margin. For wean-to-finish pigs, the margin is the value of the market hog less the cost of the pig and the corn and SBM to raise it. It focuses attention on the most volatile components that drive profitability and that are hedgeable. The margin represents the remaining revenue to pay all other costs and, hopefully, return a profit.

More information on this is available at:

<http://www.econ.iastate.edu/outreach/agriculture/periodicals/ifo/margins/WFcrushDefinition.pdf>

$\text{Margin}_{T-5} = 2 \times \text{Lean Hog Future}_T - \text{weaned pig price}_{T-5} - (10 \times \text{Corn futures /bu})_{T-5} - .075 \times \text{SBM future/ton}_{T-5}$

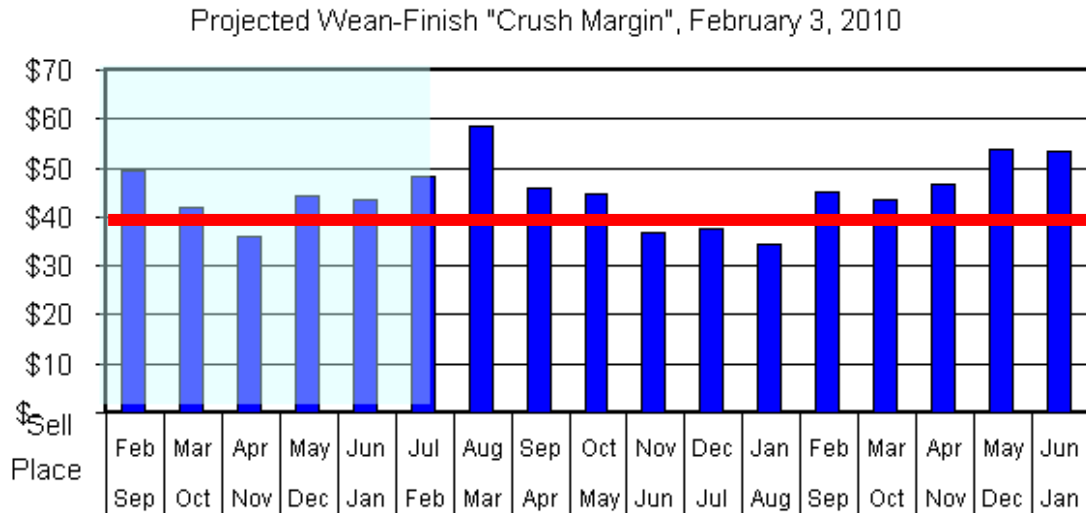
T = when hog will be sold at market

T-5 = 5 months earlier

Assumptions are a 200 lb carcass, 560 lbs corn, 150 soybean meal (SBM), & 5 months wean to finish. We make the decision to sell the hog 5 months from now, and buy the pig, corn and SBM on the same day at basis adjusted futures prices. The purchased pig is priced at 50% of the lean hog futures price, 5 months out. Individual farms will differ on amounts of corn, SBM, weights of pigs etc.

What is not included?

	\$ / head
Vit, min & complete feeds	\$11.35
G, M & D	\$3.62
Animal health / vet med	\$4.15
Labor / admin	\$5.67
Oper int	\$2.67
Utilities	\$2.57
Transport	\$2.00
Facilities	\$8.45
Total, beyond pig, corn, SBM	\$40.48



This analysis is used to manage risk. In other words, if a reasonable opportunity exists, sell the lean hog futures while buying the corn and SBM needed to finish these pigs.

CONCLUSIONS

Having production records, without financial, is a recipe for failure. Our nature is to tend to improve whatever we are focused on. Therefore, it is imperative that we focus on the right measures. Managing costs, optimizing productivity, maintaining inventories, and effective marketing will lead to profitability. This requires us to have good financial records to complement our production records.

ADVANCES IN SOW AND GILT MANAGEMENT

Rudolf Wiedmann
Centre for Education and Knowledge Boxberg, Germany
(Bildungs- und Wissenszentrum Boxberg,
Landesanstalt für Schweinezucht - LSZ)
Seehöfer Straße 50, D-97944 Boxberg-Windischbuch
E-mail: rudolf.wiedmann@lsz.bwl.de

ABSTRACT

In highly prolific sow units you have to keep a special eye on dry sows. To reduce the increasing overall losses of dead sows it is necessary in the first place to optimize the feeding management. Three main suppositions have to be fulfilled: individual, undisturbed and simultaneous. Self-locking stalls enable the sows to eat their individual quantity of concentrate in a private atmosphere. In respect to husbandry there are three aspects to consider as well. First, you have to do everything for a quick and stable social hierarchy. Second, each sow has to fill her stomach completely at least once a day. And third, the lying comfort has to be adequate to the very different situations in respect to weather and individual body condition. In this respect you need, in each pen, at least two floors with different insulation properties.

INTRODUCTION: TOO HIGH SOW LOSSES

Low hog prices have driven successful pig producers to focus a great deal on cost control. While not one of the major cost centres in swine production, replacement rate of gilts has reached a level that is too high, with more than 50% in many units. In addition, the performance and particularly health status of such herds is suppressed. Therefore we have to ask the question: How should we manage the modern highly prolific sow to lower the risk for a too early loss? What are the risk factors in respect of feeding and husbandry?

The Fachhochschule Soest in Germany investigated, in 46 piglet producer units, the background for sow losses. In many cases, there is a combination of several reasons which lead to the culling decision. Therefore the scientists identified both main reasons and secondary reasons. Most of the sows were culled due to age and fertility. But how old is an old sow? In some farms the “age” already begins after the 4th litter (Figure 1).

In many cases you cannot detect the real culling reason. In a German field study from November 2004 to November 2005, dead and culled sows from four sow herds were brought to a pathology institute and a post mortem investigation was performed. Results showed that 47 % of the post mortems were not because of infectious disease, 33% were from infections and 20% were due to ruptures and accidents (Figure 2).

We know that there are not only big differences between different farms but also between different countries. In Germany, we have a culling rate of 5 to 7%, in The Netherlands only 5%,

but in Denmark 15% on average. A certain percentage in Denmark is due to mercy killing of sows with shoulder lesions, but the overall percentage is still much too high.

Figure 1. Reasons for culling sows in German sow units. (Freitag and Wittmann, 2008)

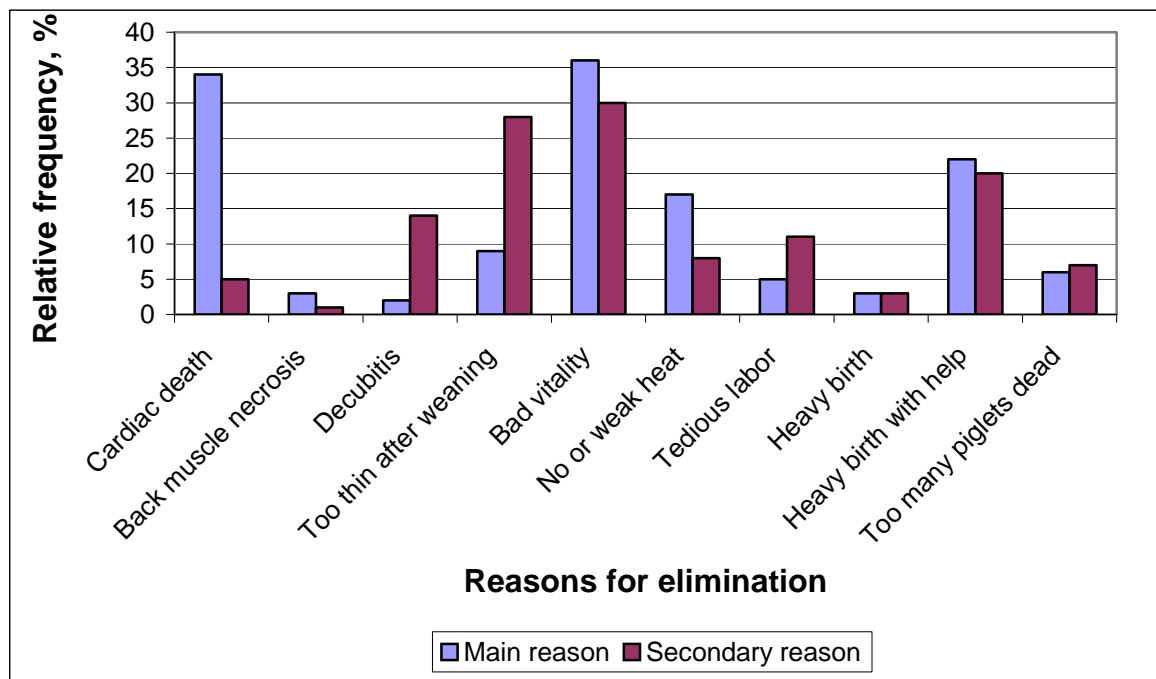
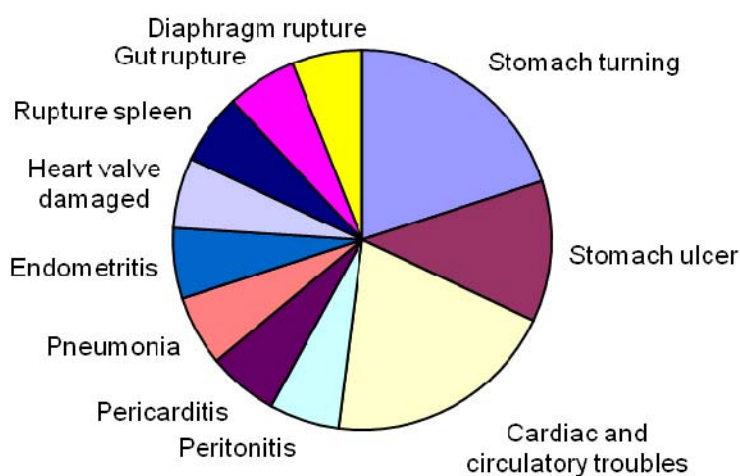


Figure 2. Pathological-anatomical diagnostic findings. (Nienhoff, 2007)



STRATEGIC MANAGEMENT MEASURES IN FEEDING

To simplify the actual problems it is useful to restrict our efforts only to the pregnant sow. Furthermore we have to differ from reasons by feeding or by husbandry. Settling new housing, firstly you should be concerned with feeding. After determining the feeding system then it is time to decide the housing system.

In Europe, sows have to be kept in groups from week 5 of gestation until one week before farrowing (EU guideline 2001/88/EG). The hierarchy, which is among sows, can be a problem when feeding them in groups. Alpha sows (these at the top of the ranking system) can tend to dominate feeder entrances. This intimidates more timid sows, who may not be able to easily access their feed.

There are 3 principal points which should be achieved by the feeding system:

1. Each sow has to be fed each day individually. Otherwise you risk undesired growth.
2. Each sow has to be undisturbed during feeding. Concentrate mixture for pregnant sows is strongly rationed and there are more than 100% differences in eating speed.
3. All sows of one compartment should eat together. All sorts of electronic feeding machines with no simultaneous feeding cannot overcome this great disadvantage.

Feeding Stalls are First Class

It is not surprising that only feeding stalls with self-locking or manual-locking doors fulfill the demands of the sows as well as the claims of managers and staff. The self-catch system has many advantages. It enables sows to have contact with other animals whenever they want, but have more privacy when eating. First of all, the system is quiet and animal friendly. Also pregnancy scanning is easier as sows can be fixed with little effort. Often the bile is empty before they start eating again and go into their stalls, so the diagnosis is generally accurate. Sows are very calm during feeding in their stalls. Feeding stalls are very common in the Netherlands and uncommon in Denmark, which is one reason for the big differences in sow losses. Feeding stalls are well suited for little as well as for very big units. People use them in conventional and organic farms. Staff with lower training can work more easily in comparison with electronic feeding systems (Table 1).

STRATEGIC MANAGEMENT MEASURES IN HUSBANDRY

In respect of housing conditions, three aspects are very important for health, performance and sustainability. These are stable social hierarchy, gut fill and lying comfort.

Stable Social Hierarchy

Sow aggression is a heritable trait and it may be possible to select against it. But the environment and management still play an important role in how sows behave. When mixing sows, a new social hierarchy has to be found. To prevent negative influence on claws, it is favourable to give

during the first two days of mixing enough space (5 m² = 55 ft²) and solid floor with deep straw. After staying in such an “area” the sows have built up their hierarchy to a high extent. For further stabilizing of this hierarchy it’s necessary to offer suitable conditions in their pens in respect to feeding system, gut fill and adequate lying comfort.

Table 1. Qualification of 5 feeding systems in respect for highly prolific sows.

Feeding system	Individual	Undisturbed	Synchronal	Behaviour	Evaluation as a whole
Slowfeeder	No	Yes/No	Yes	All right	😞
Quickfeeder	No	No	Yes	Too quick	😞
Liquid feeding without stalls	No	No	Yes	Too quick	😞
Electronic feeding	Yes	Yes/No	No	Not species-appropriate	😞
Feeding stalls	Yes	Yes	Yes	Species-appropriate	😊

Gut Fill: “Only a full sow is a peaceful sow!”

Highly prolific sows are able to eat daily during lactation more than 8 kg (16 lb) of concentrate. Therefore you can imagine, that dry sows can’t reduce this quantity to 2.5 kg (5 lb) without any problems. With single housing there was no great problem to handle permanent hungry sows. But it’s greatly different in group housing. To keep sows peaceful they have to be full. Otherwise you’ll get problems like restlessness, injuries of skin, vulva, claws, fertility, and so on.

Adequate Lying Comfort

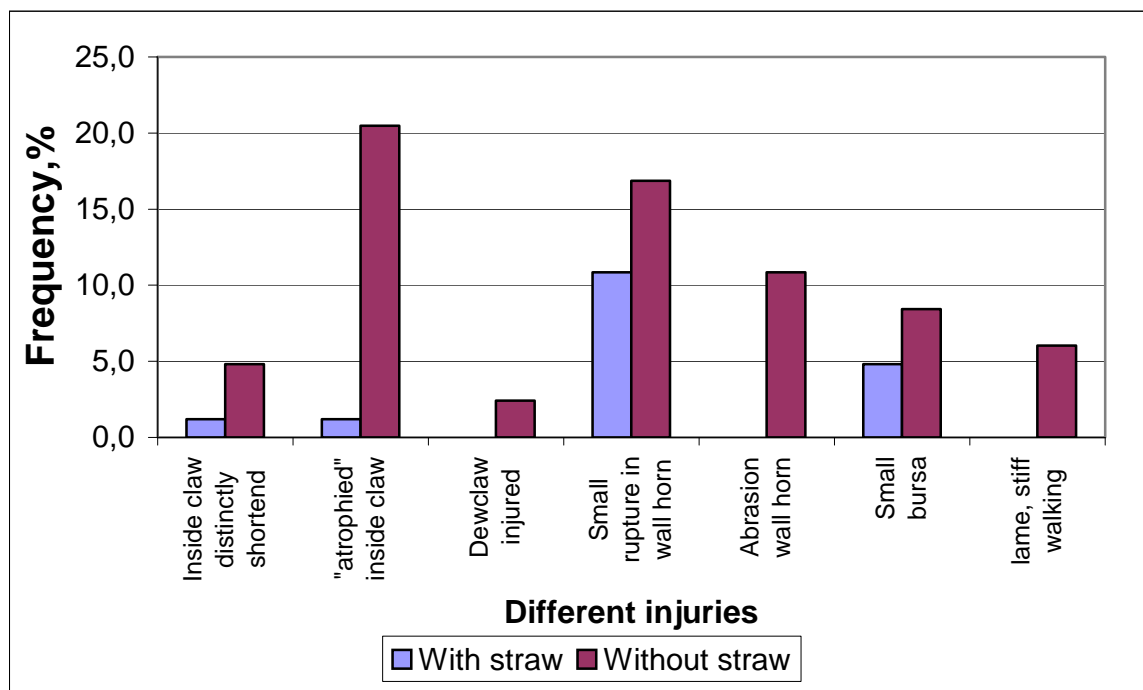
Most of the time sows are resting. Therefore you have to offer adequate facilities to keep them warm in cold weather, i.e. insulation and/or heating of building or floor in lying area. During hot weather sows need appropriate cooling. Therefore it’s for highly prolific sows performance-suppressing to lie only on slats. The resting area has to be at least solid and insulated, i.e. in housing with cold climate. Much better is sufficient and dry bedding material.

Since the skin temperature of sows is about 28°C (82°F) - like in human beings - all lying materials have to make sure, that those skin temperatures can be maintained easily. Table 2 shows the problem, that thin sows are not able to heat slats to the necessary 82°F. Such sows are more exposed to risks like colds, cystitis, and so on. Furthermore they lie more on their stomach and are not able to sleep in relaxed lateral position. Stomach lying is a main cause of leg and claw injuries. Dry straw in the lying area is a very good method to keep claw injuries on a low level. (Figure 3).

Table 2. Floor temperatures in the sow lying area with regard to body condition score.

Location of the test point	Temperature	Temperature
	°C	°F
6 ft above slatted floor	20	68
Near slatted floor	18	65
Slatted floor with thin sow	17	63
Slatted floor with normal sow	19	66
Slatted floor with thick sow	24	75
Insulated or littered floor with thin, normal and thick sows	28	82
Skin of sows	28	82

Figure 3. Comparison of pens with or without straw in the lying area in respect of different parameters of claws. (Hahn, Boxberg, 2009)

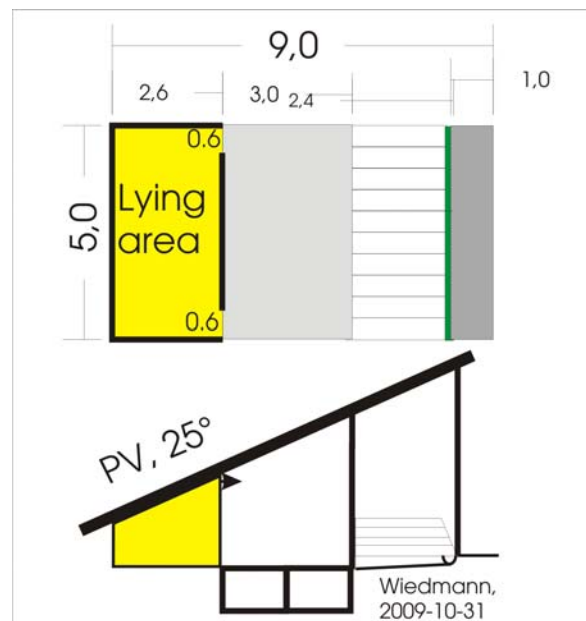


In Figures 4 and 5, you can see examples for pregnant sows with different areas for lying, feeding and dunging. Floor and walls of the lying area are insulated.

Figure 4: Structured housing for pregnant sows in a double-row with different insulated areas.



Figure 5. Structured housing for pregnant sows in a single row with photo-voltaic roof to the south (data of lengths in meter)



SOME ASPECTS TO GILT MANAGEMENT

First of all: Gilts are the “crown jewels” of each unit. Therefore, do not house them like finishers. A great deal of problems with today’s sow herds are the results of not respecting the needs of the gilts in the past.

Guidelines for Gilts

- Gilts should be kept in little groups of about 6 to 10 animals
- Offer them much space (at least 3 m² = 30 ft² per gilt) for their own fitness training (heart, muscles and fibers, immunity)
- Give them each day a lot of employment, a full gut and fresh air
- Lying areas must have different insulation (straw area and concrete area)
- Look for claw abrasion and strong, clean legs
- Keep gilts separate but not too far away from your unit
- Emphasize a firm human-animal-relation and talk to them each day
- Serve them not before they are 8 months old
- Adapt them to feeding stalls
- Contact them to boars
- Put them to the sows after 1st litter at the earliest or even better after 2nd litter

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THE SWINE INDUSTRY AND CONSUMER PERCEPTION

FOOD SAFETY, TRACEABILITY AND PUBLIC HEALTH

**Terry Whiting
Office of the Chief Veterinarian
Manitoba Agriculture Food and Rural Initiatives
Winnipeg, Manitoba R3T 5S6
E-mail: terry.whiting@gov.mb.ca**

ABSTRACT

The contemporary reality of food, farming and animal use is a result of changing relationships between the state, the market and civil society. Recent changes have resulted from pressures caused by processes of globalization, industrialization, privatization and individualization; collectively modernization. Most western democratic governments have been withdrawing regulatory and financial support from Agriculture most dramatically since the formation of the World Trade organization in 1994. Modernization of agriculture policy is eroding prior relationships between the State, the Markets and Civil Society and new policy arrangements are required to respond to current needs. Developing a policy arrangement for new areas of agricultural responsibility is difficult and demanding. This paper describes basic types of policy arrangement, some examples of their evolution, their success or failure and a possible framework to understand current events.

INTRODUCTION

Policy arrangements are nebulous constructs, difficult to identify and more difficult to objectively criticise, partly because policy arrangements are the structure in which we carry on day to day living. According to the webpage [<http://www.londonswineconference.ca/>], the London Swine Conference is a technology transfer conference coordinated by the Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Pork, Ontario Pork Industry Council and University of Guelph. This statement and the existence of this conference imply that there is a local “policy coalition” of members drawn from the sectors of the State, the Markets and Society that share a commitment to “technology transfer”. This conference also implies that this policy coalition perceive “technology transfer” is a significant common good, which they will cooperate with other like minded organizations to facilitate the delivery of.

In modern agriculture the ideas of common good provided by food safety, traceability and public health are driving the formation of other “policy coalitions” who share a common interest in the development and delivery in these policy arenas. There are other policy coalitions, however, interested in other components of agriculture such as the welfare of animals used in livestock production and the environmental externalities of livestock production. The principals described in this paper also apply to those anti-agriculture policy domains. This paper will review some theory of policy governance and provide examples to help understand these broad concepts. In the last section, ideas of future possible directions will be presented.

BACKGROUND

For centuries, the world has been divided into sovereign Nation States, most of which in the last 100 years pursued a national policy of self-sufficiency in food production. The most dominant pillar of national agriculture policy was an ongoing goal to be independent of the food supply of other countries. To reach this goal, most nations subsidized agricultural food production where under-producing sectors were encouraged, and overproduction was paid for by the government or was exported, where necessary, supported by export subsidy. Catastrophic world wars and resultant food shortages solidified food security as a core national program. Farmers in most countries up until the recent past have been buffered somewhat from volatility of the market: everything they produced was bought by somebody (overproduction mostly by the state).

Agri-Ideology

After WWII society communicated its continued support for this food security policy goal by continuing to elect governments that pursued this agenda. Western society believed in “agrarian particularism”, that is agriculture was different from other economic activities such as logging, mining and the automotive industry. The food supply was very important to society, however; farming was limited to family farms which were non-cohesive family businesses and could not provide the preconditions for modernization of agriculture. Modernization of agriculture required capital for infrastructure, research and development, extension and assistance especially to new producers both home grown and immigrant. In addition, widespread bankruptcies in a sector that contained a significant proportion of the population, such in the years between the great wars, could lead to considerable social unrest. Climate conditions such as drought and the “dust bowl” of the ‘30s were beyond the control of the individual farmer and beyond the risk management of private industry. These and many other public sentiments provided an ideology to justify special government intervention and assistance in agriculture.

The attitude of the US population to agriculture was also flavoured by an additional belief that the best characteristics of the American culture and individual Americans was from working the land, and the best American citizens were farmers.

Recent Structural and Social Change

During the last two decades, dramatic changes in the social, political and economic environments have had considerable impacts on the society’s and the consumers’ view on agriculture, government support of agriculture, food and on the way food, especially foods of animal origin, are produced. No longer does even a small proportion of citizens regularly experience agriculture environment, and agriculture production is dwarfed by many other economic sectors.

In addition to general trends in society, many specific events that had and still have an indirect or direct impact on the production of food with or from animals are:

- The BSE, Avian Influenza and FMD outbreaks in UK and Europe resulted in the massive killing of animals and a growing suspicion in the public that something essential to modern industrial food production was fundamentally wrong, wrong to animals, wrong to the

environment, contrary to the nature of food, and contrary to the human-animal contract upon which pastoral, agrarian and modern society had developed and flourished.

- The emergence of H₅N₁ poultry-human influenza in Hong Kong, recent emergence of “swine flu” in Mexico possible swine-human variant.
- The breakdown of the communistic block in the late 80’s and early 90’s, with free-market principles (neo-liberalism) replacing plan-economy prescriptions. This contagious Thatcherism has initiated the globalization of almost all economies especially in agriculture trade.
- The creation of the WTO (World Trade Organization) replacing the GATT (General Agreement on Tariffs and Trade) in 1994, leading to a growing liberalization of the trade in food and raw materials for food including animals and animal products:
 - led to the fact that food retailers and grocery chains can theoretically buy any food from anywhere in the world, and national food supplies are not any longer something that retailers are dependent on.
 - led to the fact that food producers/processors and retailers can buy (where the consumer discriminates) on qualities other than price like “freely traded” or eco-friendly products.
 - emerging oligopolists such as Wal-Mart, demanding large volume of standardized produce at cut throat prices greatly decreasing the margins available to producers, especially small producers.
 - Group actions like the “Battle in Seattle” bringing international trade policy and agriculture policy into the living room.
- The enlargement of the EU on May 1, 2004 with 10 new EU members emphasized a new trend in blocking of the globe into trading blocs as opposed to trading nations.
- In Europe there has been increased politicization and market action of the “ideas” related to GMO’s (genetically manipulated organisms) in plant production, and animal welfare in livestock production.

North America, by serendipity has been spared the brunt of the majority of the critical issues that have affected Europe. Notable exceptions have been the BSE scare, environmental concerns related to concentrated livestock feeding operations and, most recently, movements to regulate livestock production methods at the State (sub-national) level in the USA.

Today there are two major pressures at the foundational level of agriculture production:

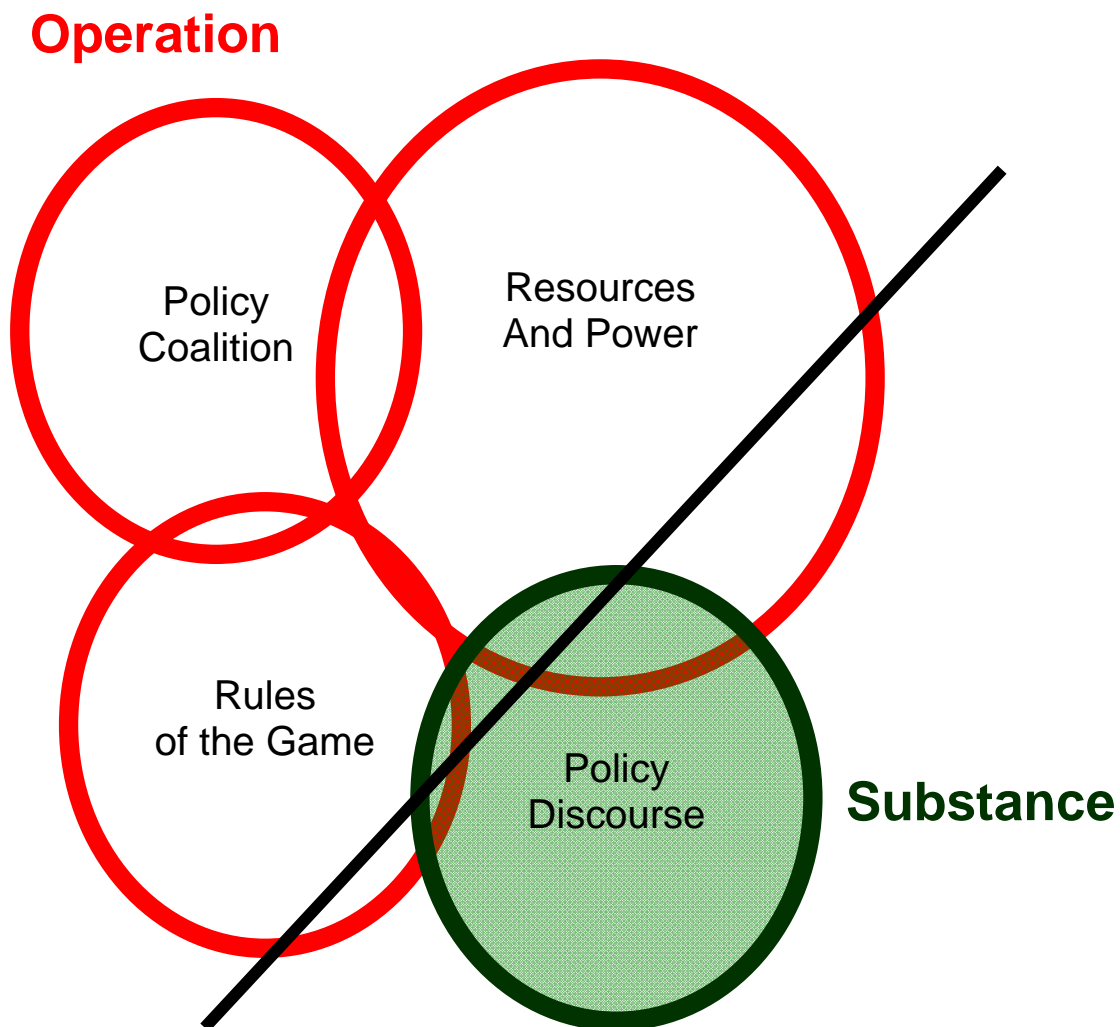
1. International trade agreements and general neo-liberal beliefs that the markets are all knowing and government participation is evil are driving an agenda of withdrawal-of-the-state from agriculture policy.
2. A growing desire by society to participate in the production of the food they consume and to re-connect, scrutinize and make accountable those methods of production. Society has an opportunity to influence the methods of food production either through the markets or through the state.

WHAT IS A POLICY ARRANGEMENT?

In its simplest form, a policy arrangement is a goal or large project and the organization that delivers the goal; it consists of the substance and the delivery mechanism. A 'policy arrangement' refers to the temporary stabilization of the organization and substance of a policy domain at a specific level of policy making (Arts et al., 2000a,b) (Figure 1).

Figure 1. Visual representation of an existing policy arrangement.

A policy arrangement is a temporary stabilization between the operational components and the policy discourse which is the substance of the arrangement. Policy arrangements are temporary and subject to continual modification from improvement to abandonment or replacement by more politically astute arrangements.



The current Growing Forward, Federal-Provincial-Territorial agreement can be used to better understand the concept of a policy arrangement. Growing Forward is a five-year commitment by Canada's federal, provincial and territorial governments to support the development of a

profitable, innovative agri-food sector that is adept at managing risk and responsive to market demands [direct quote from <http://www.omafra.gov.on.ca/english/about/growingforward/index.htm>]. Those of us who work in this policy arrangement know it is a method of transferring money to farmers to reward behaviour that aligns with the program.

At the time the federal-provincial agreement is signed we can consider the policy arrangement **temporarily stabilized**. The rules of the game, that is what things are eligible for funding and what things are prohibited, and the process for accessing the financial support are all fixed. Also in the agreement the Resources and Power are clearly defined as government based, who will pay for what and how things are approved. However, prior to the establishment of the program and for a considerable period of time, pre-stabilization, there was jockeying within the Policy Coalition related to rules of the game and the distribution of power. Probably the jockeying is already underway for the next five year plan starting in 2013.

Understanding a Policy Arrangement by Conquest “BC Farm-Fresh Eggs”

Examining how policy arrangements are de-stabilized is probably more informative than trying to document how complex policies like the multi-year national agri-food policies are negotiated.

Ungraded eggs are eggs sold outside the supply managed system in Canada. These eggs have not been cleaned, processed, candled to identify and remove cracks for diversion to pasteurization and packed in new materials with a best before date, as is the case with graded eggs. These ungraded eggs are essentially untraceable. Most provinces allow the farm gate sale of ungraded eggs directly to the final residential consumer, a one-up-one-down sale in traceability language. When health inspection staff find ungraded eggs in restaurants or retail outlets the eggs are seized and destroyed, and the establishment may have other punitive measures applied.

On January 12, 2009, the Vancouver Island Health Authority directed their food safety inspection staff (Environmental Health Officers) to ignore the presence of ungraded shell eggs in retail environments, restaurants and food service institutions. This internal directive of the Health Authority instructs enforcement staff to not enforce the regulations under the BC Health Act related to shell egg sales. This action on the island occurred concurrent with a significant increase in human *Salmonella* Enteritidis infection on the mainland traced to ungraded hatching eggs (brown shelled) illegally exiting the broiler hatching egg industry.

Most sharp minds involved in food safety should be keen to understand how a health authority comes to the decision to circumvent their own well considered food safety regulations. On Vancouver Island, a “Policy Coalition” recruiting the policy discourse of “Farm-Fresh” was able to garner media support and build on the consumer belief in the “100 mile diet” and the “buy local” propaganda to circumvent the previous policy arrangement which placed food safety as the primary purpose of food regulations. In this localized policy arena, the political power responded to the belief that access to “local foods” was a greater good, than occasional human food borne salmonella was a public evil (Wilcott, 2009).

This example emphasizes that a “Policy Arrangement” is a temporary stabilization of the particular policy concern. New “Policy Coalitions” can emerge and engage in the Policy Discourse to drive the arrangement in a different or a new direction creating new rules of the game and recruiting the resources and power.

Probably the most remarkable new policy coalition to emerge in North America in the last 10 years is the Humane Society of United States (HSUS). This organization operates no animal shelters and rescues no animals; it is a pure political activist organization. This non profit organization has an annual budget of \$85,000,000 (HSUS, 2008) and has driven state level intervention in the methods of confinement of livestock in several States (Table 1).

Table 1. Recent legislative initiatives in the USA limit or protect livestock production.

State	Proponent - Target	Initiative	Law	Force (lag Y)
Florida ¹	HSUS – Sow Stalls	2002 Amendment 10	Fla. Const. art. 10, § 21	Dec 2008 (6)
Arizona ²	HSUS – Sow Crate Veal Calf	2006 Proposition 204	Ariz. Rev. Stat. §§ 13-2910.07 to 13-2910.08	Dec 2012 (6)
Oregon	Legislature – Sow Crates	2007 SB 694,	Or. Rev. Stat. §600.150	Jan 2012 (5)
Colorado	HSUS – Sow Crate Veal Calf	2008 SB 201	Colo. Rev. Stat. §§ 35-50.5-101 to 103	Jan. 2012 calves (4) and Jan. 2018 sows (10)
California	HSUS – Veal, egg production, foie gras	2008 Proposition 2	Cal. Health & Safety Code, Division 20, Chapter 13.8 Me. Rev. Stat. Ann.	Jan 2015 (6)
Maine	HSUS – Veal, Gestation Stalls	2009 LD 1021	tit. 7 §4020 17 §1039	Jan 2011 (3)
Michigan	HSUS – Veal, egg Gestation Stalls	2009 House bills 5127 and 5128	MI Rev. Stat. §287.746	Oct 2012, Calves (3) Oct 2019 hens & sows. (10)
Ohio	Farm Coalition	2009 Issue 2 ³	Ohio Const. art XIV, § 1(A)	Livestock Care Standards Board
OK, SC, GA	Legislature	Prohibition on regulation of farm production by local gov'ts	Various	Limit Municipalities

¹ This law affected exactly 2 farms

² The Arizona law affected 1 (one) hog farm and no veal operations were in existence.

³ Prevents the introduction of State ballot initiatives to pass anti-cruelty measures in Ohio for farm animals.

<http://www.nationalaglawcenter.org/assets/farmanimal/index.html>

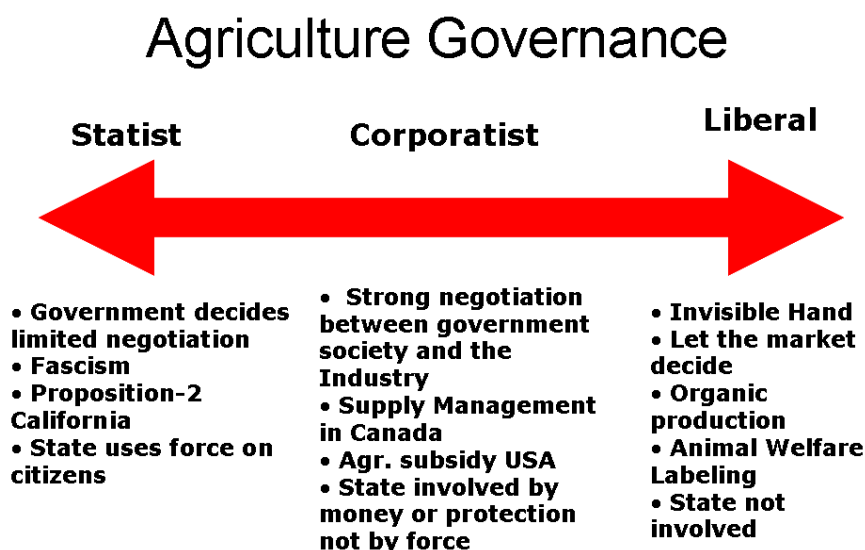
Consumers, who won't voluntarily pay more for specific production practices as an individual, will often vote with non-consumers to make everyone pay more as demonstrated in recent political campaigns in the United States (Tonsor et al., 2009). In addition, governments are often willing to constrain economic development in agriculture if supported by citizen concerns (Auger et al., 2003; Bill 17 Manitoba, 2008).

HISTORIC EXAMPLES OF POLICY ARRANGEMENTS

The default agricultural policy arrangement in most countries in the western world from the turn of the century to the mid 1980's was corporatism; agriculture industry coalitions largely directed farm policy [this continues in the USA]. Countries that have corporatist systems typically utilize strong state intervention to direct corporatist policies and to prevent conflict between the groups. Examples of Corporatist intervention are subsidies in USA agriculture policy and Supply Management, with import control policies in Canada (Figure 2). Corporatist organization is possible only within the Nation State and only when the major players in the Policy Coalition are in general agreement with the goals of the target policy.

Figure 2. General description of the major types of government interaction in public policy arrangements.

The rescue of stray and unwanted pets in North America is largely a Liberal system where non-profit organizations generate infrastructure and operate self funded shelter systems. Supply management in agriculture reflects a strong corporatist structure. The Canadian gun registry is viewed by its many opponents as primarily Statist.



The Iron Triangle - The Netherlands

In the years following WWII, food production was the sole purpose of agriculture and therefore the unified goal of the policy coalition that developed around the agriculture issues. In The Netherlands, the post war agricultural community was isolated from the urban community and civil society as a whole. Three core players emerged to direct the modernization of Dutch agriculture in the recovery from the war. The State was represented by the Ministry of Agriculture, farmers by the *Landbouwschap*, (or farmers unions) and the Parliamentary Committee on Agriculture represented the interests of society. With these three groups in total agreement, the objective to develop a modern competitive export oriented agriculture sector was rarely questioned. This iron triangle was actually a continuation of a similar policy arrangement represented by the Agricultural Crisis Act of 1933/34, which had protected farmers from low prices subsequent to a period of overproduction between the wars.

Subsequent to significant rise in public concerns over environmental externalities, massive livestock disease emergencies, and pressures of joining the European Community, the remnants of the old Ministry of Agriculture are now a subordinate function of the new super-ministry formed when the Department of Nature Conservation and Outdoor Recreation was merged with the department of Agriculture and Fisheries in 1982. There has been a dramatic shift from a client ministry solely oriented towards agricultural interest to a ministry of “general” administration. Strong public opinion and strong political pressure advocated for the integration of agriculture, nature, and possibly increased integration of the recreational and residential value of previously rural spaces (Wisserhof, 2000). Livestock farming has moved from a right to farm context to a condition where society gives its permission for some individuals to farm.

Farmers in Western Europe are increasingly being viewed as producers of, in addition to agricultural products, public goods based on countryside values, amenity and access values, landscape preservation and maintenance, and objects like biodiversity, all of which they have a right to be compensated for (Rossmiller, 1998). The taxpayer probably does not have a similar attitude to rural spaces in agricultural areas in most of Canada. Incidentally, governments paying farmers for these “additional agricultural products” based on social values are “green box” in that they are not coupled with production and do not distort international trade.

Agricultural Revolution in New Zealand 1985

In the period 1950-1970, New Zealand implemented a massive program to establish young farmers on agricultural land and provide the tools for further agri-development and growth focused primarily at the export market. By the 1970's, the hallmarks of corporatist agriculture were well entrenched, heavy direct subsidization, minimum price guarantees, subsidized banking and capital costs, single desk marketing and all possible market signals for producers to curb production were removed.

By 1984, with only 20% of farm production consumed domestically, 30% of all agriculture output was government direct payments to farmers, with assistance payments to lamb produced accounting for 76% of farm gate price. In addition, agriculture accounted for 50% of

merchandise exported meaning that consumers in other countries were benefiting from the farm subsidy.

In the mid-80's, the New Zealand economy was in a precarious state. Starting in 1985, all market distorting support for agriculture was removed, special banking services were discontinued and the government agriculture extension programs were eliminated or privatized. Land prices dropped precipitously, previously managed marginal land was abandoned, and agriculture profitability was meagre, especially in meat production. Significant economic and fiscal reform was also implemented in other sectors. Since 1984, there has been a contraction in sheep and beef production with a conversion to dairy and horticulture production. Agriculture was one of several economic imbalances addressed in New Zealand starting in 1985, but changes in agriculture were out on the bleeding edge and more aggressive than changes in other sectors, such as input price controls, employment liberalization and the financial sector (Harris and Rae, 2004).

To complete and confirm the new policy arrangement (nail in the coffin), in 1996 Proportional Representation was implemented in the House of Commons which greatly and permanently diluted the power of the rural vote in New Zealand (Johnson, 1996).

The New Zealand experiment is an example of a very strong Corporatist arrangement being radically replaced by a Statist organization with strong citizen level political support.

Part XII, Health of Animals Act, Canada 2009

Corporatism can occasionally be a very ineffective organizational model, as any individual group can block progress of the policy discussion by willful obstruction. In Canada, the Canadian Food Inspection Agency has been in corporatist negotiations with the livestock industries for more than 15 years to update the Humane Transport of Animals section (Part XII) of the Health of Animals Regulation. Major unresolved issues relate to time in transit rules, with Canada allowing livestock to be transported for time periods roughly twice the USA 28 hour rule and four times as long as comparable regulations in the EU.

There has been little, to no, discernable progress in this, essentially a social contract issue. Animal welfare is perceived as a general policy domain, not a policy limited to the agricultural community, therefore animal welfare assurance is a concern of society as a whole whether you eat pork or not. Recently Alexandra Mendès, Member of Parliament for Brossard – La Prairie, PQ introduced a private members bill [Bill C-468 (CAN)] October 28, 2009 to limit livestock transport times and to effect by legislative means what the CFIA could not successfully negotiate by co-operative means. This was a dramatic shift from a Corporatist policy negotiation to a Statist model in response to perceived failure of the previous negotiation to responsibly proceed. Parliament was prorogued before debate on this Bill and we have yet to see any evidence the livestock policy coalition understands what this initiative in parliament actually means. There is a real possibility that the discourse on transport of livestock will be removed from the current livestock policy coalition (realm of agriculture) and given in trust to a non-agriculture policy coalition (realm of society).

Updating Animal Cruelty Canada Criminal Code 2007

An appreciation of the dynamics of a changing policy arrangement and resulting political dance can be obtained by review of the attempts to update the Criminal Code animal cruelty provisions which started in earnest in 1998. After multiple variations of proposed amendments to the Criminal Code being introduced into the House of Commons, the discourse on this issue has been effectively halted or at least stalled by the passage of Senate Bill, S-213 on Dec 7, 2007 (AFAC, 2010). Where public opinion on an issue is highly divided, or the issue is highly divisive (the abortion debate), policy arrangements are difficult to form and status quos can be very stable. Long standing entrenched organizations such as The Canadian Wheat Board can be expected to be a resilient policy arrangement, and reluctant to change.

Canadian Government Unilateral Actions

The Canadian Agri-Food Research Council (CARC) (1974-2006) was the most important national advisory body influencing agri-food research and policy. Now disbanded, it was funded by the Research Branch of AAFC, and had a small full-time staff in Ottawa. Its membership included representatives from AAFC and each provincial government (only one for Atlantic Canada), a representative from universities with colleges of agricultural and/or veterinary medicine, representatives of a number of national organizations (such as the Canada Grains Council, the Canadian Federation of Agriculture, the Canadian Forage Council, the Canadian Pork Council, the Agricultural Institute of Canada and the Canadian Horticultural Council), and chairs of four national “Canada committees.” The latter were the Canada Committees on Crops, Animals, Natural Resources, and Food; each of these committees met at least once a year to formulate recommendations to go to CARC.

The four “Canada committees” were the apex of a series of national or regional committees, generally referred to as “expert committees.” For example, the Canada Committee on Animals formed a sub-committee, the “expert committee on animal welfare” which met annually to identify research needs in both science and policy. Each expert committee involved representation from various provinces; the meat processing industries, the national livestock associations, veterinary and animal science universities and the Canadian Federation of Humane Societies; the producer representation was generally minimal on most of these committees.

CARC maintained an inventory of agri-food research in Canada, and assisted various sectors in developing national research and development strategies. For example, research strategies were developed for dairy and pork. The CARC web site, www.carc-crac.ca is now defunct; a search of the AAFC website returns no reference or history to suggest CARC ever existed and there is no successor group at the federal level to replace the functions of CARC. One could suggest that the federal government simply went out of the animal welfare consulting business, or effectively removed animal welfare from the federal agriculture ministers’ agenda.

CARC was a classic instrument of corporatist policy negotiations. It facilitated connection and communication between social and institutional power blocks involved in agriculture policy. Its dissolution represented a decisive policy decision that moved the process of policy making to a statist or liberal approach. An approach with less communication with society at large can be

viewed as more Statist, even though in Agriculture policy is largely about subsidies, and what industries and programs qualify for public support.

The Agriculture Policy Framework

On June 2001, the federal, provincial and territorial Ministers of Agriculture took an additional dramatic new approach to the participation of society in agriculture. New agriculture policy development would be a shared and integrated process based on 5 year plans. Costs for agriculture policy would continue to be jointly shared by the federal and provincial governments. The first 5-year plan was called the Agriculture Policy Framework (APF). It was primarily a business plan to try and keep farmers profitable. Topics made it onto the agenda if they could affect farm profitability, such as the areas of science and food safety. Environmental stewardship, which essentially is a social policy concern and the sole purvey of the Provinces under the Canadian Constitution, was also included in the scope of the APF. This, in part, may be explained as most provinces in Canada had implemented new environmental protection legislation related to manure management between 1995 and 2000, making consideration of the environment a cost of production.

Farm animal welfare is becoming a growing issue in State level politics in the USA with several policy coalitions successfully challenging the Corporatist arrangements, for example Proposition-2 in California. Concern for farm animal welfare may be a social issue similar to environmental protection, but, was clearly excluded from the APF agenda and therefore no program related to farm animal welfare was eligible for funding under APF. The other dramatic change in overriding policy arrangement was the decision for the federal government, through AAFC, to no longer fund new programs, only the start up process of such programs. This reflects a markedly liberal conviction with a movement towards non-involvement of the government/society in the business and economy of agriculture.

The new 5-year plan started in 2008 and is called the “Growing Forward” policy framework with \$1.3 billion in federal funding. Farm biosecurity and livestock traceability were added to the agenda of approved initiatives but, animal welfare is not in scope, with the exception of a side agreement signed with Alberta. If farm animal welfare is a true citizen concern, it is not a concern of the current FPT (Federal-Provincial-Territorial) policy arrangement. Provincial farm animal welfare initiatives can not be funded jointly with the federal government as other agriculture issues are, but, are the sole initiative of the province.

New Policy Coalitions and Organizations

There are three emerging organizations on the Canadian landscape that give some hope for a future where new social issues, such as farm animal welfare, can be reasonably reflected in public policy, using the current agricultural policy coalitions. The first is the National Farm Animal Care Council [<http://www.nfacc.ca/>].

Agriculture and Agri-Food Canada's Advancing Canadian Agriculture and Agri-Food (ACAAF) Program provided initial funding to establish a national Council on farm animal care. This is a non-government organization with a mandate to provide a national coordinated approach, to

promote responsible farm animal care. The Council is composed of and funded primarily by the livestock industry. This organization will replace the function of developing farm codes of practice previously delivered by CARC. The NFACC must become self funded by the agricultural business interests in the near future as there is no method of funding this organization under the current FTP policy arrangement.

Secondly, the provinces departments of agriculture have all reorganized to appoint a Chief Veterinary Officer and there is a consultative council of CVO's in Canada. It is clear that, in the near future, improvements to farm animal health and legislation and programs related to improved animal health will be increasingly a shared jurisdiction with the provinces. This is consistent with Section 95 of the Canadian Constitution which makes agriculture and immigration the only 2 policy fields where the nation and the provinces share responsibility. One of the early projects of the CCVO group was to participate in the development of a national Farm Animal Health and Welfare Strategy (Anon., 2009). Shared delivery of animal health policy will require significant re-arrangement of the national policy coalition as previous disease control programs have been largely national and not a shared jurisdiction.

Counter to all regular Agriculture policy of the Federal Government; on Friday Nov 6th 2009, The House resumed consideration of the motion of Mrs. Simson (Scarborough Southwest), seconded by Mrs. Jennings (Notre-Dame-de-Grâce—Lachine), That, in the opinion of the House, the government should support the development and adoption of a Universal Declaration on Animal Welfare at the United Nations [<http://www.udaw.org/>] as well as at all relevant international organizations and forums; (Private Members' Business M-354). The question was put on the motion, as amended, and it was agreed to (GOC-HOC, 2009). This suggests that some animals, or at least the idea of animal welfare, is part of the greater national consciousness, just temporarily not reflected in national agriculture policy.

CONCLUSIONS

Agriculture policy is very much like a sport and when playing the sport, it is very important not to lose control of the ball. Corporatism, the old rule of the game is, if not dead, suffering from a serious injury. Producers must aggressively support their views and their place in the policy coalition or lose a voice in agriculture policy.

Although counter incidents can be identified, the overall power shift in the way policy is decided in Canada and other western democracies can be characterized as a withdrawal-of-government and are manifested in two distinct ways. There is a strong shift from the producer making decisions on his/her farm to the retailer describing the method of production. Also, there is a rise in the relative political influence of near direct citizen policy coalitions. In the trade arena, there is a strong shift of power from the Nation State to multi-national corporations (Thompson et al., 2007). Some have argued that the use of the term multi-national is misleading, and that the adjective “un-national” better reflects a business practice model characterized by disregard, distrust and demeaning of any attitude that would try to balance the self-determination of nations or social convictions of peoples with the profit and efficiency of trading groups.

Animal farming is no longer viewed simply as a means of food production. Instead it is considered as relevant to other key social goals, such as food safety and quality, environmental protection, sustainability and warranty of a suitable humane treatment of animals. Therefore, governments, retailers and producers are increasingly recognizing the multi-functional nature of humans' perception of food as fundamental aspects of product image and quality, which create a need for reliable systems aimed at farm monitoring of methods of production and providing guarantees on appropriate production conditions and traceability. In other words, the way a product is produced is an attribute of an overall 'food quality concept'.

The major holistic proactive tools recognized for adopting standardized methods of production at farm level is the implementation of on-farm measures based on the principles of HACCP (Hazard Analysis Critical Control Points) and on the principles of quality management (QM-Systems) and certification programs (Quality Assurance) such as ISO 9000:2000. The need to improve the method of production of food of animal origin in response to the consumers' and the society's expectations has been realized and addressed for at least 10 years. These changes are most evident in countries with a developed pork production, especially in countries that export pork (Denmark, The Netherlands, Belgium, the USA and Canada). These countries have, in slightly different ways, developed standards for swine production that are driven by the producer associations (the Canadian Pork Quality Assurance System, and the PQA System of the U.S. National Pork Producer Council), or by industry associations (the Danish Quality Management System for pork, the Quality Assurance System of the UK Meat and Livestock Council, the Dutch Produktschap voor Vee and Vlees with its renowned IKB-program (Integrale Keten Beheersing), and the German QM-System for food from feed to retail (QS-System) (Blaha, 2005).

The major re-active tools to deal with social concerns in agriculture have been legislative at the national or sub-national level, including the increasing oversight of manure management and environmental protection, the graduated "Phasing-out" of the most egregious animal welfare components of management systems. In late January 2007, the world's largest producer and pork processor, Smithfields (Smithfield Foods, Inc. SFD), announced voluntary plans to replace gestation stalls at its 187 company-owned sow farms. In January 2008, Maple Leaf Foods Inc., reported that they also will also phase out the use of sow gestation stalls in favour of group housing at all its hog production operations within the next 10 years.

Producer groups should be vigilant in investing in policy coalitions that participate in the ever-changing discourse related to the production of human food of animal origin.

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BETWEEN THE GATE AND PLATE: A GROCER'S PERSPECTIVE ON THE INFLUENCE OF CONSUMER DEMANDS ON THE VALUE CHAIN

**Stacie Sopinka
Loblaw Brands Ltd.
1 President's Choice Circle, Brampton, Ontario L6Y 5S5
E-mail: stacie.sopinka@loblaw.ca**

ABSTRACT

Pork is an integral part of the Canadian diet. In the past decade, social, economic and work related changes have altered the nature of what consumers demand from their fresh meat products. What opportunities exist for the pork industry to address these dynamic requirements?

FACTORS AFFECTING HOW CANADIANS CONSUME PORK

Health Concerns

Canadians are facing a variety of health concerns, of which some are related to or influenced by food. In 2005, the World Health Organization predicted that, over the next 10 years, 2 million Canadians will die from a chronic disease. Within 10 years, deaths from chronic diseases would increase by 15% and deaths from diabetes would increase by 44%.

The number of obese and overweight Canadians continues to increase. These are both contributing factors to chronic disease. In 2005, The World Health Organization predicted that by 2015, 73% of Canadian men and 68% of Canadian women will be overweight. Over one-quarter of Canadians aged 31 to 50 get more than 35% of their total calories from fat. This is a threshold beyond which health risks increase.

Data from the Canadian Health Measure Survey (CHMS) indicate that nearly one-fifth (19%) of Canadians aged 20 to 79, roughly 4.6 million people, had hypertension. Another 20% had readings in the pre-hypertension range, and 61% had normal blood pressure. Not surprisingly, 85% of consumers stated that they would like to reduce sodium in their diet.

Canadians are focusing more attention on what they eat. Specifically they are focused on:

1. Decreasing their overall caloric intake, with special attention to calories from fat
2. Reducing their overall sodium intake
3. Eating a well balanced diet

When asked, 76 per cent of consumers identified that nutrition is the most important factor when planning meals. Only 13 per cent of Canadians ranked taste as more essential than nutrition.

Reducing Calories from Fat

There are many ways that consumers can incorporate pork into a healthy diet. In order to encourage pork as a protein that promotes health and wellness, more focus should be placed on the lean fat content of many pork cuts. Focused consumer exposure is best achieved when nutritional information is marketed directly on the package. Consumers are increasingly looking for on-package nutritional information, even for non value added cuts.

Trim specification is very important in the consumer decision making process. By reducing visible fat, pork cuts will be more attractive to consumers who are monitoring their fat intake.

Consumers are looking for methods of stretching their shopping budget. By promoting the use of pork as an ingredient as opposed to centre of the plate, consumers would see that they can both save money and reduce their caloric intake. Finally, educating the customer as to the correct portion size will assist them in choosing pork as part of their diet.

Reducing Sodium Intake

Processors of pork can assist Canadians in reducing their sodium intake by maintaining a responsible level of sodium in both enhanced pork and ready-to-cook pork products. By offering a variety of recipes that promote the use of sodium alternatives such as dry rubs and marinades pork can be marketed as a flavourful protein option that contributes minimally to a consumer's overall sodium intake.

Well Balanced Diet

One of the best methods of encouraging a well balanced diet is to promote the consumption of meals in the home as opposed to those eaten in restaurants. Through the promotion of pork-based recipes (such as stir fries, soups and salads) consumers can include pork as a healthful part of their diet and not exceed the daily recommended amount of protein as per Canada's Food Guide.

Consumers can be encouraged to cook at home through the marketing of on-pack recipes and supporting dietary information. For younger generations, this information is of growing interest and is increasingly being sourced from social network sites such as Facebook and Twitter.

Finally, by cross merchandising pork with other healthy ingredients such as vegetables consumers will be assisted in finding meal solutions and eating a well balanced meal.

Meal Preparation and Lifestyle

Canadians are increasingly changing their eating habits to fit around their work and leisure activities. Over 62% of women with children participate in the workforce. Families are challenged to create family mealtimes in an era where individual family member's schedules are juggled. As a result of this fast paced environment, 75% of meals made in 2009 were made in 15 minutes or less.

Most meals consumed in the typical Canadian home are prepared quickly and are not complex in nature. However, as a result of consumers eating fewer meals outside of the home, they are on occasion looking to create “restaurant quality” meals within their homes.

Convenience Foods and Pork

There are several opportunities to make pork more attractive to the time starved consumer. Providing fresh meat that is value added by cut, as opposed to seasoning, is one simple method of providing the consumer with a quick method of cooking a healthful meal. This notion of component cooking is extremely popular in England where retailers such as Tesco and Sainsbury market a wide variety of fresh washed and chopped produce in conjunction with sliced fresh meat and sauces. Similarly, Loblaw Brands Ltd. continues to grow its fresh washed and chopped vegetable category and promotes fresh meat in conjunction with our signature PC Memories of sauces.

Providing straight forward cooking instructions on the package with links to recipes and simple meal solutions will assist those looking for information. Consumers express an interest in multiple on pack recipes for frequently purchased items.

On those occasions when consumers want to recreate a restaurant experience at home they are looking for slightly different assistance. For a premium in-home dining experience, consumers are looking for more unique cuts, in store support from staff and more complex recipes.

Foods of Conscience

This category includes a broad scope of products that are defined by their enhanced attributes and benefits. They are unique in the way that they are produced and processed. They sometimes have attributes that make them more environmentally responsible and often have more stringent quality assurance attributes.

Consumers are attracted to foods of conscience for a variety of different reasons. Consumers sometimes choose these foods because they reflect both their individual and community values. Consumers are more likely to form an emotional attachment to products of this nature. They have a greater sense of trust with ethical products and project a sense of higher level of quality in their expectations.

Consumers purchase foods of conscience for a variety of reasons - 46% of consumers feel that they provide a positive long term health benefit, 43% feel they offer better nutritional value, and 38% are drawn to these products because they commit to better treatment and health of the animals.

In the United States, Organic and “natural” sales are stagnant. Although, 18% of American’s purchase “natural” meat in 2009 sales have remained flat to 2008. Despite the recession, sales have not decreased for a variety of reasons. Ethical products tend to be purchased by more affluent consumers that are less likely to be affected by the recession. There are now more outlets offering “natural” products and programs are more extensive in their offering.

Traceability and Transparency

A recent study conducted by the University of Michigan examined consumer awareness of food safety concerns. Initial results found that over a third of consumers are willing to pay a premium for third party food safety certification (upwards of 30 % or more). Although higher price and brand recognition were sometimes interpreted by consumers to provide higher safety standards, it was third party or government certification that provided the highest level of confidence.

A variety of different approaches have been used in marketing quality assurance attributes. Tasmanian company Field Fresh is using QR (Quick Response) Codes to link Japanese consumers with their farmers. These codes, which are applied to each package of fresh meat, are readable by cell phones. The consumer can immediately access information about BSE certification, the grower and details regarding the exact animal from which the meat was cut.

In France, supermarkets such as Monoprix market various meat products with Quality Assurance Certification validating both origin and species. Premium independent butcher's shops, such as Cumbræ's in Toronto, are educating consumers through use of online videos which discuss breed specific attributes amongst many other topics. All of these systems create transparency to the supply chain, ultimately building a connection and sense of trust between the brand and the consumer.

Environmental Impact

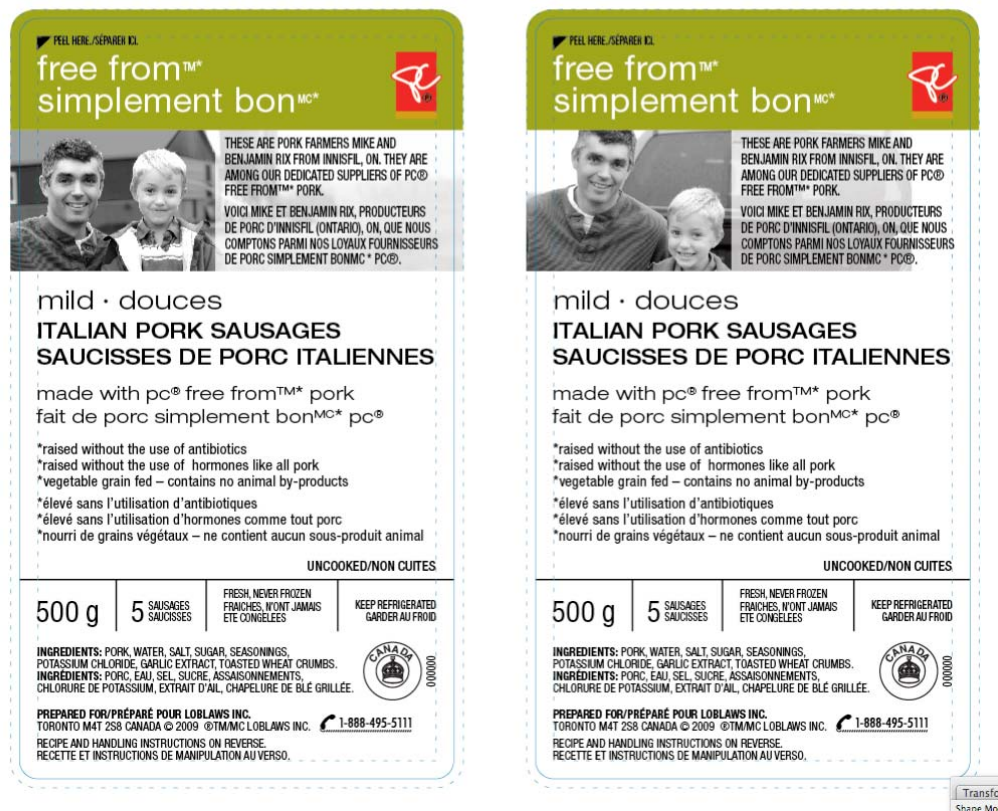
Consumers are gaining heightened awareness of the impact of animal rearing on the environment. Concerns include the effect of animal generated methane gas on the ozone, the intensive carbon footprint of the production of animals, and the impact of non recyclable fresh meat packaging. In 2006, worldwide animal agriculture has been reported by United Nations to be responsible for 18% of green house gas emissions.

Despite a limited growing season, Canadians are attempting to eat more locally where possible. Newsletters such as The Locavore, written by Elbert van Donkersgoed, connect consumers with opportunities to meet and purchase from local suppliers. Ontario's Greenbelt Plan was announced in 2005. This initiative resulted in the protection of 1.8 million acres of sensitive Ontario farmland. In Loblaw Companies Ltd. stores, consumers now have the opportunity to purchase even more regional fruit and vegetables. "Grown Close To Home" is a three week national store event that runs from mid-August to the beginning of September. Canadians believe the freshest produce comes from local farmers. They also believe buying local produce is good for the economy.

There are several initiatives within the meat industry that are examples of how consumer concerns regarding environmental impact can be addressed. Tesco supermarket in England has added a carbon footprint logo to a variety of its fresh meat products. This assists consumers in making informed decisions as to which cut of meat is best suited to their needs. The city of Seattle, Oregon has recently banned polystyrene trays. This affects all tray overwrapped fresh meat product which must now be packaged on plant based trays in order to comply.

CONCLUSIONS

Today's consumer is living in a dynamic economic, social and work environment. There are numerous factors that affect the Canadian consumer's consumption of pork products. These factors include health, environmental and economic concerns. Globalization has heightened awareness of such issues as greenhouse gas emissions and carbon footprint. Canadians are becoming increasingly aware of prevalent health risks and the role that diet plays in regards to chronic disease and obesity. In order to meet consumer's demands, the pork industry must address their concerns through meat quality, innovative marketing tools and educational information.



PC Free From Pork

- Raised without the use of antibiotics
- Raised without the use of hormones like all pork
- Vegetable grain fed – contains no animal byproducts
- Specially selected and trimmed
- Meets specific marble and colour specifications



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BREAK-OUT SESSIONS

CASTRATION IN THE SWINE INDUSTRY AND THE IMPACT ON GROWTH PERFORMANCE – PHYSICAL VERSUS VACCINATION

Frank Dunshea
University of Melbourne
Parkville, Victoria 3010, Australia
Email: fdunshea@unimelb.edu.au

ABSTRACT

In most parts of the world, male pigs that are destined for the market are physically castrated very soon after birth in order to reduce the risk of boar taint. However, entire male pigs are more efficient and deposit less fat than barrows, particularly at high slaughter weights. Also, animal welfare activists are lobbying for a cessation of physical castration in many parts of the world, particularly the EU, with a high likelihood that this could lead to inferior pork and processed products. A welfare friendly alternative is vaccination against gonadotrophin releasing factor (GnRF) which allows producers to capitalise on the superior natural growth and carcass characteristics of intact boars without the risk of boar taint. Vaccination against GnRF results in superior feed efficiency and carcass lean yield over physical castration, while maintaining pork eating quality. There have been very few studies that have compared the lysine requirements of boars and barrows, and none with contemporary genotypes. Recent data suggests that the lysine requirement of boars is slightly higher (ca. 0.6 to 0.9 g/kg) than for gilts and barrows. Given that the penalty in growth performance for having inadequate dietary lysine is greater in boars than in gilts or barrows, it is important to ensure that dietary lysine requirements are met to obtain the maximum benefits of boar production coupled with vaccination against GnRF.

INTRODUCTION

The castration of male domestic animals of most species, with the exception of breeding stock, has been practiced for centuries. Traditionally, the major reasons for castration were to control the reproductive state of contemporary females (as often male and female animals were grazed or housed together), to take advantage of the propensity for castrate animals to fatten (fat is (was) highly valued in some cultures) and to reduce the incidence of rutting and aggressive behaviours often observed in entire animals.

Another issue, which is particularly pertinent to pork production, is that non-castrated male pigs (boars) may exhibit flavours and odours, collectively called boar taint, that are offensive to many consumers. During sexual development and when mature, boars accumulate substances, predominantly androstenone and skatole, in their fatty tissue that are regarded as the main contributors to this boar taint in pork (Bonneau, 1982). To avoid tainting of the meat, boars destined for fresh meat consumption in Australia, New Zealand, the UK and South Africa have, until recent years, been slaughtered before full sexual maturity. For example, in the UK it is stipulated that weight of carcasses utilized for fresh pork production must be less than 85 kg (MLC, 2003). In other countries (Asia, North America, much of the EU) taint has been

overcome by physical castration of the boar before weaning. For example, in the EU approximately 100 million male pigs are physically castrated every year, representing 80% of the male population (EFSA 2004). However, physical castration results in significant reductions in growth performance and excess deposition of fat (Campbell and Taverner, 1988; Dunshea et al. 1993; 1998; 2001, Suster et al., 2006). In many markets there is a penalty for having over fat pigs as consumers and processors alike are demanding leaner and generally heavier pigs. For example, over recent years, the average weight of pigs at slaughter in most countries has increased, driven by the efficiencies associated with the slaughter of heavier pigs (MLC, 2003). While genetic selection has meant that carcass fatness is continually being reduced, the upward pressure on slaughter weights has placed a conflicting pressure on carcass fatness. This is particularly so for physically castrated male pigs (barrows) that have a declining rate of lean tissue deposition during the late finishing phase (Suster et al., 2006).

INCENTIVES FOR UTILIZING BOARS IN A PORK PRODUCTION SYSTEM

The potential lean tissue growth and efficiency of weight and lean tissue gain are greater in boars than in barrows, prompting the cessation of castration 30 years ago in some markets, particularly those that are focused on lean meat production. Some of these differences in tissue nutrient partitioning rates were elegantly demonstrated in a recent study designed to investigate the interactions between housing and sex in contemporary genotypes (Suster et al., 2006). Suster et al. (2006) found that under group-housed conditions there was very little difference between boars and barrows in daily gain and lean tissue content until 122 d of age (ca. 77 kg). Beyond 17 weeks of age, the barrows grew faster than the boars but deposited less lean tissue and more fat. Thus, at 154 d of age the boars weighed 5 kg less than the barrows (103 vs. 108 kg) but contained 3 kg more lean tissue (69.1 vs 66.2 kg), almost 6 kg less fat (18.2 vs 23.8 kg) and 2 mm less P2 back fat (15.1 vs 17.1 mm). In pigs raised in ideal conditions, including individual penning, the differences were even more profound in favour of boars (112 vs 113 kg liveweight; 73.1 vs 66.8 kg lean tissue; 20.6 vs 27.1 kg fat; 15.9 vs 20.6 mm P2 back fat). Also, over the finisher phase the feed conversion ratio (FCR) was 13% higher in barrows than in boars (3.50 v. 3.10). These data for efficiency and P2 back-fat were very similar to that observed elsewhere (Dunshea et al., 1993; 2001). Indeed, a meta-analysis of up to 10 studies conducted with group-housed pigs shows that physical castration increases feed intake (+467 g/d, $P<0.001$), FCR (+0.48, $P<0.001$) and back fat (+4.9 mm, $P<0.001$) with modest increases in growth rate (+31 g/d, $P=0.011$) and carcass weight (+2.1 kg, $P<0.001$) over the finisher phase compared to entire boars (Table 1). While the differences in feed efficiency have been extensively chronicled during the finishing phase where they are most pronounced because of the decline in lean tissue deposition in the barrows, boars are actually more feed efficient and leaner than barrows throughout the entire post-weaning growth phase (Campbell and Taverner, 1988; Hennessy et al., 2009).

The relative efficiencies associated with boar and barrow production systems have been well summarized by the MLC in the UK (MLC, 2003). In this work, the MLC commissioned a desktop study to investigate the efficiencies associated with producing heavier pigs and found that 10% increase in slaughter weight would reduce the cost of production by € 0.05/kg. Based on slaughter weights of 108 and 130 kg for boars and barrows respectively, it was estimated that

the cost of production of boars was € 0.05 greater per kg carcass weight but € 0.17 less per kg of lean tissue. However, in this model the slaughter weight of the boars was limited to 108 kg to ensure that all carcasses were below 85 kg and so could enter the fresh pork market. Commercial pork producers should consider increasing pig slaughter weights as a means of lowering unit costs during both production and processing stages (King et al., 2000) but obviously cannot if legislation does not allow it or if meat quality is likely to be compromised. If the carcasses could be guaranteed to be free of boar taint, using a technology such as vaccination against GnRF, allowing boars to be safely slaughtered at 130 kg, then the cost of production of boars would be less than barrows on both a carcass weight and lean tissue basis.

Table 1. Average fixed effects of physical castration (barrows – boars) from meta-analyses of data from studies with group-housed pigs^a.

	Effect	sed	95% CI	P-value	# studies
ADG (g/d)	-31	15.5	(-61.4, -0.6)	0.011	8
ADFI (g/d)	-467	30.9	(-531, -40)	<0.001	7
FCR	-0.48	0.030	(-0.54, -0.42)	<0.001	7
Carcass weight (kg)	-2.14	0.656	(3.43, -0.86)	<0.001	10
Back fat (mm)	-4.9	0.29	(-5.1, -3.9)	<0.001	10

^a Analyses only included data from studies where data were collected over a nominal finisher phase.

CONSTRAINTS TO UTILIZING BOARS IN A PORK PRODUCTION SYSTEM

The major reason why male pigs are still castrated in much of the world is because of the issue of boar taint. The principal compounds contributing to taint in boars are androstenone and skatole, which are found at much higher levels in the carcasses from boars than from either gilts or barrows. As mentioned above, one approach to reduce boar taint, apart from physical castration, is to slaughter boars at light weights before they have reached sexual maturity. However, this runs counter to the desire to increase slaughter weights as a means of lowering unit costs during both production and processing stages. In the UK it is stipulated that weight of carcasses utilized for fresh pork production must be less than 85 kg (MLC, 2003). The European Community legislation (Directive 64/433/ EEC) decrees that carcasses from boars that are over 80 kg may only be allowed to be used for human consumption provided they are processed (used in smallgoods) or tested for taint. However, processing does not necessarily eliminate boar taint (McCauley et al., 1997). Pigs with the steroidogenic capacity to produce high concentrations of testosterone also have the potential to produce androstenone, and hence to have detectable levels of taint in the carcass. A survey of Australian and New Zealand boars revealed high concentrations of both androstenone and skatole in boars as light as 85 kg live-weight (Hennessy et al., 1997). Therefore, although slaughtering boars at lower weights may reduce the incidence of boar taint, it will not guarantee meat free from boar taint. Thus, boar taint remains the major impediment to the utilization of boars in a pork production system.

While it is accepted that boars are leaner and more efficient than barrows, the growth performance of boars in groups under commercial conditions is generally less than that of

individually-housed boars (McCauley et al., 2000; Suster et al., 2006) suggesting that the putative benefits may not be as marked as assumed when pigs are housed under commercial conditions. Furthermore, during the late finishing phase, group-housed entire males often grow at a similar or slower rate than barrows (De Haer and de Vries, 1993; Dunshea et al., 2001; Suster et al., 2006), possibly because of increased sexual and aggressive activities between entire males. From the peri-pubertal period onwards boars exhibit negative aggressive and sexual behaviours that can detract from feeding (Cronin et al., 2003). For example, Cronin et al. (2003) found that at 21 weeks of age, boars had more aggressive behaviours (27.9 vs 9.5 bouts/pig/d) and sexual activity (7.2 vs 0.1 mounts/pig/d) than barrows resulting in less time spent eating (5.3 vs 7.2% of time) and lower feed intake (2.69 vs 2.90 kg/d). These negative behaviours and reduced feed intake are major reasons why boars do not perform as close to their potential as barrows do when housed under commercial conditions (Suster et al., 2006). Also, the negative behaviours that occur with mixing of boars around slaughter causes carcass damage and reduced meat quality (Dunshea et al., 2009; Lealiifano et al., 2009).

THE ALTERNATIVE TO PHYSICAL CASTRATION – VACCINATION AGAINST GONADOTROPHIN RELEASING FACTOR (GNRF)

Growth and Behavioural Responses

An alternative method of inhibiting sexual development and aggressive behaviours and reducing the accumulation of boar taint compounds in carcass fat, is immunization against GnRF resulting in a reduction in plasma gonadotropins and testosterone (Bonneau et al., 1994; Dunshea et al., 2001; McCauley et al., 2003; Oliver et al., 2003; Nghia et al., 2008). Recently, a vaccine containing a modified form of GnRF in a low reactogenic adjuvant system has been developed to reduce the production and accumulation of both androstenone and skatole in pig carcasses (Dunshea et al., 2001). The vaccine formulation and dosage regimen allows pigs to be immunised relatively close to slaughter. Any taint substances already present are progressively metabolized, allowing the entire boar to be slaughtered at a higher live-weight without taint, having earlier benefited from the effects of its own testicular steroids on growth and carcass composition (Dunshea et al., 2001). The decrease in testosterone appears to also have some additional effects on sexual, aggressive and feeding activity (Cronin et al., 2003) with resultant positive effects on growth performance. Thus, vaccinated boars grow faster than non-vaccinated boars and at a similar rate to the barrows but with a similar FCR as the boars. Back fat depth was intermediate between the boars and the barrows.

The reduction in testosterone as a result of vaccination against GnRF has a profound effect upon behaviour. Cronin et al., (2003) found that there was a reduction in both aggressive and sexual activities in vaccinated boars who exhibited similar activities as barrows (Table 2). As a consequence the vaccinated pigs increased the amount of time they spent eating and their feed intake. Another indicator of reduced negative activities was the reduction in lesion scores in vaccinated pigs observed upon mixing in lairage (McCauley et al., 2001; Table 2). While comparison with individually-housed contemporary boars clearly showed that the growth performance of the group-housed boars was well below their potential during the finisher phase, vaccination against GnRF provided a means of ameliorating this reduction in performance

(Dunshea et al., 2000). Indeed, the growth rate of group-housed vaccinated boars and individually-housed entire boars were identical over the 5 week period after secondary vaccination (1090 vs 1099 g/d), being approximately 20 and 15% higher than the group-housed entire boars and barrows, respectively. Importantly, the variation in growth performance was also less, which makes nutritional and sales management easier (Dunshea et al., 2009). There are now a number of studies conducted with anti-GnRF vaccination across the globe and these have been incorporated into a series of meta-analyses. These analyses of up to 16 studies show that vaccination against GnRF increases feed intake (+512 g/d, $P<0.001$), ADG (+149 g/d, $P<0.001$) and carcass weight (+1.5 kg, $P<0.001$) over that of boars, with only small increases in FCR (+0.07, $P<0.001$) and back fat (+1.2 mm, $P<0.001$) (Table 3). The small increases in FCR appear to occur in smaller group sizes where negative activities may not be as great as in larger groups. Therefore, the increased growth rate and carcass weight of boars vaccinated against GnRF, combined with assurances of high quality pork free of boar taint, provide real incentives in markets where physical castration is not normally practiced. This becomes even more appealing in countries where metabolic modifiers such as porcine somatotropin (pST) or ractopamine are approved to ensure that additional feed consumed in the late finishing period is converted into lean meat (see below).

Table 2. Behavioural traits of boars, barrows and boars vaccinated against GnRF at 21 weeks of age (data are from Cronin et al., 2003 and McCauley et al., 2001).

	Boar (B)	Barrow (Ba)	Vaccinate (V)	Δ B-V	Δ Ba-V
Aggressive bouts/pig/d	27.9	9.5	9.5	18.4	0.0
Mounts/pig/d	7.2	0.1	0.6	6.6	-0.5
Time feeding, %	5.3	7.2	7.7	-2.4	-0.5
Feed intake ^a , kg/d	2.69	2.9	3.32	-0.6	-0.4
Fighting lesion scores ^b	1.01	0.26	0.30	0.7	0.0

^a Determined over the last 4 weeks prior to slaughter.

^b Fighting lesion scores on a 4 point scale from 0 to 3 with 0 having no lesions and 3 severe number of lesions with carcass condemnation.

Table 3. Average fixed effects of vaccination against GnRF (vaccinates – boars) from meta-analyses of data from studies with group-housed pigs^a.

	Effect	sed	95% CI	P-value	# studies
ADG (g/d)	149	18.4	(113, 179)	<0.001	14
ADFI (g/d)	512	30.9	(469, 565)	<0.001	10
FCR	0.07	0.054	(-0.04, 0.18)	<0.001	10
Carcass weight (kg)	1.48	0.412	(0.67, 2.29)	<0.001	16
Back fat (mm)	1.2	0.17	(0.9, 1.6)	<0.001	16

^a Analyses only included data from studies where animals slaughtered between 4 and 5 weeks after the secondary vaccination.

^b Determined over the period between the secondary vaccination and slaughter.

The incentives for vaccinating against GnRF in markets where physical castration is practiced are even more compelling. There are now a number of studies comparing the finishing performance and carcass quality of vaccinated boars and barrows and these have been incorporated into a series of meta-analyses. These analyses of up to 11 studies show that vaccination against GnRF increased ADG (+173 g/d, $P<0.001$) and reduced FCR (-0.33, $P<0.001$) and back fat (-3.4 mm, $P<0.001$) with a small increase in ADFI (+115 g/d, $P=0.004$) and a small decrease in carcass weight (-1.16 kg, $P=0.015$) (Table 4). The large decrease in back fat combined with only a small decrease in carcass weight indicate a substantial increase in lean meat yield in the vaccinated pigs. McKeith et al. (2009) summarized 30 studies (internally- and externally-sponsored) and found that the average un-weighted carcass back fat, loin eye area and lean tissue in were -10.2, +1.7 and +4.6%. Also, it should be borne in mind that the improvements in FCR are cumulative across the entire grower/finisher period (Hennessy et al., 2009; Hanchun et al., 2009). For example, Hanchun et al. (2009) found that feed efficiency was improved by 6.5% from weaning to slaughter in vaccinated pigs compared to barrows.

Table 4. Average fixed effects of vaccination against GnRF (vaccinates – barrows) from meta-analyses of data from studies with group-housed pigs^a.

	Effect	sed	95% CI	P-value	# studies
ADG (g/d)	173	15.6	(142, 204)	<0.001	8
ADFI (g/d)	115	46.9	(23, 209)	0.004	5
FCR	-0.33	0.030	(-0.39, -0.27)	<0.001	8
Carcass weight (kg)	-1.16	0.616	(-2.37, 0.05)	0.015	11
Back fat (mm)	-4.9	0.29	(-5.1, -3.9)	<0.001	10

^a Analyses only included data from studies where animals slaughtered between 4 and 5 weeks after the secondary vaccination.

^b Determined over the period between the secondary vaccination and slaughter.

Antibody, Endocrinal and Metabolic Responses

Antibody titres to GnRF peak a week after vaccination and gradually decline over the next 8 weeks (Claus et al., 2007; Bauer et al., 2008; Dunshea et al., 2008). The intensive bleeding studies of Claus et al. (2007) and Bauer et al. (2008) show that plasma androstenone, testosterone and LH had all reached a nadir 6-10 days after the second vaccination. Plasma urea nitrogen (PUN), an accurate proxy for excess amino acid catabolism (Dunshea, 2002), was found to be increased at 14 and 28 days after vaccination against GnRF (McCauley et al., 2003) as a result of either increased protein intake, decreased lean tissue deposition or both. Temporal studies (Claus et al., 2007; Bauer et al., 2008) indicate that PUN begins to increase within the first few days after vaccination, certainly before any increase in feed intake, suggesting that changes in protein metabolism occur very quickly. Indeed, when feed intake was restricted to either 2 or 3 kg there was a rapid increase in PUN between 8 and 10 days after the second vaccination (Bauer et al., 2008). Plasma IGF-I, which has been shown to be positively related to previous growth rate, decreased more gradually and did not reach a plateau until beyond 14 days after the second vaccination (Claus et al., 2007; Bauer et al., 2008). Plasma leptin concentrations were increased at 14 and 28 days after vaccination against GnRF (McCauley et al., 2003), possibly in response to increased feed intake and fat deposition that occurs around this time. However, there are no

data investigating the temporal pattern of plasma leptin in the immediate period after vaccination. These data suggest that boars that are vaccinated against GnRF have reduced steroidogenic capacity very soon after the second vaccination with the accompanying effects on muscle and fat metabolism and feed intake occurring very soon after. The effects on steroidogenic capacity seem to be still at least 8 weeks after secondary vaccination even though antibody titres decrease by 6 to 8 weeks post-vaccination (Dunshea et al., 2008).

Adrostenone and skatole are both fat soluble and highly labile and freely exchange between adipose tissue and plasma. Therefore, reductions in plasma adrostenone and skatole should theoretically precede reductions in the concentrations of these compounds in adipose tissue. Dunshea et al. (2008) found that vaccination decreased adipose tissue androstenone over the first 2 weeks (0.40 v. 0.17 $\mu\text{g/g}$, $P<0.01$) after the second vaccination and it remained lower until at least 8 weeks (1.12 v. 0.14 $\mu\text{g/g}$, $P<0.01$). On the other hand, adipose tissue skatole was not decreased at 2 weeks after the second vaccination but was at 4, 6 and 8 ($P<0.05$) weeks (Dunshea et al., 2008). In another study, Dunshea et al. (2009) found that adipose tissue skatole concentrations were decreased by 17 days after the secondary vaccination and continued to decline until at least 28 days after the vaccination. Also, Lealiifano et al. (2009) found that adipose tissue androstenone was decreased at 2 weeks after secondary vaccination and remained low until at least 6 weeks after injection. Adipose skatole was very low in the control boars and so there was no significant difference between samples taken at 0, 2, 3, 4 and 6 weeks after secondary vaccination. However, the pooled adipose tissue skatole concentrations from 2, 3, 4 and 6 weeks after secondary vaccination were lower ($P<0.05$) than those obtained from pigs that did not receive a secondary vaccination. Thus, it appears that vaccination against GnRF decreases boar taint compounds and improves carcass weight for between 4 and at least 8 weeks after the secondary vaccination. If the major source of boar taint is androstenone then pigs may be slaughtered as early as 2 weeks after the secondary vaccination. However, in markets where skatole is an issue, further work is required to describe the temporal pattern of adipose tissue skatole.

Managing Vaccinated Boars

Despite the rapid antibody, endocrinal and metabolic responses to vaccination against GnRF, the effects on feed intake, growth and body composition do not become apparent until beyond 2 weeks after the secondary vaccination (McCauley et al., 2003; Oliver et al., 2003; Claus et al., 2007; Lealiifano et al., 2009). As adipose tissue androstenone is decreased by 2 weeks after the secondary vaccination, it should be possible to slaughter vaccinated boars at 2 week post secondary vaccination without any increase in back fat over that of the boars and with the surety that the boars taint compounds have been cleared from the carcass fat (Dunshea et al., 2008; Lealiifano et al., 2009). However, in practice most producers slaughter at 4 to 6 weeks after the secondary vaccination to be certain that all boar taint compounds have been cleared although this may be associated with some small increases in carcass fatness. In many markets the increase in fatness is not an issue and may really be desirable especially since it may be associated with an increase in intramuscular fat (D'Souza et al., 2000). These markets will be also those that can make use of the increase in carcass weight and indeed may wish to extend the slaughter age out to 8 weeks after vaccination to maximise carcass weight without compromising boar taint compounds (Dunshea et al., 2008). There needs to be research aimed at investigating the way in

which the additional energy consumed by vaccinated boars can be converted to carcass and/or carcass lean to maximise the profitability in various markets. These strategies will clearly not be the same in all markets.

In an attempt to reduce the effect of the increase in feed intake on back-fat after vaccination against GnRF, recent studies were conducted to investigate the interactions between vaccination against GnRF and ractopamine (Rikard-Bell et al., 2009; Moore et al., 2009). Ractopamine is currently registered in the USA and many other countries, but not the EU, for use as an in-feed metabolic modifier. Dietary ractopamine increased lean tissue and decreased fat mass, particularly in vaccinated boars (Rikard-Bell et al., 2009; Moore et al., 2009a). Therefore, dietary ractopamine may be a means of ensuring that the increased feed intake observed in vaccinated boars is directed towards lean tissue rather than fat over the last few weeks before slaughter. Similar synergies have been seen between vaccination against GnRF and pST treatment (McCauley et al., 2003; Oliver et al., 2003) although pST is unavailable in many markets.

Nutrition of Boars and Vaccinated Boars

In any production system it is important to pay attention to nutrition, particularly dietary protein and lysine. In order to model and estimate nutrient requirements in response to any management strategy, it is necessary to have accurate data on tissue deposition rates, maintenance requirements and feed intake (Schinckel and de Lange, 1996) and we know that vaccination against GnRF has the potential to impact on all of these parameters. To date, there have been no published studies conducted to investigate the effect of vaccination against GnRF on lysine requirements although it is realistic to assume that up until at least 2 weeks after the secondary vaccination their nutrient requirements should be similar to that of the boar since both lean tissue gain and feed intake are similar until 2 weeks after vaccination (Dunshea et al., 2008). Indeed, the rate of lean tissue deposition of vaccinated boars appears to be maintained (Oliver et al., 2003; Dunshea et al., 2008; Moore et al., 2009) or decreased only slightly (McCauley et al., 2003; Rikard-Bell et al., 2009) compared to that of entire boars until approximately 4 weeks after the secondary vaccinations. This would suggest a similar requirement for total available lysine intake, although it should be noted that feed intake is universally increased beyond 2 weeks after secondary vaccination and therefore the lysine content of the diet could likely be reduced beyond this point. Also, the PUN responses suggest that there is excess protein (lysine) by 2 weeks after the secondary vaccine (McCauley et al., 2003; Claus et al., 2007; Bauer et al., 2008) which indicates that lean tissue deposition is reduced relative to boars at this time. While there are no tissue deposition rate data beyond 4 weeks after secondary vaccination, it is likely that lean tissue would decrease and fat deposition increase relative to boars. It is important that the temporal pattern of tissue deposition rates and feed intake be further explored to be incorporated into models to predict nutrient requirements over this period of rapidly changing metabolism.

There are also very few data comparing the lysine requirements of boars and barrows, particularly in contemporary improved genotypes. Given that the lysine requirements of gilts are generally considered to be similar or slightly higher to that of barrows (NRC, 1998) and that there have been a number of studies comparing the lysine requirement of boars and gilts, it is realistic to use the gilt requirements as a reference point. During the early 1980's, a number of studies were conducted that suggested that the protein deposition potential and lysine

requirements of grower boars (up to 60 kg) was slightly higher than that of gilts (Batterham et al., 1985; Giles et al., 1986). However, more recent studies suggest that, although the protein deposition and growth potential of boars is greater than that of gilts, there is little difference in the lysine requirements of grower and finisher boars and gilts (King et al., 2000; O'Connell et al., 2005;2006). For example, King et al. (2000) found that there was no difference in the lysine requirement to maximise protein deposition and feed efficiency in heavy (80 to 120 kg) finisher boars and gilts. O'Connell et al. (2005) found that, in three studies in grower boars and gilts (20 to 68 kg), there were no differences in the lysine requirements to maximise growth and feed efficiency. In heavier pigs (60 to 100 kg), these authors found lysine requirements were slightly higher in boars than in gilts in one study but not in two others (O'Connell et al., 2006). In the most recent study conducted with high-performing grower pigs, it was found that the lysine requirement of boars was higher than that of gilts (Moore et al., 2009b). The studies that have shown no difference in lysine requirement have often been conducted with individually-penned pigs where the full feed intake potential can be expressed and often in these cases boars consume more feed than gilts (Dunshea et al., 1998; King et al., 2004). However, in commercial conditions *ad libitum* feed intake of boars is well below (ca. 70%) that which is seen under ideal conditions (Dunshea et al., 2000) and slightly less than gilts (Dunshea, 2005) and this may be where the differences in lysine requirement between boars and gilts may be exhibited. Therefore, it appears that despite large differences in protein deposition rates between the sexes, boars have similar, or slightly higher, dietary lysine requirements, suggesting that boars use dietary lysine more efficiently than do gilts and barrows. Very recently, Quiniou et al. (2010) characterized the growth performance and feed intake patterns of gilts, boars and barrows and, according to simulations performed with the InraPorc software, the digestible lysine requirement was on average 0.1 g/MJ net energy higher for boars than for gilts and barrows.

In an effort to clarify the situation, the published data where lysine requirements of boars and gilts have simultaneously been determined were subject to a meta-analysis and the overall effect was that boars require a slightly (ca. + 6%) higher dietary lysine content than gilts (10.9 vs. 10.3 g lysine/kg, $P < 0.001$). A multi-regression analysis of lysine requirement indicates that lysine requirement decreases with live weight (-0.076 g lysine/kg per kg), is greater for boars than for gilts (+0.88 g lysine/kg), and has increased over time (0.16 g/kg per year). It should also be noted that since the slopes of the lysine dose response curves are greater in boars than in gilts, the penalty in growth performance for having inadequate dietary lysine will be greater in the former. Also, the requirements of both boars and gilts estimated in this manner are greater at any live weight than those suggested by the NRC (1998). In part, this may reflect the fact that much of the data used to generate the NRC (1998) requirements were obtained some time ago and there has been steady improvement in lean tissue potential. An additional consideration when estimating lysine requirements of vaccinated is that because feed intake increases markedly over the period beyond 2 weeks after the secondary immunization, it may be possible to decrease both the lysine and energy contents of the diets or restrict feed beyond this point. Alternatively, growth modifiers such as ractopamine (Rikard-Bell et al., 2009; Moore et al., 2009a) or pST (McCauley et al., 2003; Oliver et al., 2003) may be used in some markets. In many production systems, the ability to change diets at this point is limited. However, another strategy may be to have a diet change and introduce a metabolic modifier for the final 2-3 weeks before slaughter.

CONCLUSIONS

Boars are more efficient and deposit less fat than barrows, particularly at high slaughter weights. However, the risk of boar taint in peri-pubertal boars has resulted in legislation or recommendations in some countries that boars are slaughtered before they reach 85 kg carcass weight. Animal welfare activists are lobbying for a cessation of castration in many parts of the world, particularly the EU. However, this could result in inferior pork products being placed in the market. A welfare friendly alternative is vaccination against GnRF which allows producers to capitalise on the superior natural growth and carcass characteristics of intact male pigs without the risk of boar taint. Recent data suggests that the lysine requirement of boars is slightly higher (ca. 0.6 to 0.9 g/kg) than for gilts but it is important that this is verified and quantified. Given that the penalty in growth performance for having inadequate dietary lysine is greater in boars than in gilts, it is important to ensure that dietary lysine requirements are met to obtain the maximum benefits of boar production, coupled with vaccination against GnRF. Also, it is important that the temporal pattern of tissue deposition rates and feed intake be further explored to be incorporated into models to predict nutrient requirements over this period of rapidly changing metabolism. This will be important to ensure that the benefits of vaccination against GnRF can be optimised in all the markets where it will be available.

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MANAGING BOAR TAIN: FOCUS ON GENETIC MARKERS

E. J. Squires and F. S. Schenkel
Department of Animal and Poultry Science
University of Guelph
50 Stone Road East, Guelph, Ontario N1G 2W1
E-mail: jsquires@uoguelph.ca

ABSTRACT

Male pigs are normally castrated to prevent boar taint, but this reduces feed efficiency, lean gain and has a negative impact on animal welfare. Alternatives to surgical castration are immunocastration and the development of genetic markers that can be used in a marker assisted selection breeding program to produce pigs that are free of boar taint. Our approach is to identify single nucleotide polymorphisms (SNPs) in candidate genes that encode the enzymes involved in the synthesis and degradation of the boar taint compounds, androstenone and skatole. We used a sample set of about 1300 animals representing 8 different lines, comprising 6 breeds, for the discovery and validation of SNP markers. So far, we have validated about 80 effective SNPs in 28 candidate genes. The SNPs that were associated with fat skatole and androstenone and the strength of the associations varied among the eight lines of pigs, although some SNPs were effective in several lines. Application of the markers to produce pigs that were homozygous for the favourable alleles would decrease average fat skatole levels from 20-54% and fat androstenone from 26-61%, depending on the line. We also determined that none of these markers were associated with negative effects on production traits. A genetic solution for boar taint will eliminate the need for castration of male piglets. This will dramatically improve the profitability and decrease the environmental impact of pork production, as well as address the increasingly important animal welfare concerns about castration.

INTRODUCTION

Why Castrate?

Young male piglets are castrated to prevent off-odours and off-flavours (boar taint) in the meat at slaughter weight. Castration prevents boar taint, but intact boars have improved feed efficiency, nitrogen retention and lean gain compared to castrates, which could result in significant economic gains to producers. The use of entire male pigs for pork production will improve pork production efficiency, but this brings with it also concerns about pork with boar taint and husbandry of entire males pigs which are more aggressive than castrates (Lundström et al., 2009). A major driving force for using entire males is the growing animal welfare concerns against castration. Several EU countries will ban surgical castration in the next few years (even with anaesthetic) and some major grocery stores in The Netherlands have now decided not to sell pork from castrates. Controlling boar taint without surgical castration would, therefore, have dramatic benefits for production and consumer acceptance of pork products.

What Causes Boar Taint?

Boar taint is caused by the accumulation of two compounds, androstenone and skatole, in the fat. Androstenone is a steroid produced in the testis as the boar nears puberty, and it acts as a sex pheromone to regulate reproductive development in gilts and induce a mating stance in sows. Skatole is produced as a bacterial breakdown product of the amino acid tryptophan in the gut. It is produced in equivalent amounts in the gut of both males and female pigs, but it is poorly metabolized and eliminated by males, so it accumulates in fat.

Boar taint from skatole is affected by diet and environment (management). The main source of the tryptophan for skatole production comes from the turnover of cells lining the gut, and this can be reduced by including sources of fermentable carbohydrates in the diet. Skatole can also be absorbed from the manure, so dirty pigs of any sex can accumulate high skatole levels in fat. Androstenone production is controlled by the sexual maturity of the boar, so diet does not have much of an effect on boar taint from androstenone. Androstenone levels could be decreased by slaughter at lighter weights before puberty begins, but this is not economical.

OPTIONS FOR CONTROL OF TAINT

Two promising alternatives to deal with boar taint are the use of genetic markers to select pigs that have reduced propensity to produce boar taint (Zamaratskaia and Squires, 2009) and the use of an immunocastration vaccine (Improvac, developed by Pfizer; Dunshea et al., 2001; Moore et al., 2009; Pauly et al., 2009).

Immunocastration

A promising method for controlling boar taint is by immunocastration, instead of surgical castration. Immunocastration works by injecting a vaccine which stimulates the production of antibodies against gonadotropin releasing hormone (GnRH). GnRH is produced by the hypothalamus in the brain to drive the release of luteinizing hormone and follicle-stimulating hormone by the pituitary gland, which stimulate the development of the testis. The antibodies inactivate GnRH to shut down testicular development to the same extent as surgical castration. However, since the vaccine is given to pigs near slaughter, they grow as normal boars for most of their life and retain the performance advantages of intact boars.

Genetic Selection

Genetics can affect both the production and metabolism of boar taint compounds, and these effects can be found both within breeds and among different breeds. For example, levels of androstenone are much higher in Durocs than in the white pig breeds. There is also a wide variability in the amount of boar taint that individual pigs have within a breed. The heritability of both androstenone and skatole is moderate to high, but previous attempts to select for pigs with low boar taint have resulted in reproductive problems (reviewed in Zamaratskaia and Squires, 2009). The development of specific genetic markers for boar taint would minimize these negative effects on reproduction.

The use of genetic markers to produce lines of pigs that are free of boar taint but otherwise grow as normal boars is a long term solution to raising entire male pigs for pork production. A number of studies have shown differences in expression of candidate genes encoding enzymes involved in the metabolism of boar taint compounds between high and low boar taint pigs and between different pig breeds. However, only a few studies have reported SNPs in these genes that are correlated with levels of boar taint. A recent report from Norway (Moe et al., 2009) is the first association study to compare a large number of SNPs to boar taint in Duroc and Norwegian Landrace breeds. They found significant marker effects for fat androstenone in Duroc, but not in Landrace, and significant marker effects for fat skatole in both breeds. Individual markers explained from 2.5-16.3% of the total variation in the traits

At the University of Guelph, we have developed genetic markers for boar taint based on candidate genes that encode the enzymes involved in the synthesis and degradation of the boar taint compounds, androstenone and skatole. We have a database of about 1300 animals representing 8 different lines, comprising 6 breeds (Duroc, Hampshire, Landrace, Large White, Pietrain and Yorkshire), that we have used for the discovery and validation of genetic markers, mostly single nucleotide polymorphisms (SNPs) in the DNA. We compared the sequences of candidate genes from pools of DNA obtained from animals from the extremes of the boar taint phenotypes in each line for SNP discovery. We then genotyped all the animals in our database for each SNP and conducted association analysis for each SNP with the boar taint phenotypes, i.e. androstenone and skatole.

So far, we have about 80 effective SNPs in 28 candidate genes for boar taint. The strength of the associations of the SNPs with skatole and androstenone levels in fat varied among the different lines. The SNPs that were associated with fat skatole and androstenone varied among the eight lines of pigs, although some SNPs were effective in several lines. The number of significant SNPs across lines varied from 5 to 17 and from 3 to 16 for skatole and androstenone, respectively. A large proportion of effective SNPs were associated with both skatole and androstenone (65%) across lines, which corroborates with the reported moderate positive genetic correlation between these two boar taint compounds (e.g., Tajet et al., 2006). Application of the markers to produce pigs that were homozygous for the favourable alleles would decrease average fat skatole levels from 20-53% and fat androstenone from 26-61%, depending on the line. We also determined that none of these markers were associated with negative effects on production traits. We are now working with a commercial company (JSR Genetics) to validate these SNPs in their lines. The ultimate goal is to identify the causative mutations in the handful of most important genes, and then use these markers in breeding programs to develop lines of pigs that are free of boar taint but otherwise grow as normal boars.

These findings represent significant progress towards a genetic solution to boar taint. Work is continuing to characterize additional SNPs for boar taint and to validate these markers in commercial swine populations. The control of boar taint by marker assisted selection will eliminate the need for castration. This will significantly improve the profitability of pork production and address animal welfare concerns about castration that are now a hot topic in several EU countries.

CONCLUSIONS

Castration to prevent boar taint limits productivity and increases animal welfare concerns of commercial pork production, so alternative strategies for controlling taint are needed. Immunocastration effectively controls boar taint, but the development of low boar taint lines of pigs by marker assisted selection would provide a long term solution to the problem. This will improve pork quality and consistency, profitability, environmental impact and animal welfare in pork production by eliminating the need for castration of male piglets. In terms of production efficiencies it is anticipated that the use of entire male pigs will improve profits per pig by more than \$5, which is based on analyses that were conducted previously by de Lange and Squires (1995) and adjusted to 2010 economic conditions. Intact males also produce less manure and thus excrete less nitrogen and phosphorous in the manure than castrates, thereby decreasing the environmental impact of pig production.

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GREEN INITIATIVES: OVERALL EVALUATION OF INNOVATIVE PIG FATTENING SYSTEMS FOR ANIMAL-WELFARE LABEL PRODUCTION

Wilhelm Pflanz
Centre for Education and Knowledge Boxberg, Germany
(Bildungs- und Wissenszentrum Boxberg,
Landesanstalt für Schweinezeit - LSZ)
Seehöfer Straße 50, D-97944 Boxberg-Windischbuch
E-mail: Wilhelm.Pflanz@lsz.bwl.de

ABSTRACT

Changing public opinion and subsequently increasing political pressure require new solutions in farm building and housing. Within the current research project four innovative pig-fattening systems are evaluated for their effects on animal welfare and profitability. The ethological assessment concept consists of four parts, among them direct observation with the scan-sampling method supported by a new video technique and the integument scoring following the method after “Ekesbo” will be specified. In addition, the systems are compared and evaluated according to indoor air quality, functionality and consumer acceptance. Therefore, twenty recently built pig-fattening units (five single fattener houses per system) on commercial farms are investigated in a field study.

INTRODUCTION

In this research project, four innovative pig-fattening systems are evaluated for their effects on animal welfare and profitability. In addition, the systems are compared and evaluated according to labour time requirements, indoor air quality, functionality and consumer acceptance. Therefore, twenty recently built pig-fattening units (five units per system) on commercial farms are investigated. A database is created that will reveal, on one hand how the common requirements of a good relationship between animal welfare and good profitability for the farmers can be fulfilled with these new systems, and on the other hand where problems are and how they can be approached. Finally, the results will be discussed in a public “round table dialogue” with experts including representatives from animal welfare organisations, consumer organisations, agricultural and veterinarian administration, scientific institutes, as well as marketing organisations and practical farmers with the aim of knowledge sharing for all participants and lead to a better understanding between all interest groups involved.

FIELD STUDY DESIGN

The research project evaluates four innovative pig-fattening systems. For each system, five similar stables are monitored, to have statistically more robust results and to reduce the “farmer effect”.

Investigated Pig Fattening Systems

Altogether twenty recently built pig-fattening units on commercial farms had been investigated. The single systems are characterized as follows:

- 1) Insulated confinements with slatted floors and improved animal welfare (larger groups of 20 to 40 animals, pens structured in functional areas, activity stimulation) (Figure 1).
- 2) Sloped floors with a single climatic area, including both insulated as well as non-insulated buildings. Limited straw quantities are offered to the pigs (30 to 60 g per animal per day). However, the dung removal system is still slurry-based (Figure 2).
- 3) Open front units with free ventilation and insulated sleeping boxes. Limited straw quantities are offered and the dung removal system is slurry based (Figure 3).
- 4) Straw-based classic two-area-pen systems with indoor pen and training area on slatted as well as solid floors outside. Straw is offered as activity stimulation or bedding (Figure 4).

Figure 1. Example of a conventional stable with improved animal welfare (activity stimulation).

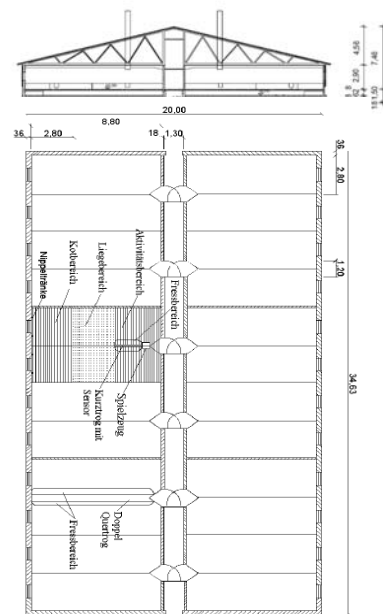


Figure 2. Example of a sloped floor stable with limited straw offering.

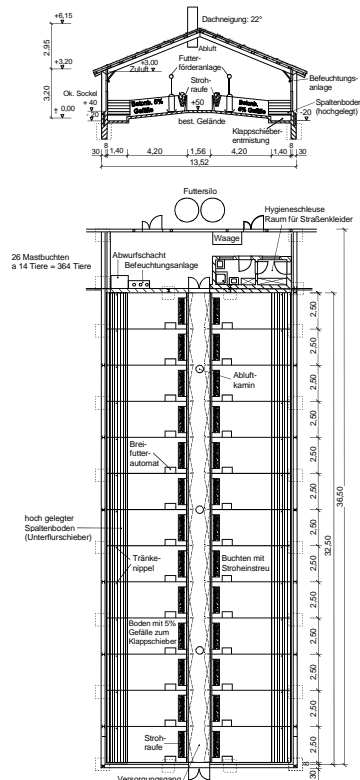


Figure 3. Example of an open front unit with free ventilation and insulated sleeping boxes.

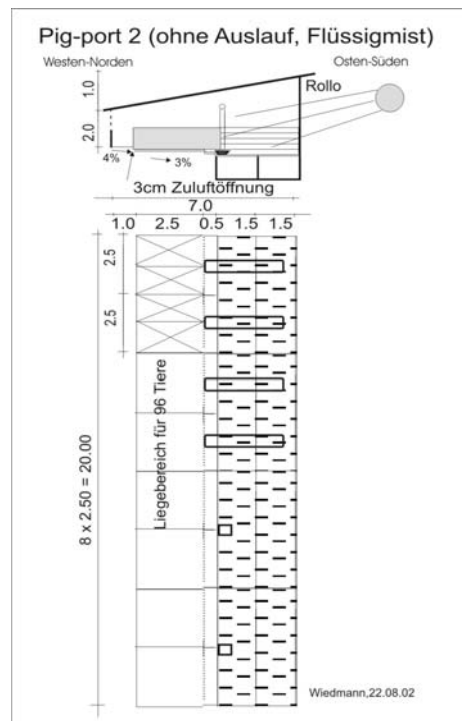
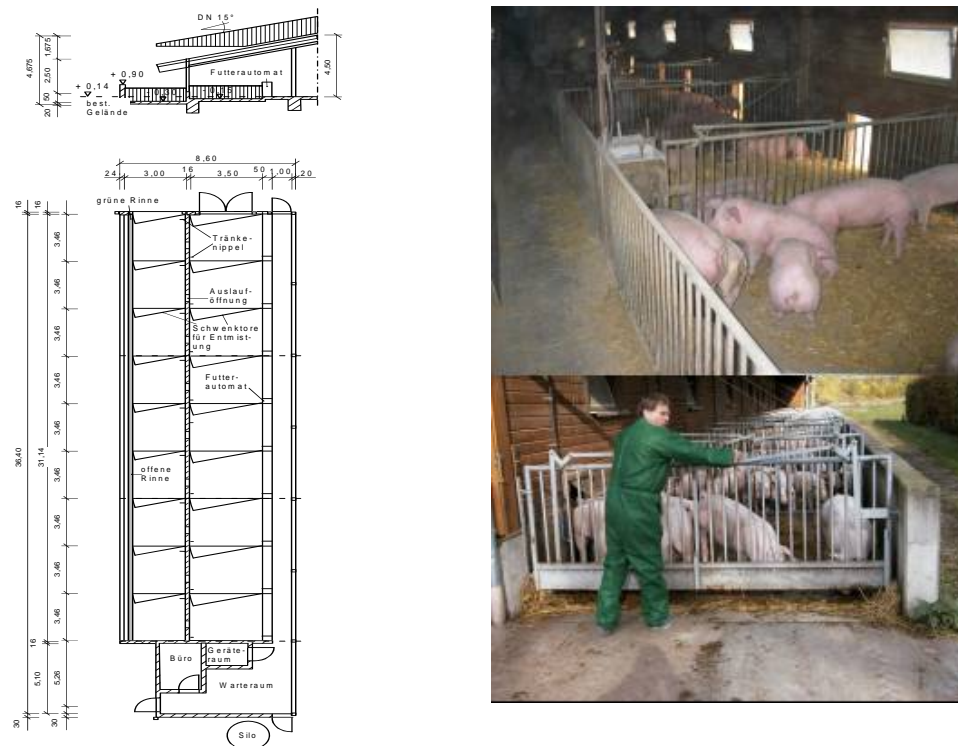


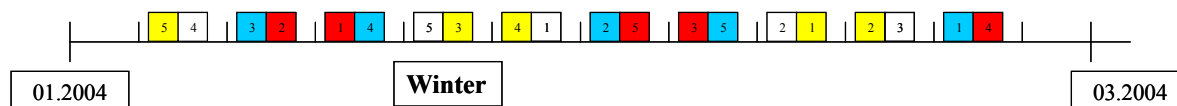
Figure 4. Example of a straw-based classic two-area-pen system.



Time Schedule

The units were studied for one year, thus including the seasonal effects. The year was divided into four 3-month observation periods similar to the seasons. In every observation period, each single stable was investigated for two days. Two farms were investigated each week, so in a ten week period, all pig houses were inspected. The single systems and farms were randomly distributed in every season.

Figure 5. Time schedule for the investigation section “winter”.



■ = System a ■ = System b ■ = System c □ = System d

1- 5 = continuous farm-number within one system

Methods of Investigation

The main topic of this paper is the evaluation of the pig fattening systems for their effects on animal welfare. The ethological assessment of the systems was based on four pillars or methods. Two methods investigated animal welfare directly (animal based) and two methods investigated animal welfare indirectly (production-environment based). The first direct approach of the

assessment concept was the direct observation of the animals by the scan sampling method supported by a new video technique. Direct observation against video observation has the advantage of a more exact and better spacial view; further it is possible to use all senses, such as hearing. (Etter-Kjelsaas, 1986).

Adversarial is the missing repeatability of the single observations, the potential animal manipulation and the health impact of the observer in the stable. The pigs were observed in two weight-ranges, from 40 to 50 kg and from 70 to 80 kg live weight. The pigs were all classic fattening breeds. The observation was divided into two parts. First it was scored where the animals are and what their body position was, e.g. lateral laying in the laying area. Based on these results, it could be concluded whether or not the functional areas were voluntarily accepted in the structured pens (Weber, 2003). In the second part, the behaviour shown (explorative behaviour, playing behaviour or stereotypic behaviour) was scored with 15 characteristics to get information about the relationship between housing environment and the opportunities to live out the behavioural attributes being typical for the species. Reverse stereotypic behaviour like blank chewing was a negative indicator for a housing system.

During the observation days, no disturbance like cleaning or penning of animals occurred in the stables. In housing systems with straw, littering had to be done at least one hour before the observation started in order to have no expectations from the animals to the observer. During the direct-observation periods between 9 – 11 a.m. and 3 – 5 p.m. (main activity periods) the observer sat on a raised chair. After an adaptation period to the animals of at least 20 minutes before the first scan started, the watcher noted the scans in a time interval of six minutes per pen, always observing two pens in rotation. The six minute interval related to the average duration of the single behavioural parameter. The notification was done on a mobile and full ruggedized tablet PC with a pen on the touchscreen. An observation software (ETHOSCAN 04) had been programmed, which provides standardization of the data collection (Lehner, 1996). If there were stables with pen areas that cannot be observed directly (sleeping boxes, exercise areas), a specifically designed mobile video technique supported the observation contemporaneous. The technique consisted of four mobile cameras with wireless transmitters and a mobile receiver station with a digital video-recorder (clip maker) and a monitor which could be fixed to the observation chair. As a result, all pen areas could be observed at the same time. Because of the many observation dates, there had been several observers needed, and therefore it was necessary to have a good repeatability between the single persons. Therefore every season, an observer standardization with all persons being concerned was done on a farm (all watchers scan at the same time the same pen). The correlation coefficients between the single persons were between 80 and 90 %.

The integument scoring was done with a method following “Ekesbo”. Here, 20% of the pigs from four pens were randomly selected and scored. Two pens were scored during the weight-range 40 to 50 kg and two pens with 70 to 80 kg. Because of field conditions, the scoring list concentrated on the main aspects and was not so specific as in literature (Gloor, 1988). With this method, information was estimated about interaction between housing environment and animals (direct effects like sharp edged slatted floor) and the housing system influence on behaviour between animals (indirect effects). A pictorial criteria catalogue with the items dirt, dermis and hair, ears, body, tail, extremities and claws was made to standardize the observer.

Every three months (every season) the production environment of each stable was scored. Stable condition and pen soiling was recorded to investigate, if there is any relationship between season and, for example, pen soiling.

Finally, all fixed effects including pen measures, ventilation system, dung removal system, feeding system, activity stimulation, and management were regarded in a general farm recording. These data were estimated and compared to literature and governmental laws and ordinances.

In addition, temperature and humidity outside the stable and inside in the animal area (if there are two different climatic areas for the pigs, two measurements were made) were constantly recorded with data loggers. In the animal area, the data loggers were protected with wire baskets. During the two observation days, noxious gases (NH₃, CO₂, H₂S, CH₄,) were included in the measurements in the activity areas as well as in the sleeping boxes. Luminous intensity was measured at the brightest spot in the darkest pen, just as well as in the scan and “Ekesbo” pens at the height of the animals.

RESULTS

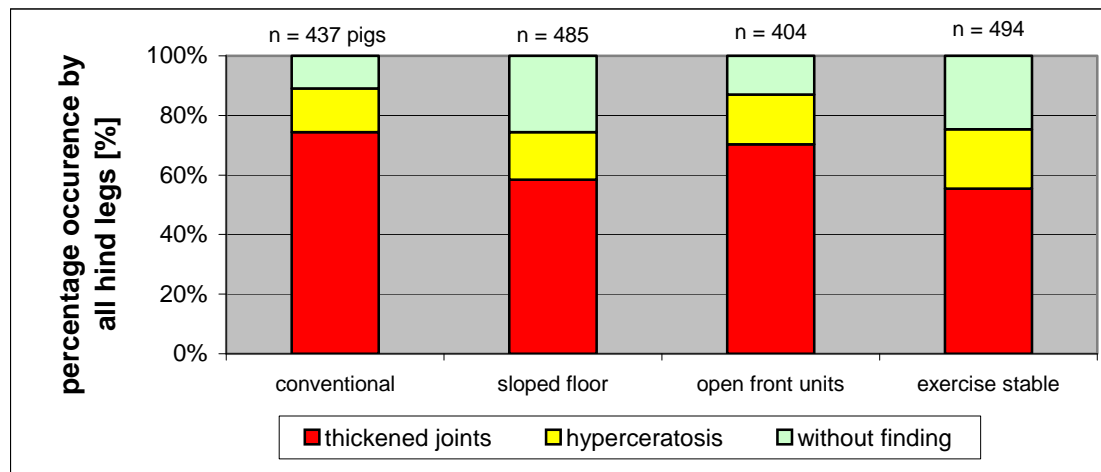
The results can be summarized as follows: The acceptance of the lying area in housing systems with separate climatic areas (open front stable 82.07%, outdoor exercise stable 62.64%) was twice as good as in systems with an uniform climate area (improved conventional system 31.39%, sloped floor system 43.94%).

A higher quantitative and qualitative exploration behaviour “rooting” was exercised in housing systems with straw litter, whereas a more frequent treatment of the pen equipment offered occupation technique in systems without straw was observed. Behavioural disorders were found to decrease from conventional systems (4.91%) to sloped floor systems (3.1%) to open front stable (2.34%) to outdoor exercise stable (2.26%), but on an altogether acceptable level.

Less pathophysiological changes with respect to injuries at the extremities, thus lamenesses, were detected in pens with straw litter compared to systems without straw, which underlines the absorbing protective function for the extremities of even small amounts of straw. Notwithstanding, these bodily changes existed across all housing systems on a high level (Figure 6).

A significant increase of the parameter “changes at the tail” is associated with a reduced net pen floor area per pig. All parameters to evaluate the animal friendliness of the housing systems were strongly influenced by the individual farm, thus the farm effect was partly higher than the effect of the housing system.

Figure 6. Integument scoring of the extremities behind.



In the course of the year the cleanness of the lying areas of nearly all stables was satisfactory. The highest risk for an utilisation reversion of the functional areas existed in the summer months for the outdoor exercise stable. The indoor climate measurements were at acceptable levels for the hydrothermal complex in nearly all stables. During the autumn months, especially in insulated stables, relatively high indoor air ammonia concentrations (> 20 ppm) occurred. The measurement of the illuminance revealed, that nearly no insulated stable met the legal requirement of 80 lux during 8 h (animal welfare productive livestock ordinance, 2006).

The calculated building costs per animal place (1.0 m²/pig each) amounted to 611€ for the improved conventional system, to 513€ for the sloped floor system, to 447€ for the open front stable and to 423€ for the outdoor exercise yard stable. For a conventional animal place according to animal welfare productive livestock ordinance (2006) with a required minimum floor space of 0.75m²/pig would calculate into building costs of 458€. The work requirement per animal place was higher in systems with straw litter (sloped floor system 1.42 APh, outdoor exercise system 1.76 APh) compared to systems without straw (conventional stable 0.98 APh, open front stable 0.81 APh). However, these differences were mainly caused by workings independent from the housing system.

The assessment of the animal friendliness of the housing systems is overriding for the overall consumers' judgement. They prefer stables with exercise yards relatively near to outdoor conditions. Slotted floor is not directly rejected when it is embedded in an integrated animal friendly concept. The donation of small amounts of straw with respect to the offer of occupation techniques were not recognised as to their ethological importance.

Further research has to be done particularly in a cause analysis since all systems result in the occurrence of thickened joints at the extremities of the pigs. Most likely a remedy can be found with floor materials which can be installed with operational reliability.

In view of the aim in this study, the outdoor exercise yard stable as well as the open front stable achieved the highest rank in the final overall evaluation with the digit of 1.9, closely followed by

the sloped floor stable with the rank digit of 2.5. For the improved conventional stable a rank digit of 3.7 was determined. In the whole study, the individual farm effect on the potential of the respective system became obvious.

In summary, all investigated stables in this field study with good construction work, pen design and corresponding animal care and marketing management were acceptable concerning animal friendliness, operational reliability and economics. Depending on the definition of requirements it has to be decided individually which pig housing system is the most suitable for a single farm.

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GREEN INITIATIVES FOR THE SWINE SECTOR

Donald Hilborn
Ontario Ministry of Agriculture, Food and Rural Affairs
401 Lakeview Drive, Woodstock, Ontario N4T 1W2
E-mail: don.hilborn@ontario.ca

As part of the new Green Energy Act, Ontario has introduced a number of processes to streamline the development of green energy projects. These processes include changes to several acts...

- Planning Act
 - exempts renewable energy generation facilities and renewable energy projects from zoning by-laws
- Environmental Protection Act
 - creates one approval process called Renewable Energy Approval (REA)
- Electricity Act
 - gives renewable energy generation facilities that meet prescribed requirements priority access
 - directs the Ontario Power Authority (OPA) to develop a Feed-In Tariff (FIT) program

Of particular interest to swine operations is the development of the FIT program. This program offers 20 year contracts for the purchase of renewable power from solar, wind, water, biogas and biomass systems. There are many categories of renewable energy types and sizes with the following being of high interest.

Micro Solar ≤10 kW	Roof or Ground	80.2 cents per kWh
Solar >10 kW to 250 kW	Roof	71.3 cents per kWh
Biogas >100 kW	“On-Farm” (regulated under the Nutrient Management Act (NMA))	19.5 cents per kWh
Biogas >250 kW	“On-Farm” (regulated under the Nutrient Management Act (NMA))	18.5 cents per kWh
Biogas >500 kW	All cases	16 cents per kWh

- all biogas may be able to obtain an additional 0.4 cent per kWh community adder
- all biogas gets a 35% bonus for production during peak hours and a 10% reduction for production during non peak
- all biogas gets a 20% of CPPI inflation increase

As a general note, the current average value of the energy component of non-renewable electricity is around 5 cents per kWh so all the prices specified above are substantial incentives.

SOLAR OPPORTUNITIES

The Ontario FIT price paid for solar energy is one of the highest incentives in the world.

Swine farmers in Ontario have the following number of opportunities to “harvest” the sun. There are 4 categories of systems that could be considered for rural use.

Micro-Fit System (<10 kW)

A 20 year contract for \$0.802 cents per kWh is available from the OPA. A micro-fit project can be located on a roof or on the ground. Due to increased complexities in attaching the panels to the roof (primarily unknown structural capacity of the roof) it is anticipated that most micro-fit systems being installed in rural Ontario will be ground mount systems. Conversely, in more densely populated areas, it will be difficult to find unshaded locations for ground mount trackers so likely roof mount systems will be most common.

The ground mount systems can be fixed or be a tracker system. A tracker system will give a significantly higher electrical yield but capital and operating costs will be higher. There is not a consensus on which type of system is most economically viable.

Installation costs for 10 kW micro fit systems will range from \$70,000 to \$110,000. Annual yields of 1000 to 1600 kWh per kW of panel can be expected giving returns in the 11% range after annual costs such as depreciation and maintenance are removed.

The FIT contract is obtained via the OPA website. There are no fees for this application.

For systems installed in 2010, 40% of the system must be constructed in Ontario to meet domestic content requirements. The OPA has a chart that must be followed to meet this requirement. For 2010, either the panels, the inverter (unit that safely converts power from DC to AC allowing connection to the grid) or the support system (unit that attaches the panels to the ground or roof) must be constructed in Ontario.

In 2011, this requirement increases to 60%. This means that at least a component of the panels must be constructed in Ontario.

A number of announcements have been made indicating that several solar panel manufacturers will be locating in Ontario.

Roof Mounted System

For good quality panels properly located it takes about 70 ft² of roof area to have 1 kW of power production. Many of Ontario's larger livestock and machinery storages have southern exposed roof areas of 10000 ft² or greater. This allows for at least 100 kW of solar panels.

The roof must be strong enough to support the solar panels and any additional loads they cause. Conventional solar panels (and supports) will add about 3.5 to 5 lbs per ft². In many cases, an engineer's report proving an existing roof is strong enough may be necessary to obtain a building permit (and insurance).

There are alternative panels available that are very thin and flexible that bond to roof membrane materials. These types of panels may be better for use on existing roofs due to their minimal weight.

Adjusting new construction to maximize solar panels should be fairly inexpensive. This involves orienting the building and roof slope to maximize solar exposure and building the structure strong enough to support the additional weight of the panels.

The FIT price is \$0.713 per kWh for systems 250 kW or less, \$0.635 per kWh for systems 500 kW or less, and \$0.539 per kWh for systems up to 1000 kW. Most farm based systems will be less than 250 kW.

The cost per kW installed is estimated to range from \$5,000 to \$7,000 per kW. If the panels are well located, between 1000 to 1200 kWh can be expected per kW of panel. So a gross return of \$71,000 to \$85,000 per year on a 100 kW may be available from a system costing \$500,000 to \$700,000.

Connecting to the grid will more be challenging with these larger systems especially if only a single phase line is available to the farmstead. Systems under 250 kW (500 kW in some cases) are classified in Ontario as a "Capacity Allocation Exempt Facility". This classification will give some benefits to gain connection to the grid and to move thru the FIT approval process. However, single phase lines will likely not be able to handle inputs much greater than 100 kW. This may be lowered if several generators are located on the same line.

For 2001, the domestic content requirement is 50%. This means (in most cases) the inverter and support system or the panels must be constructed in Ontario. After 2001, the requirement increases to 60% (same as micro-fit).

Ground Mount System

The FIT price for ground mount systems drops to \$0.442 per kWh so interest is expected to be mostly for very large systems. Systems over 100 kW cannot be installed on class 1 and 2 soils with a 500 MW limit on class 3 soils (if the areas are zoned for agricultural use).

There may be some interest in installing 100 kW systems in rural Ontario.

BIOGAS OPPORTUNITIES

The Ontario FIT prices for biogas are not the highest in the world but have the potential to give a good return for some larger livestock facilities if the project is reasonably priced and works well.

Feedstocks for digesters include manure, purpose grown energy crops and off farm sourced organics. It is generally thought that the Ontario FIT prices are not high enough to facilitate systems operating with a high percentage of energy crops as inputs.

At least 22 biogas projects are operating or being constructed in Ontario. All these projects are using some manure (one project only uses manure for startup and infrequent additions) and off farm source materials such as grease trap wastes from restaurants.

Swine manure has some limitations. It is generally high in moisture content (limits energy yields) and higher in nitrogen content (may inhibit biological process). Swine manure works well in co-junction with dairy or beef manure inputs and off farm sourced material inputs (if they have lower nitrogen content).

Using the OMAFRA AD Calculator, the following information is developed (note this calculator assumes that the full biological yield of materials are obtained. This requires fresh manure requiring daily removal of manure from barn).

- 5000 Hog Finishing Barn produces 8000 m³ of manure at 7% DM per year. A 1300 m³ digester is required giving a total methane yield of 130,000 m³. Assuming an operating time of 7500 hours per year, a 63 kW generator is required at 35% electrical efficiency. At a FIT price of \$0.199 per kWh (assumes community adder is available) the annual yearly electrical income is \$97,000.
- It is estimated that the system costs \$500,000 (\$8000 per kW (el)). Considering generator costs, insurance, electricity use, maintenance and using an interest rate of 7% and a 10 year payback, the annual cost is \$96,000. This gives a return of about \$1000.
- Increasing the payback period to 15 years generates an annual return for labour and risk of \$17,000.
- The addition of good quality off farm material (20% DM) at 25% of the total input volume will increase the required generator size to 218 kW. Using a 10 year payback the spreadsheet predicts an annual return for labour and risk of \$54,000.

The above points demonstrate the reason why off farm material is used as an input in all digesters built so far in Ontario. There is a concern that there will be a limit on the availability of these materials depending on number of plants built and future uses.

Prices and knowledge will continue to evolve. The OPA has committed to reviewing the FIT prices within a 2 year period. Ontario based technology and knowledge is rapidly improving due to the installation of the 22+ projects.

For swine operations new ideas such as the use of very heavily bedded pack barns should be considered. The value of the additional electricity produced by the addition of the bedding is anticipated to be much higher than the cost of the bedding.

Future barns should be developed considering integration of green energy systems such as solar panels and biogas systems. This means the use of south facing, steeply slope roofs and manure systems that minimize dilution and allow for transfer of fresh manure from the barns.

ALTERNATIVE FARROWING SYSTEMS

Rudolf Wiedmann
Centre for Education and Knowledge Boxberg, Germany
(Bildungs- und Wissenszentrum Boxberg,
Landesanstalt für Schweinezucht - LSZ)
Seehöfer Straße 50, D-97944 Boxberg-Windischbuch
E-mail: rudolf.wiedmann@lsz.bwl.de

ABSTRACT

Loose housing for gestating sows is an established European housing system. Furthermore, in some countries like Sweden, Norway and Switzerland crates are not allowed in the farrowing units. Statistical results of the transition period from Switzerland show that there are no overall differences in piglet losses between farms with or without crates. But you cannot pass Swiss parameters in pig production to other countries. EU-barometers show that an overwhelming majority of consumers do not agree with crates. It is a question of how long we can exist in the market against the interests of consumers. Management of alternative farrowing systems is one of the biggest challenges for pig producers. We need different housing conditions, new breeding objectives, adapted animals, mindful staff and a better understanding of sows. We are just at the beginning of a new era.

There is a broad spectrum of causes for piglet crushing and there are already a lot of management tools and equipment available to reduce crushing considerably. Single parameters are closely associated and it is very difficult to judge them separately. Piglet crushing is not only a question of configuration of the pen. Design and temperature of the nest box may help to reduce piglet crushing. Fundamentally, producers should place greater emphasis on selection of sows with respect to mothering properties. In addition to the housing conditions there is an influence on the behaviour of sows by the manner of sow-handling.

INTRODUCTION: LOOSE NURSING SOWS

Many breeders and scientists criticised the farrowing crate concept when it was first introduced. Their concern was the lack of attention to the welfare requirements of the sow. Nevertheless, different models have been developed and popularised around the world to such an extent that the farrowing crate has become a recognised, standard feature of the farrowing pen.

Sows may be housed in farrowing pens for about four weeks. It is an important period in the whole reproduction cycle. The pen first has to provide a calm and relaxing atmosphere during the last days of pregnancy. It should allow the possibility to perform behavioural activity connected with farrowing, for example, nest building. The facilities should be suitable for the farrowing act, including the ability for stock people to safely assist in piglet delivery. And finally, once sows are nursing their litters, consideration has to be paid to the micro-environment, protection and space for the growing piglets.

Loose housing for gestating sows is well established in Europe. But what happens when sows are allowed to move in the farrowing pen? Until now the argument has been that piglet losses are too high in free-range pens. But statistical investigations from Switzerland show there is no significant difference in the overall losses of piglets kept in pens with or without farrowing crates (Table 1). Crating of sows is supposed to avoid piglet crushing, but natural behaviour like nest building on the day of farrowing and during the birth cannot be carried out. Comfort behaviour (stretching, shaking, scratching and rubbing) takes only a little time during the course of the day. But it is generally regarded as being most important for an animal's welfare in respect of physiological and ethological aspects. Table 2 shows performance of the last business year in both Boxberg units. We have more weaned piglets in the units without crates but at the same time also 6% more piglets lost.

Table 1. Piglet losses on farms with or without crates in their farrowing units. (Weber, 2006, Switzerland)

Farm	With crates	Without crates
Number of farms	482	173
Number of litters	44.837	18.824
Piglets born alive/litter	11.0	11.0
Piglets born dead/litter	0.7	0.6
Piglets weaned/litter	9.6	9.6
Piglets lost overall, %	12.1	12.1
- Crushed, %	4.5	5.4
- Other reasons, %	7.6	6.7

Table 2. Comparison of performance with or without crates in the farrowing pen (conventional and alternative part of Boxberg/Germany).

Performance - July 2008 to June 2009	With crates	Without crates
Number of sows	178	65
Non-return-rate, %	15.4	6.5
Piglets at large/litter	12.44	13.1
Piglets born alive/litter	12.16	12.93
Piglets born dead/litter	0.38	0.17
Birth weight, kg	1.53	1.45
Piglets weaned/litter	9.57	9.76
Weaning weight/piglet, kg	7.54	8.2
Piglet losses, %	20.06	26.27
Piglets weaned/sow/year	19.21	22.56

SOME PROBLEMS WITH SOWS IN FARROWING CRATES

The transition to alternative farrowing systems is based on problems in farrowing units with crates. Some of them are listed below:

- Group housing for pregnant sows enforces natural behaviour like separation between the lying and dunging area. This exercised behaviour cannot be executed in the critical time during birth and suckling period leading to negative consequences, like constipation.
- Sows in crates cannot carry out effective nesting behaviour. Therefore, births last longer, there are more dead piglets, and more problems with MMA (mastitis, metritis and agalactia).
- Separated functional areas for lying, feeding and dunging with solid floors in the lying area make it possible to reduce the temperature in the farrowing house to about 50 to 59°F. Thus piglets stay more in their nest, sows eat more and give more milk.
- With low overall temperature you save money on heating energy and staff has better environmental conditions.
- In separated areas you can better adapt the floor to different demands. Thus sows suffer less from shoulder lesions, dewclaw, claw and leg injuries. Natural standing up and lying down behaviour reduces teat injuries and you can achieve more natural abrasion of claws.
- Loose nursing sows are much cleaner compared to sows in crates.
- Crates are not favoured by the majority of the European consumers and the EU intends to respect consumer demands.
- Furthermore the EU is aiming to be the leader in animal health and animal protection. In this manner, we think we can create more value for producers.

COMPARISON OF DIFFERENT EQUIPMENT IN FREE-RANGE PENS

To reduce piglet losses in an experiment at the Centre for Education and Knowledge Boxberg, Germany in one part of the alternative unit different equipment was installed. Primarily the farrowing pens have been subdivided in several areas to determine the location of crushing (Where?). Second, the sow behaviour leading to crushing was described (How?). Third, the point of time of the occurrence was noticed (When?). Fourth, behaviour of the piglets during the incidence of crushing (Why?). The study included behaviour of the sows during 24 hours before farrowing. There was video recording 24 hours before farrowing until 10 days following. Furthermore, an ethogram with relevant parameters of behaviour of the sows was established. To estimate the overall situation, the temperatures outside and in the sow lying area as well as in the nest box were recorded. Table 3 shows the overall performance without crush bars over four replicates.

Table 3. Performance without crush bars over four replicates.

	Born alive	Born dead	Crushed	Rest of dead piglets	Overall losses	Weaned
Sum	234	20	33	24	57	177
Absolute average/litter	12.3	1.05	1.74	1.26	3	9.32
Relative average/litter	--	--	14.10%	10.26%	24.36%	--

This study showed that most of the piglets (45%) are crushed in the middle of the pen. Piglet crushing was mainly caused by lying down of the sows (58%). Most of the piglets (78%) were

crushed within the first day after birth. Almost all crushing incidents (97%) took place in the first 3 days after farrowing. 45% of the crushing incidents occurred during active phases of the piglets in the lying area of their mother.

Iron Bar in Front of the Nest and a Sloped Board in the Experiment

Due to these results we installed 2 crush bars in the pen; One iron bar in front of the nest box and a sloped board along the long side of the pen to encourage the sows to lie down in this area. The results showed that there were not any piglets crushed in front of the nest box. It was not possible to reduce piglet crushing at the long side of the pen. We did find out through video analysis that piglets used the space under this board for sheltering. Thus the piglets could save themselves during the lying down procedure of their mother. On the other hand, the sloped boards were also an invitation for piglets to lie down with the rear part of their body under this board and it might be the case that they were crushed while sleeping. Therefore we recommend that producers should not use much straw in the pen during the first 3 days after farrowing but instead use saw dust or shavings.

The study of behaviour showed impressively how all sows used straw intensively for nest-building 12 hours ante partum. We noticed more crushed piglets in those litters with sows showing, during this period, an agitated and nervous behaviour with lots of changes in position. In the case of too low or too high temperature in the nest box, the piglets stayed closer to their mother, thereby increasing the risk for piglet crushing.

Altogether the losses caused by crushing were reduced in the experimental group when compared to the standard farrowing pen (Tables 4 and 5). But in the experimental group, there were 2.5 more piglets born alive. Furthermore one sow in this group crushed 7 piglets, two days after farrowing, in one night.

Table 4. Performance in the comparison group without any crush bar in replicates 5 and 6.

	Born alive	Born dead	Crushed	Rest of dead piglets	Overall losses	Weaned
Sum	106	8	9	8	17	89
Absolute average/litter	10.6	0.8	0.9	0.8	1.7	8.9
Relative average/litter	--	--	8.5%	7.54%	16.04%	--

Table 5. Performance in the group with crush bars (experimental group) in replicates 5 and 6.

	Born alive	Born dead	Crushed	Rest of dead piglets	Overall losses	Weaned
Sum	118	1	15	9	24	94
Absolute average/litter	13.11	0.11	1.66	1	2.66	10.44
Relative average/litter	--	--	12.71%	7.63%	20.34%	--

EXPERIENCES FROM COMMERCIAL FARMS WITHOUT CRATES

Organic farms are not allowed to use crates for their sows. In addition, some conventional farms with outdoor or indoor breeding have used free-range farrowing for many years. So there are many valuable experiences to lower the risk for piglet losses. Some of them are described below:

Positive Sow Parameters

- Stable human-animal relationship. It is worthwhile to worry about the gilts at a very early age.
- Calm sows - especially before birth - are mostly careful with their piglets. Therefore take the time to ensure a quiet atmosphere in the farrowing house. Furthermore the sows have to be housed in the farrowing room one week before farrowing.
- Enough milk production enables piglets to stay away from their mother for longer periods.

Negative Parameters in Respect to Temperatures

Optimal temperature in the lying area during farrowing time is about 68°F; after farrowing is about 50 to 59°F. Adapt the temperature to the lying behaviour of the piglets.

- Too high temperature in the nest disposes the piglets to lie partly or completely outside of the nest.
- Too low temperature in the nest is one of the reasons why piglets are looking for warmth by their mother.
- Too high temperature during hot weather in the sow lying area disposes the piglets to stay outside their nest.

Reasons for Breeding and Selecting

- Gilts have to be housed in small groups. So they have many possibilities to find a wall for lying down and to get accustomed to this behaviour.
- Most of the litters of gilts have no or only one crushed piglet. So, if one gilt crushes more than two piglets you should not serve her again.

- In closed herds with their own gilt production you should select for a certain amount of maternal instinct in your multiplication sows.

Structural Aspects: Optimization of the Nest

- Larger litters need larger nest sizes. At least 1 m² (11 ft²).
- The entrance to the nest must be very broad so piglets have got a bigger chance to find their way into the nest.
- People should not use curtains in front of the nest to save energy. Curtains are big obstacles for little piglets.
- Sows are allowed to put their head into the nest. The iron rail in front of the nest has a height of 30 to 35 cm (1 ft) to avoid jamming.
- With about 10 cm (0.3 ft) deep nest floor you can increase the attractiveness of the nest dramatically. This way most of the straw in the nest remains there. Piglets recognize very well the difference between the sow lying area with only sawdust and the plentiful straw in their nest. With deepened nests and straw you can put your in-floor water heating on at a high temperature (104°F).
- With a single leaf damper, piglets can be separated easily from the service alley for different management actions.

Structural Aspects: Optimization Farrowing Rails

- You need straight or curved iron rails to avoid a dead zone in the pen for piglets. Newborn piglets must not be able to get trapped in a dead zone and be able to circulate with their mother at any time.
- Boards on the walls of the pen stimulate adapted sows to lie down against them.
- Researchers notice most of the piglets are crushed in the middle of the pen. This is because this area is the largest one and frequented most often. A lot of crushing is due to changing of position by the sows. Thus more piglets are crushed during position changes than compared to lying down behaviour. A number of farms have had positive experiences with a steering stick in the middle of the pen (Figure 1).

Figure 1. Many farms wean about one more piglet/sow/year by the steering stick.



Structural Aspects: Optimization Feeding

- Feeding should not be in the lying area but outside in a second area of the pen or outside of the farrowing house. Thereby piglet injuries through restlessness during feeding time are much lower and the tidiness in the pen is much better (Table 6).
- Some people feed nursing sows only with dry concentrate in the pen to check more easily how much feed sows accept.

Table 6. Advantages and disadvantages of different trough positions.

Trough position	Inside near survey alley	Inside near exit to yard	Outside in the yard
Overview	+	+	-
Tidiness	--	-	++
Safety for piglets	--	-	+

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ALTERNATIVE FARROWING OPTIONS

Larry Bowman
Jones Feed Mill
2555 Lobsinger Line, Heidelberg, Ontario N0B 2M0
E-mail: LarryBowman@jfm.on.ca

ADVANTAGES OF ALTERNATIVE FARROWING

1. Providing for niche markets

- Greater return on investment
- Setting yourself apart from the industry norm

2. Conscience of animal welfare standards

- Growing awareness of animal welfare
- Producers recognizing animal husbandry

3. Opportunities for sustainable hog production

- Stability for next generation producers
- Cost of production opportunities

4. Setting an example that Ontario can supply pork that meets all global demands

- Providing markets with superior product
- Opportunity to meet buyers and consumers of your product

CHALLENGES OF ALTERNATIVE FARROWING

1. Higher pre-wean mortality

- Farrowing pen challenges
- Restriction on antibiotics

2. Higher labour expenses

- Bedding, straw, etc.
- Slat restrictions

3. Stringer Protocols set out by prospective meat buyers

- Farm to fork traceability
- Varied certification protocols

4. Higher square footage requirements

- More barn space needed
- Dealing with aggressive animals

THE USE OF BYPRODUCTS AND HIGH FIBER INGREDIENTS IN SWINE DIETS

**Casey Neill and Noel Williams
PIC North America**

**100 Bluegrass Commons Blvd. Suite 2200, Hendersonville, Tennessee 37075
E-mail: casey.neill@pic.com**

INTRODUCTION

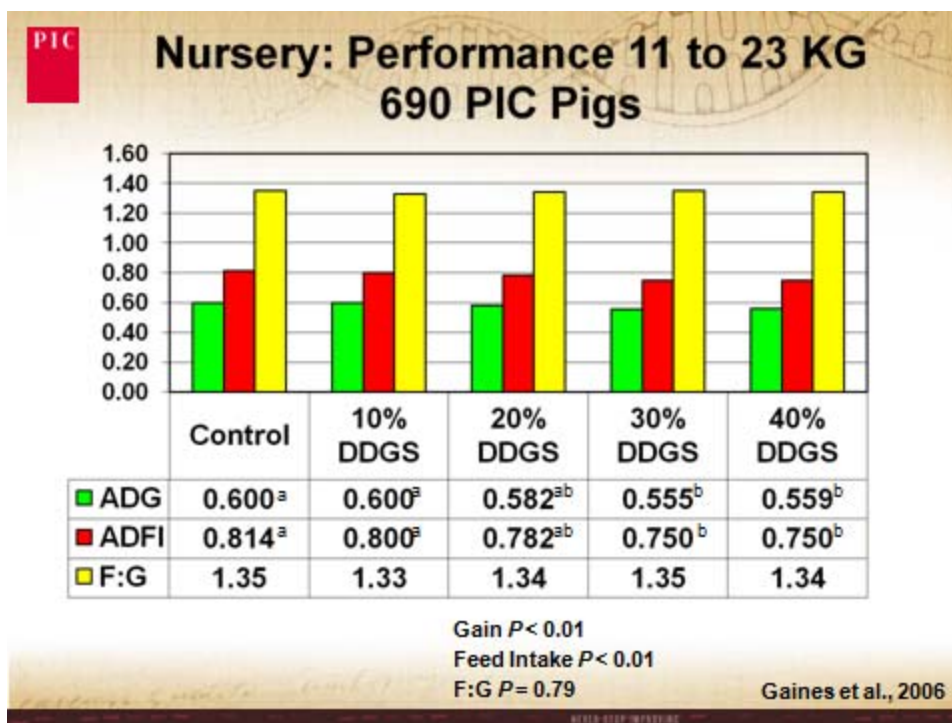
With increasing feed costs, many producers are looking for alternative feedstuffs to use in their operations to help reduce the cost of production. Some alternative feedstuffs include ingredients that also have a high level of fiber. The two main byproducts that we will focus on will be distiller's dried grains with solubles (DDGS) and wheat midds or shorts.

There has been many commercial and university research trials conducted using DDGS. Many trials have demonstrated similar growth responses when DDGS were fed compared to a corn-soybean meal based diet. However, many trials have demonstrated a decrease in growth performance. Some of the differences can be a result of inconsistency of the nutrients from byproducts like DDGS. The ethanol process can differ from plant to plant and therefore the byproduct can be very different from plant to plant. DDGS nutrient levels can be very variable from plant to plant.

If DDGS are fed, make sure the nutrients from that source are well known. Using one source of DDGS is ideal so you can maintain a consistent source of nutrients to the pig.

Below is a picture of four different DDGS sources. The difference in color is noticeable. When ethanol plants burn DDGS during the drying process amino acid digestibility may be reduced and pigs' performance will be reduced.

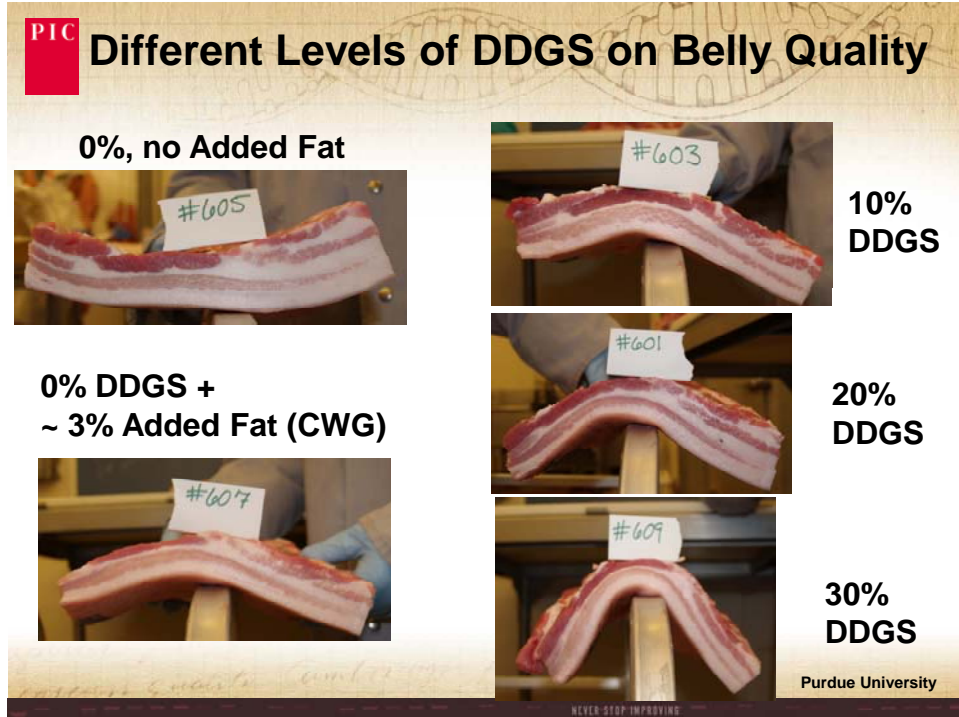




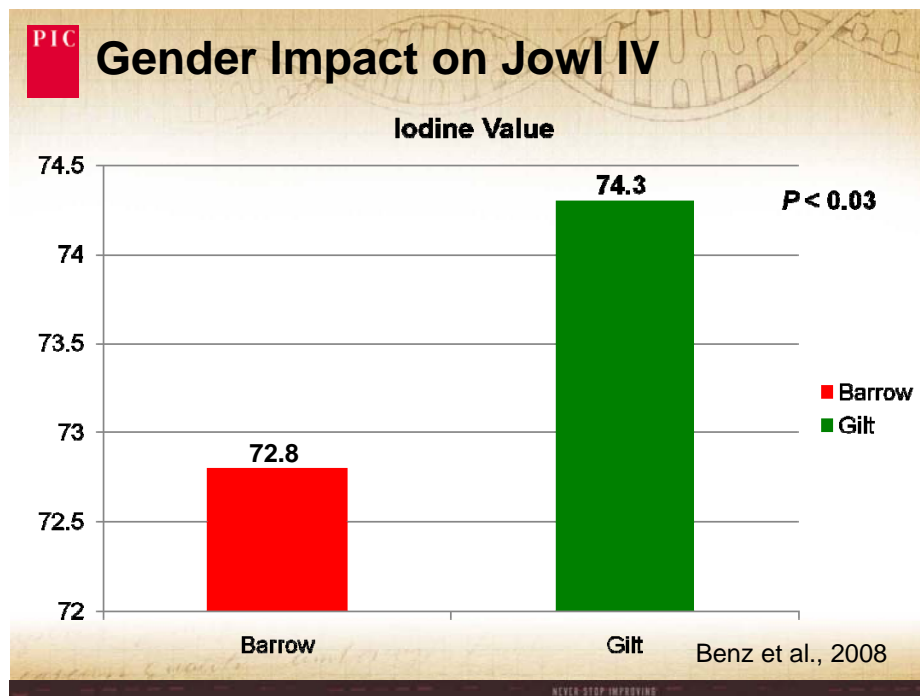
FEEDING BYPRODUCTS

One of the biggest areas of caution is how to introduce byproducts to your pigs. You should not introduce too fast as the pigs need a time of adjustment to the new ingredient. That may be why some research trials showed a decrease in growth at high levels of DDGS because the pigs went from a corn-soybean meal diet to DDGS with a sudden diet change. Introducing byproducts slowly will allow the pigs to adjust to the new feed without them going off feed. Most producers start at 5% then increase at the next diet phase change another 5%. Changing too fast will cause off-feed pigs and poor growth.

Iodine Value (IV) is a measurement to estimate the amount of unsaturated fatty acids in carcass fat. In other words, IV is an indicator of fat firmness. Nutrition can affect carcass fat firmness by what ingredients the pigs are fed. Ingredients like soy oil and DDGS can have a major impact. Some packers have started testing and put an IV spec of 73 in place.

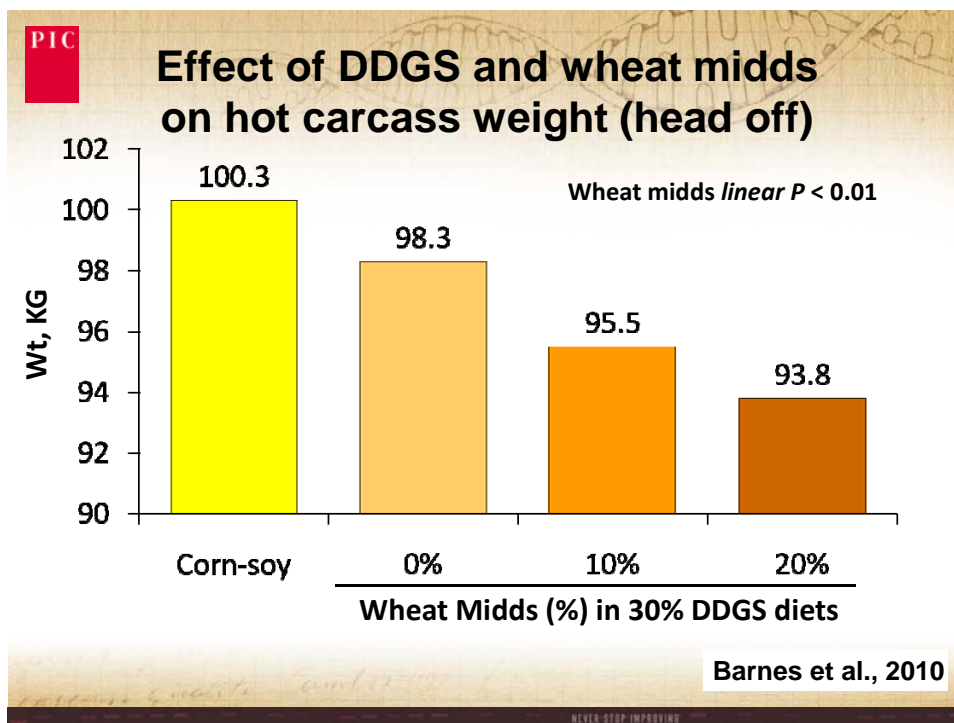
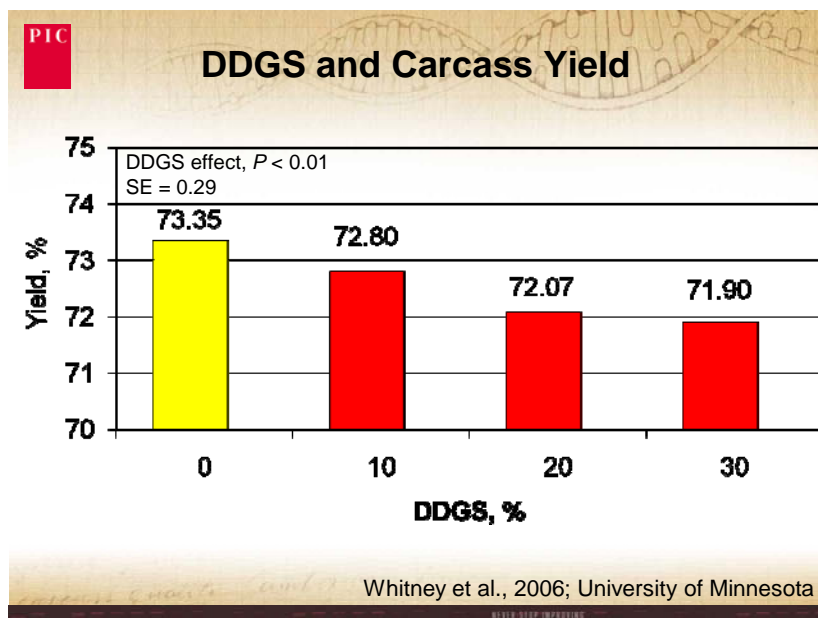


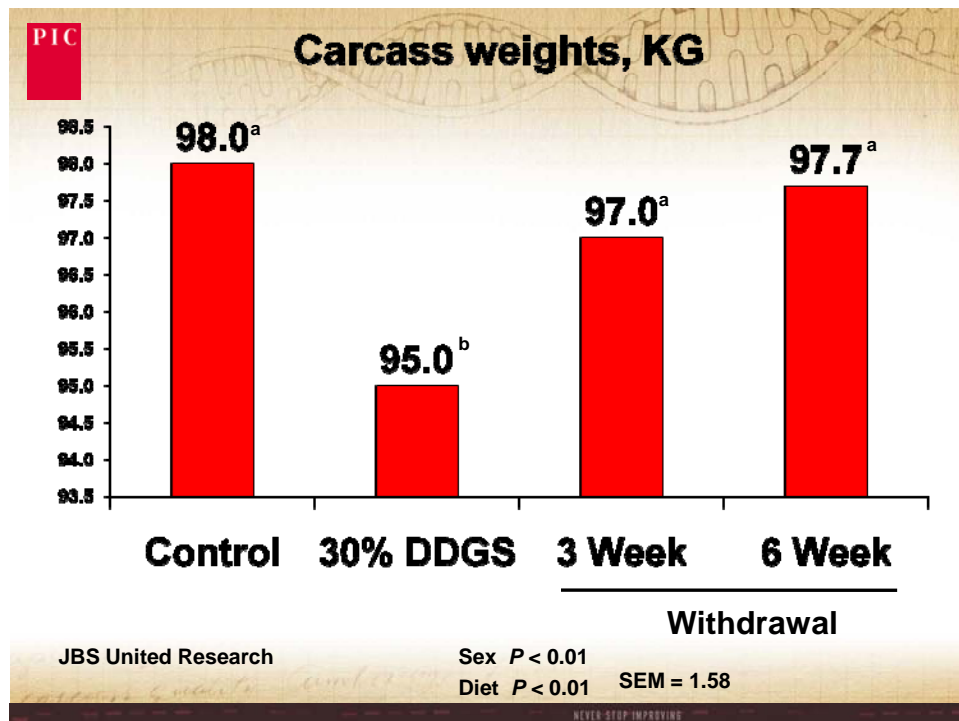
Other factors can impact IV such as gender, grain source and season.



Effects of Nutrition on Carcass Yield

Another area of caution when using byproducts, like DDGS and wheat midds, is that these ingredients have high fiber content and carcass yields can be reduced when inclusion rates are not lowered before slaughter. Below are some research results showing a decrease in carcass yield and weight. One way to avoid a reduction in carcass yield is to reduce or withdraw the byproducts in late finishing.





Many producers have adopted a feeding program to introduce byproducts in early pig diets and then lower the levels toward the last few diets before marketing to avoid the carcass yield reduction. If ingredients are introduced too fast then pigs will go off feed and vices may occur. When byproducts are misused vices can occur. For example, one week DDGS is in the diet then the next week DDGS is taken out and other ingredients are used like wheat midds or bakery meal, then the week after DDGS are back in the diet. Being inconsistent will cause problems to occur such as poor growth and vices. Being consistent is very important and the key to managing the use of byproduct ingredients.

Economics do favor the use of DDGS even if there is a carcass yield reduction. Up to \$2.00 to \$5.00 per pig can be saved when using DDGS.

A good website for resource information on the use of DDGS is www.ksuswine.org. Here you can use your individual ingredient prices and the calculator will estimate the cost savings and also the net return after carcass yield reduction.



Typical Level of DDGS in Life-cycle Diet Programs

Phase	Live wt.	Diet %		Comment
		Typical	Extreme	
Nursery 3	11	5	10	Slow Exposure
Nursery 4	16	10	20	
Fin 1	23	15		SID Formulation
Fin 2		20		
Fin 3		25	40	Carcass IV
Fin 4		20		
Fin 5		15		
Fin 6	130	10		Yield Preserved
Gestation		20 to 40	50	Toxin Confidence
Lactation		10 to 20	25	GES Exposure !

Net Revenue: \$2.25 – 3.00 / pig

NEVER STOP IMPROVING

Special Considerations for Sows

When introducing byproducts to sows, several factors must be considered. The first is to make sure the ingredient is free of mycotoxins. If the price of a byproduct is very cheap then there may be issues with mycotoxins or nutrient values. Introduce the ingredient slowly in the gestation diet first at maximum of 5%. After 2 to 3 weeks, increase the level another 5% if you are targeting 10%. Then start with the lactation diet at 5% for another 2 to 3 weeks before increasing the level again.

When feeding byproducts to sows make sure the same ingredient is in both the gestation and lactation diets. This will help with consistency of the feed and sows transitioning back to the gestation feed after being on lactation feed for 3 to 4 weeks. Being consist is very important when feeding sows alternative ingredients.

The last issue when managing the use of alternative feed ingredients is that the bulk density is different with ingredients with higher fiber content. If high fiber ingredients are used, make sure your mixer is not over loaded. Once too many ingredients are put into the mixer, smaller inclusion ingredients, like phytase, synthetic amino acids, vitamins, and minerals, will not get properly mixed. Just because the mixer may be rated at 3 tons, does not always mean you can get that much volume inside when using wheat midds, DDGS, bakery, or other byproducts. Do a mixer efficiency test to make sure your ingredients are being mixed right. You may have to lower your batch size down to 2 or 2.5 tons to get all the volume to fit.

The same can be said for feed trucks and feed bins. This can cause an increase in feed mill charge and delivery.

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BYPRODUCT FEED INGREDIENTS FOR SWINE DIETS - OPPORTUNITIES AND CHALLENGES

Ron Lackey
Ontario Ministry of Agriculture, Food and Rural Affairs
581 Huron Street, Stratford, Ontario N5A 5T8
E-mail: ron.lackey@ontario.ca

INTRODUCTION

High commodity prices coupled with low pork prices have made it necessary for pork producers to consider their options for reducing feed costs. The biofuel industry has created new markets and competition for grain commodities containing starch and sugar for ethanol production as well as commodities with oils and fat for biodiesel production, contributing to volatile but generally stronger grain commodity prices. This situation is not unique to North America and is prompting producers globally to focus less on maximizing production and more on minimizing feed costs. Various byproducts from grain and food processing can be potentially cost effective alternatives as a partial substitute for the more traditional nutrient dense commodities such as corn, wheat and soybean meal. There are those that would suggest utilizing byproduct ingredients is the direction that the livestock industry should be or will be heading anyway and that the future of the livestock industry will depend on the animals' ability to make use of alternative feed resources that are unusable by people. In a recent Feed Management magazine article, Dr. Pearse Lyons, founder and president of Alltech, predicted that "in five to ten years from now, very little maize will be used in animal production. What will become more common will be fibre feeds, those containing a higher level of cellulose. There will be more protein sources as well as fibre and less starch and fats."

This presentation will discuss the process for selecting byproducts, mainly from an energy replacement strategy perspective, some considerations about fibre, a potential limiting factor in byproducts, and a look at some of the byproducts based mainly on available supply here in the Ontario market, with a particular emphasize on distillers dried grains with solubles from corn based ethanol production.

BYPRODUCT SELECTION

Replacing nutrient dense feed ingredients in pig diets with byproduct feed ingredients is not a straightforward process. The biofuel industry and other grain and oilseed processors generate a number of different byproducts. However the concentration of the residual components in these byproducts is quite different than their parent commodity such as corn, wheat or soybeans. As a result, many of them cannot be considered a one-to-one replacement for commodities such as corn or wheat in swine diets. Their nutrient concentrations and other limiting factors can, in some cases, make a nutrient replacement strategy a little like fitting a square peg into a round hole. In order to facilitate this process, it is very important that we understand the nutritive value

of byproducts, the risks and potential extra costs associated with their use and of course, the potential economic benefits when properly formulated into pig diets.

Often the selection and purchase decision making process of alternative feeds involves a combination of subjective as well as objective evaluations, with the subjective based slightly more on perception and the objective based more on factual information.

Subjective Evaluation

- Price per tonne or unit - a good place to start.
- Quality assessment – appearance, moisture content, smell, colour, taste.
- Limiting factors - particle size, flowability, bulk density, storage, transportation.
- Consistency - uniformity composition, supply.

Objective Evaluation

- Value/cost effectiveness – considers potential performance, prediction models.
- Nutrient content - proximate analysis, SID, NE, and available phosphorus levels.
- Inclusion rate - projected performance, limiting factors, anti nutritional factors.
- Availability - ingredient available on a local, continuous basis.

Tables 1 and 2, while not providing all the necessary information for diet formulation, can be useful in the decision making process.

FIBRE CONTENT CONSIDERATIONS

Several byproduct ingredients are partially made up of the residual seed coats or bran of the parent commodity and therefore contain levels of fibre that are two to three times higher than their parent, as shown in Table 3. Such byproducts are referred to as fibrous byproducts or fibrous feeds, although there is no official definition. Fibrous feeds traditionally have not been widely utilized in pig weaning, growing and finishing diets due to the well documented negative impacts of performances because of lower protein and energy digestibility and lower nutrient density. Fibre has been considered a limiting factor for inclusion in diets. However, not all fibre is created equally and differences in fibre digestibility do exist and are due to many factors, including the type and amount of fibre in the feed, as well as pig size.

It is known that sows have greater capacity to extract energy from fibrous feedstuffs compared with growing pigs (Noblet & Le Goff, 2001), as shown in Table 4.

Table 1. Feeding value of energy feeds compared to corn.

Feedstuff	Relative value compared to corn, %
Corn	100
Alfalfa meal, dehydrated	65 to 75
Barley	90 to 95
Dried distillers grains	75 to 112
High lysine corn	110 to 115
High oil corn	110 to 115
Nutridense corn	110 to 115
Millet	90 to 95
Milo	96
Oats	70 to 80
Oat groats	110 to 115
Rye	80 to 85
Fat and oil	210 to 220
Soy hulls	60 to 65
Triticale	95 to 105
Wheat	105 to 107
Wheat middlings	90 to 95
Whey, dried	100 to 110

Adapted from the NPPC Feed Purchasing Manual, Nebraska and South Dakota Swine Nutrition Guide, and Swine Nutrition Guide from the Prairie Swine Centre.

Table 2. Typical maximum usage rates for common energy sources.

Ingredient	Maximum recommended percent of complete diet*				Limitation
	Starter	Grow-finish	Gestation	Lactation	
Alfalfa meal, dehy	0	10	25	0	High fiber
Bakery waste, dehy	25	*	*	*	High salt
Barley	25	*	*	25	High fiber
Beet pulp	0	5	50	0	High fiber
Corn	*	*	*	*	None
DDGS	5	10	20	5	Amino acid balance and palatability
Corn gluten feed	5	10	*	5	High fiber
Corn, hominy feed	0	60	60	60	Amino acid balance
Fat/oils	8	5	5	5	Feed handling
Millet	10	40	40	10	Difficult processing
Molasses	0	5	10	5	Low energy
Oats	5	20	50	0	High fiber
Oats groats	+	+	+	+	None
Rye**	0	25	25	10	Variability
Sorghum (milo)	+	+	+	+	None
Soy hulls	0	10	20	0	Fiber and bulk density
Triticale**	10	+	+	50	Variability
Wheat bran	0	10	30	10	High fiber
Wheat, hard	+	+	+	+	None
Wheat middlings	5	25	+	5	High fiber
Wheat shorts	10	40	40	40	Variability
Whey, dried	40	15	5	5	High lactose

Adapted from the NPPC Feed Purchasing Manual, Nebraska and South Dakota Swine Nutrition Guide, and Swine Nutrition Guide from the Prairie Swine Centre.

*Percentages suggest maximum allowable inclusion rates for energy sources. Economics and pig performance standards must be considered for actual inclusion rates. Most or all of the nutritional limitations can be overcome with proper formulation.

**Must be free of ergot.

+ Denotes no nutritional limitation in a diet balanced for essential amino acids, energy, minerals, and vitamins.

Table 3. Fiber concentration (DM basis) in corn, soybean meal, and other fibrous feedstuffs fed to livestock.

Feed Ingredient	CF,%	NDF,%	ADF,%	TDF,%	SDF,%	IDF,%
Corn	2.6	9.0	3.0	6.4	1.7	4.7
SBM, 44% CP	7.0	13.3	9.4	33.1	1.6	31.5
SBM, 47% CP	3.0	8.9	5.4	27.6	1.4	26.2
Alfalfa	26.2	45.0	35.0	56.7	4.2	52.4
Oat bran	-	19.2	-	15.8	7.5	8.3
DDGS	9.9	44.0	18.0	42.9	0.7	42.2
Oat Straw	40.5	70.0	47.0	76.6	2.2	74.4
Soybean Hulls	40.1	67.0	50.0	83.9	8.4	75.5
Wheat Straw	41.6	85.0	54.0	71.5	0.5	71.0
Corn Stalk	34.4	67.0	39.0	77.3	2.9	74.4
Sugar Beet Pulp	19.8	54.0	33.0	65.6	11.7	53.9
Potato Pulp	-	-	-	33.3	11.0	22.3

Sources: NRC (1998); NRC (1988); Dale (1998); and Univ. of Minnesota laboratory analysis. CF = crude fiber, NDF = neutral detergent fiber, ADF = acid detergent fiber, TDF = total dietary fiber, SDF = soluble dietary fiber, SBM = soybean meal, and DDGS = dry distillers grains with solubles.

Table 4. Comparative digestibility from growing pigs and sows.

	Mean of 72 Diets¹		Mean of 14 Diets²	
	Growing Pigs	Sows	Growing Pigs	Sows
Digestibility, %				
Crude Protein	50	60	75	85
Crude Fat or EE	38	42	55	69
Fibre	49	55	38	64
ME (MJ/kg DM)	12.23	13.15	13.49	14.43

EE, ether extracts; ME, metabolisable energy.

¹Data from Fernandez et al. (1986) and Jorgensen et al. (unpublished).

²Data from Noblet and Shi (1993).

The most widely accepted definition of fibre is the sum of non starch polysaccharides plus lignin. It is the proportion of the feed that is not digested by endogenous secretions of the digestive system, but are broken down to a variable extent by microbial fermentation largely in the large intestine (Knudson, 2008).

This chart may help to better understand fibre, but it also serves to demonstrate the complexity of fibre. The effect of fibre inclusion in swine diets has received considerable attention and research, but many aspects of fibre in swine diets remain somewhat controversial.

Fiber Analysis			
Crude fiber	NDF, ADF	Enzymatic – chemical	
Cellulose Lignin Hemicelluloses	Hemicelluloses Cellulose Lignin	Total NSP Soluble NSP Insoluble NSP Low molecular weight sugars Monomers	Cellulose Pectins β -glucans Pentosans Xylans etc.

In theory, the performance of pigs fed dietary fibre will not decline if one formulates diets in such a way that pigs consume adequate amounts of net energy, ileal digestible amino acids and other essential nutrients (Johnston et al., 2003). Both the digestible energy (DE) and the metabolizable energy system (ME) are used currently in swine nutrition, but the net energy (NE) system is seen by many as the superior system to more precisely formulate diets that include fibrous byproduct feeds in particular. The net energy system reflects the energy the pig will actually utilize. For ingredients that have a higher protein content and for ingredients that have high fibre content, it's much more effective to utilize net energy (NE) as a system for formulating the diets because both the DE and the ME systems tend to over-value ingredients that have high fibre and high protein, in addition to undervaluing fat (Dr. Martin Nyachoti, 2009).

Increasing attention has been paid in the past decade to dietary fibre in swine nutrition due to its multiple functionalities as well. Dietary fibre is considered as a possible means to reduce nitrogen losses (reduce ammonia emission) of production units, to improve pig intestinal health and animal welfare, in addition to reducing feed costs.

BYPRODUCT OPTIONS FOR ONTARIO SWINE PRODUCERS

Distillers Dried Grains with Solubles

- Considered a good source of amino acids, energy and phosphorus suitable for inclusion in swine diets at all phases of production.
- A cost effective alternative feed – become more widely used in Ontario pork production – potential to save \$3 to \$9 per market hog for each 10% added (Shurson, 2009).
- Ontario currently has 6 corn based ethanol production units in operation with 4 of these plants supplying approximately 560,000 dry tonne equivalents of DDGS to the market (some of this tonnage also sold as wet distiller or condensed distiller's solubles). In addition, some DDGS are being imported from the USA.
- Considerable DDGS/swine nutritional research has been conducted in the last ten years in North America.

- Swine researchers, Dr. Hans Stein at the University of Illinois and Dr. Gerry Shurson at the University of Minnesota, summarized the research from North America that was published prior to 2008. (H.H. Stein & G.C. Shurson, 2009) – a great reference document for the swine industry!
- The following are points from their summary;
 - Average DE and ME similar to corn, NE approx. 86% of corn NE.
 - Phosphorus in DDGS is highly digestible for pigs, with an apparent total tract digestibility of 60% reported.
 - The concentration of most amino acids (AAs) are 3X greater than corn, but the standard ileal digestibility of most AAs is approximately 10 % less than in corn.
 - The total dietary fibre levels in DDGS are approximately 3X greater than those in corn.
 - The apparent total tract digestibility of dietary fibre is less than 50%, which results in reduced digestibility values for DM and NE values for DDGS.
 - The report concluded that research on practical ways to enhance DM and energy digestibility, specifically by improving the digestibility of insoluble fiber fraction, could improve the feeding value of DDGS.
 - Table 5 summarizes their recommended inclusion rates for DDGS in swine diets.

Table 5. Inclusion rates of DDGS.

Item	Recommend	Maximum
Gestation	50 %	50%
Lactation	30%	40%
Nursery, 1+2	0	20%
Nursery, 3+4	30%	30%
Grow-Finish	30%	45%
Late Finish	20%	30%

- Fat quality in pork from pigs fed DDGS has been a concern. Adequately firm fat should have an iodine number below 70-74. Hogs fed at 20% level had around a 67 reading, whereas 30% level raised it to 73. By removing DDGS from the finishing diet, with a 30% inclusion for the last 2 weeks, the iodine number lowered to 67 (Beltranena et al., 2009).
- Lysine is suggested to be most variable in digestibility, which is believed to be in large part due to heat damage.
- Colour is often used to subjectively assess quality, with dark coloured DDGS presumed to have less amino acid digestibility than the golden coloured DDGS.
- Current and past research projects at the University of Guelph (Ridgetown College) are looking at the potential effects of colour of DDGS on pig performance and the possibilities of colour as an objective tool for assessing DDGS quality.
- Tables 6 and 7 summarize the pig performance from a feeding trial where levels of 10% and 20% DDGS are used at the Ridgetown campus of the University of Guelph and the data collected from six plants both in Ontario and in close proximity to Ontario as part of a research project looking at variability, as well as colour as an indicator of DDGS digestibility.

Table 6. Effects of dietary treatment on pig growth rate, feed intake and carcass quality.

	Control diet	10% DDGS + Lysine	20% DDGS + Lysine	10% DDGS No Lysine
Growth Performance				
Number of pigs	24	21	23	16
Days to market (by pen)	56.6	56.7	55.2	56.6
Average daily gain, kg	1.13	1.12	1.14	1.09
Feed Intake Measurements				
Total feed intake, kg	174.7	170.6	171.3	170.9
Average feed intake, kg/d	3.11	2.99	3.11	2.96
Feed efficiency (F/G)	2.80	2.73	2.73	2.63
Cost of gain (\$/kg) – 2005	0.50	0.47	0.46	0.45
Carcass Measurements				
Dressing percentage	79.6	79.8	79.4	79.5
Yield index, %	61.3	61.1	60.5	60.8
Grade fat, mm	17.1 ^a	17.8 ^{ab}	19.3 ^b	18.5 ^{ab}
Meat depth, mm	62.0	62.6	61.3	64.0

McEwan et al. (University of Guelph)

^{ab} LS within row that do not share a common superscript differ significantly (P<0.05).

Bakery Byproduct

- Composed of many types and proportions of bakery products.
- Energy levels similar to corn can be higher depending on their composition and their sugar and fat levels in particular.
- Less than 2% crude fibre levels.
- Great ingredient for all phases of pig production.
- Relatively small particle size.
- Prices can be high due to competition from other non ruminant nutritional markets.
- Cautions - they can have relatively high sodium levels; flowability challenges because of the fat content and small particle size and their makeup can be quite variable.

Table 7. DDGS nutrient content and availability for six participating ethanol plants.

	A	B	C	D	E	F
Nutrient Content (% as fed)						
Dry matter	87.4 ^b	88.2 ^{bc}	88.5 ^c	87.6 ^b	88.1 ^{bc}	86.3 ^a
Crude protein	26.8 ^{bc}	28.9 ^d	25.3 ^a	25.2 ^a	27.3 ^c	26.1 ^{ab}
NDF	29.7 ^a	29.2 ^a	33.8 ^c	33.6 ^c	30.9 ^{ab}	32.4 ^{bc}
Fat	9.6 ^a	10.6 ^b	10.1 ^{ab}	10.1 ^{ab}	9.7 ^a	9.9 ^{ab}
Starch	2.2	3.1	3.5	2.5	3.7	2.5
Phosphorus	0.77 ^{ab}	0.74 ^a	0.76 ^{ab}	0.79 ^b	0.78 ^{ab}	0.85 ^c
Sulphur	0.44 ^a	0.84 ^c	0.47 ^a	0.47 ^a	0.65 ^b	0.58 ^b
In vitro Nutrient Digestibility (%)						
Dry matter	62.2 ^b	67.4 ^c	59.5 ^a	61.4 ^{ab}	61.4 ^{ab}	62.6 ^b
Crude protein	80.9 ^b	86.1 ^c	80.7 ^b	77.9 ^a	80.1 ^b	79.9 ^b
Colour Evaluation (CIE, L* a* b* scale) for Unground Samples						
Colour L*	55.4 ^{bc}	50.2 ^a	57.8 ^{cd}	59.3 ^d	53.8 ^b	59.3 ^d
a *	10.7 ^c	11.0 ^c	9.2 ^{ab}	8.9 ^a	9.7 ^b	9.2 ^{ab}
b *	48.4 ^d	39.9 ^a	46.2 ^{bc}	50.0 ^d	44.6 ^b	48.2 ^{cd}

McEwan et al. (University of Guelph)

^{abcd} LS means within row that do not share a common superscript differ significantly ($P < 0.05$).

L* = lightness of colour (0 = black, 100 = white). Higher values for a* and b* are indicative of increased redness and yellowness, respectively.

Corn Gluten Feed

- Fibrous byproduct of wet corn milling - consists of the corn bran, some corn germ and steep water.
- Traditionally, because of its fibre content and lack of palatability, it was not considered a good alternative feed for swine.
- Good supply in Ontario –CASCO plants in London, Cardinal or Port Colborne and Collingwood Ethanol (only wet byproducts from Collingwood plant).
- Cardinal plant currently pellets some of their gluten feed.
- Research would suggest when fed to gestating sows at high levels (around 90%) the energy value is 70 to 80% of the net energy of corn (Honeyman).
- Has low level of fat (3%) compared to DDGS but higher level of residual starch (12-15%).
- Fibre in CGF may be more readily digested due to the fact it has undergone the wet milling process and can meet all the energy needs of gestating sows (Honeyman).
- Yen and al. showed pigs performed well when corn gluten feed was included as part of the diet up to 30%, replacing corn and soybean - pigs ranged in starting weight from 23 kg up to 55kg.
- Yen and al. - determined that supplemental Tryptophan was beneficial as well as pelleting.
- NE value for sows need to be determined.
- A byproduct whose feed value could be enhanced by processing (e.g. pelleting as well as enzyme specific to gluten feed).

Wheat Shorts

- Wheat shorts are the layer of the wheat kernel just inside the outer bran layer covering the endosperm and usually contain 5 to 10% crude fiber and 15 to 20% crude protein (good source of lysine and threonine).
- Energy wise, on a NE basis, are approximately 85-88% of the value of corn.
- 10% inclusion for starter pigs and 40% for grower/finisher and sows. Can support good performance in properly balanced diets.
- Make a good ingredient in pelleted feed products and pelleting can potentially improve the value of the shorts.

Soybean Hulls

- Soybean hulls - separated from the soybean during the solvent oil extraction process.
- Potentially beneficial and cost effective as a source of fiber (56.4% NDF), protein (12.0%) and energy (NE 1003 kcal/kg), particularly in sow diets.
- Despite high fibre level, they have low levels of lignin.
- Can help reduce ammonia levels in barns.
- Inclusion at around 5% in grower finishing diets.
- Low bulk density- can affect feeding systems and storage; most soyhulls are sold in a pelleted form.
- Potential improvement in digestibility with future technologies - e.g. enzymes or processing.

SUMMARY

Byproduct feed ingredients such as DDGS can be used as cost effective partial replacements for higher priced commodities traditionally used in nutrient dense swine diets. Pig performance may not be affected if inclusion is based on researched inclusion rates and using effective net energy diet formulation, standardized ileal digestible amino acids and digestible phosphorus. Inclusion rates beyond this may save feed costs but may have a negative effect on pig performance. In those situations, the cost versus benefit in the whole production system will need to be considered. The future use and effectiveness of byproduct ingredients and, in particular, ones considered to be fibrous, will depend upon effective supplemental enzymes, practical and timely feed quality evaluation technology, innovative processing technologies, vendor assurances and possibly genotype selection.

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MANAGEMENT BY MEASUREMENT

Dennis DiPietre
KnowledgeVentures, LLC
1802 E. Whisenhunt Rd., Columbia, Missouri 65201
E-mail: hogs2denis@aol.com

and
Janette Richards
5353 Mooresville Drive, R.R. #2, Lucan, Ontario N0M 2J0
E-mail: jrichards@hsqi.com

INTRODUCTION

Most people, at one time or another, have thought about trying to do something better. Thinking about doing something better, or thinking about making a change, can be the easy part. Quite often, actually making the change is not. Trial and error is one approach that has been used in the past. Unfortunately, this approach can sometimes be seen as jumping to conclusions without enough study of the problem(s) and the results can be less than expected. Another approach is to conduct an extensive study of the problem before a change is tried. This can often lead to complete paralysis as nothing actually gets done, tested or changed. There are 3 basic questions that should be addressed when trying to make a change.

What are we trying to accomplish?

What changes can we make that will result in improvement?

How will we know that a change is an improvement?

These questions provide a foundation for managing both change and improvement. Focusing on these questions stresses learning, by testing changes on a small scale rather than studying the problem before any changes are attempted. The key to improvement is to manage your measurements. One of the best skill sets that can be used in order to provide rapid learning and to make changes that improve your operation is the Plan – Do – Study - Act (PDSA) Cycle. The PDSA Cycle is a flexible model that has been used in many different situations and incorporating this into your everyday management decisions will help to make changes to your operation that will not only be successful, but will also improve your bottom line.

AN EXAMPLE

As we enter an unprecedented period of risk for swine producers, understanding the sources of risk being served up from the many sources of risk and developing systematic strategies with coherent tactics to reduce the farm's exposure to it will be important. What we would like to accomplish over the next year is to understand the sources of risk and put in place strategies to mitigate it. As a measurable outcome, we would like to operate within a narrower spectrum of the total riskiness or price and cost variability that occurs. Some of the risks faced by pork producers in the next decade are outlined below.

Input Cost Risk

Subsidized and mandated use of ethanol has tied the price of corn to the price of oil. The factors which influence the price of oil can now exert influence on the price of corn unrelated to its use or demand as a feed ingredient. Oil prices vary with supply and demand which can include politicization of supply (oil as a weapon) as well as the relative value of the dollar against other major world currencies since the world oil trade is conducted in dollars. The implication is that nominal feed ingredient prices can rise even in the face of falling livestock demand as currency valuations change. Instability in the world economic situation is spinning increased price risk into livestock production costs.

Political Risks

In the great asset bubble burst of 2008, world grain prices doubled and in some cases tripled in a very short period of time. This led over 40 countries to ban exports of key grain and meat supplies in order to preserve local supplies and avoid food panics and political upheaval. This hoarding action served to slow the market based adjustment of world prices since grains could not move freely from lower priced areas to higher priced areas. Some countries began to make long term plans to reduce their exposure to global market shortages by making long term **leases** and purchases of arable land in other countries such as Africa, Brazil and parts of Asia to grow their own future supplies and prevent future shortages from their own domestic production. These privatized supplies may cause future price volatility as they may represent significant sources of future world grain stocks that may be withheld from global trade to reduce food security issues for owner countries.

Global Trade and Export Related Price Risks

Many developed countries have reached saturation levels of pork production with respect to domestic demand. When these countries possess global strategic advantages for crop or livestock production, the only way to grow is through increasing reliance on exports. Exports by countries with comparative production advantages is a win-win for all on a global basis but exports can be highly variable, subjecting the exporting country periodically to large volumes of perishable food commodities forced upon a saturated domestic demand. Factors impacting export volatility include new trade barriers or requirements, sudden outbreak of export-stopping disease or food safety issues/contaminations, hysterical reactions affecting demand (H1N1), political tactics such as embargoes, sudden changes in the relative values of trading country currencies etc. Increasing growth by relying on ever increasing domestic production destined for foreign markets is a siren song of increasing benefits coupled with the prospect of periodic train-wrecks.

Quality Risk

Packers are constantly refining their pricing grids to deliver the most value for them in their meat and processed product markets. As the pork trade has changed from a highly competitive, disaggregated market, characterized by large numbers of buyers and sellers of commodity pork, to one of integrated production and processing coupled with long term supply contracts into large

distribution chains, pricing has changed to support the development of increased uniformity of production. A one pound difference in total carcass weight can increase or decrease the value of the entire carcass by 5% to 25% depending on the packing grid. Understanding production variance and implementing strategies to reduce it is becoming increasingly important. Endogenously reducing variation through improved health and by creating a more consistently ideal production environment and feeding protocol throughout the life of the animals, as well better selection strategies for market ready animals, pays large dividends. In addition, centering the total mass of reduced variance (weight) carcasses over the most valuable price points of the buying grid will produce a consistently higher profitability even when profits are low and losses occur.

Forward Pricing

Using futures markets or pre-pricing (or forward pricing) strategies to lock margins rather than hog prices and input costs independently is becoming an important tool in reducing the level of total income and financial risk faced by modern farms. There is no longer anything we can call a “high” or “low” hog price. June CME lean hog contract prices for 2009 sold at \$100/cwt in the late summer of 2008 but future corn prices and bean meal prices were so high at the time, locking a margin was very difficult. High and low prices are very relative terms. We are interested in monitoring opportunities to capture profits (a combination of input and output prices which results in a profit) rather than locking high hog prices or low feed prices independently.

The PDSA cycle is a scientific approach to change and improvement. Sometimes referred to as the “Shewart Cycle” (originally developed by Walter Shewart in the 1930’s) or the “Deming Cycle”, as W. Edwards Deming successfully promoted and used this method, starting in the 1950’s.

PLAN

Identify an opportunity and plan a change. Part of the plan will involve figuring out what things are going wrong (identifying the problem) and to come up with ideas for solving these problems. Plan not only what you are going to do, but also figure out how you will know if the plan actually works! Not all change is an improvement. The plan for a test or change should cover who will do what, when, and where. Part of the plan is also deciding what data will need to be collected. Set objectives and then outline the tasks or activities that are required to put the plan into action. Nothing can be more frustrating than planning a change, making a change and then not knowing whether or not it made any difference. Deciding how you will know if anything is better is often overlooked in this stage.

In our example we have decided to try two relatively simple changes to reduce the variability of prices and costs which are present in the market and in doing so, we hope to improve overall profitability and increase our access to capital.

1. Our first plan is to collect individual carcass data from our packer in an electronic format. Most packers will provide this through email if a producer requests it. Once we are collecting this data we will measure the average weight marketed and the standard deviation of pig weights marketed to test our farm's variability of production. As a target for the year, we will attempt to reduce the standard deviation of individual market weights by 20% (which is an achievable goal for most producers). We will do this through a variety of improvements in selection strategies and health and management practices focusing on providing more consistently high quality care to our pigs.

2. We learn how to calculate and track what is commonly called the “hog crush”, the margin which forward pricing opportunities are offering for hogs and feed ingredients or prepared feeds. We will develop a marketing plan which “locks” margin in increments when prearranged targets are met. For instance, when a future margin of \$25/head is available, we will forward price 50% of our production, when \$20/head is available, we will forward price 30% of our production, when \$15/head is available we will forward price 15% of production and so on.

DO

Easy – carry out the plan! But maybe not - testing a change is not always easy. Often, things may happen that were not actually planned. Or the change may not impact anything that you are measuring. We may begin measuring standard deviation of marketed weights and gradually reduce it only to find that a new disease has entered our herd and despite our efforts, erased the gains we have made in variance reduction. There could also be some unwanted side effects. The best approach is to test the plan on a small scale. This is important, as small scale tests or changes are more effective and easier to carry out. If the plan involves too many changes, or is too difficult or hard to do, the results may be hard to evaluate and you could end up with outcomes that do not mean a lot or are hard to interpret. We would like to establish a baseline of variation first and then attempt to reduce it but factors such as changes in management, vacations of key employees and new diseases entering the herd may cloud our results. Changing too many things at one time can also be the cause of misleading results. Try and make any changes in a way that can be both observed and understood. So, carry out the test and record your results long with any associated problems or unexpected data. The end result of testing the plan is to evaluate the impact of a change and to learn about different alternatives. The next step is to analyze or “study” your data.

STUDY

The real emphasis of this phase is to build new knowledge. Study is the driver for learning. Without it, improvement is nearly impossible. Often, the Plan and Do portions are completed while the Study portion is NOT being performed well or regularly. Studying the available literature on variation and its causes, consulting with the farm's veterinarian and soliciting observations and recommendations from those directly involved in pig care can not only provide increased information but help build a team effort.

Forward pricing requires the help of someone experienced with markets. Local university extension or agricultural economists can provide important literature and guidance. Your packing plant procurement division can inform you of programs that are offered for locking prices of pigs just as feed dealers almost always offer forward pricing programs for their products. The key to remember is that we are locking margins, a combination of pig pricing and feed pricing rather than trying to independently lock a “high” hog price and/or a “low” feed price.

ACT

What you decide to do here all depends on what you learned during the Study part of the cycle. If the experiment was successful, it would now be time to implement any change(s) on a larger scale. These changes need to become part of the normal practice in your business. If the experiment was only partially successful, or not successful at all, you would need to start the cycle again, but with a different or modified plan. Once a satisfactory result is obtained, and the changes are included in your day-to-day procedures, then is it time to repeat the whole cycle of Plan – Do – Study – Act again, with a new problem or challenge. The more you do it, the more improvements that you make, the better your business will be.

CONCLUSIONS

Improvement comes from the application of knowledge. To use the PDSA effectively, adapt it to your own situation. There is no need to spend weeks studying a problem. It may be better to start the cycle with a Study rather than a Plan, as you usually have to figure out what your current situation is before you charge off and make changes. Try out ideas on a small scale as this can save you a substantial amount of time, effort and money. With forward pricing, you can execute a plan on paper for several weeks or months without actually committing yourself to the prices to see how your plan would have turned out prior to actually making financial commitments.

MAKING THE MOST OF YOUR HERD HEALTH VISITS

Kevin Vilaca
Maitland Swine Services
Listowel, Ontario, N4W 2M7
E-mail: vilacak@synergyservices.ca
and
Jeff and Nancy Balfour
Jena Farms Inc
R.R. #1, Fullarton, Ontario N0K 1H0
E-mail: jenafarms@quadro.net

INTRODUCTION

This presentation is co-authored by Kevin Vilaca and Jeff Balfour in order to give you two perspectives: the veterinarian's view and producer's view. Our goal is to give you insight into our working relationship in order to show you how decisions have been made on farm over the last 6 years and to provide tips with real-life examples of changes we have made.

BACKGROUND – WHERE WE COME FROM

Dr. Kevin Vilaca, DVM – Maitland Veterinary Professional Corporation and Linwood Veterinary Clinic

After graduating high school, I enrolled at the University of Guelph taking a four-year Bachelor of Science Agriculture Degree. Each summer I worked for the swine professors Dr. Cate Dewey and Dr. Bob Friendship at the Ontario Veterinary College, on the Ontario Sentinel Project funded by Ontario Pork.

After finishing my Agriculture degree, my interests in swine lead me to pursue a Masters Degree in Epidemiology with an emphasis in swine health. My research focused on the PRRS virus and how PRRS vaccination affected boar fertility. One year into my Masters Degree, I decided to pursue a Veterinary Degree. Not giving up on my Masters, I completed it during the summers that followed.

After graduation from OVC, I worked at Kirkton Veterinary Clinic for 2 ½ years as a swine veterinarian before joining Maitland Veterinary PC in 2006. Last year I started splitting my professional time between Maitland Veterinary PC and Linwood Veterinary clinics.

Jeff Balfour- Jena Farms

I purchased the original farm in 1986 and launched a 65 sow farrow-to-finish operation in a barn originally built in 1980. In 1988, an addition was added to the barn to increase the capacity to 150 sows, still farrow-to-finish. In 1996, a second barn was added for the finishing process and

the older barn renovated to increase the sow herd to 275 sows. At this time, Nancy and I also incorporated the farm, now known as Jena Farms Inc. Throughout this time period, the land base was gradually growing as well. In 2002, the decision to start three production sites was implemented. An 850-head sow barn was built on a nearby farm (within 4 miles of the “home farm”) and a newly built nursery barn was contracted to handle the early weans from this new sow barn. Since 2002, we’ve gradually added contract finishing spaces to the operation to handle most of the sow barns production.

BASIC WORKING PRINCIPLES

Keys to Successful Working Relationship - Veterinarian Point of View

First and foremost, it is vital that the veterinarian have a clear understanding of the goals and needs of the producer. This may sound simple, yet if the direction and long term goals of the producer are not clearly understood then frustration and miscommunication are inevitable. When was the last time you clearly explained to your vet what your goals and expectations are?

In these economic times, it goes without saying that costs and finances must be top of the priority list. It is vital that any decision that is made have an economic benefit. These decisions in turn must be based on solid science as well as an understanding if the science will apply to the specific clients’ farm. We have all seen the NEW “flavor of the month” that sweeps across the province promising to revolutionize the industry only to find it gone a year later.

Open communication is essential to success. Producers must be willing to hear the honest truth and not be offended by it or take it as criticism. It is of no value for the producer or the vet to walk onto a farm and sugar coat things when things are clearly not going well. Swine vets see many barns and have seen many different ways of doing the same thing. It is their responsibility to tell you which one would be best applied to your production situation. It is then the producers’ responsibility to take this information and make the final decision.

Veterinary medicine is not only about treating pigs and dealing with disease, but more importantly it is preventing these diseases from happening in the first case. There should be clear and open discussion with your vet to keep them up to date on things that are going on. All it takes is a phone call just to say “hey I have questions for you”. Most vets spend a great deal of their day behind the wheel of a car, so answering a quick question is not an issue. There have been numerous situations where a simple phone call caught things before they really got going. The end result is a healthier herd and ultimately that the producer has made money.

When it all comes down to it, it is the clients who have a mutual understanding of goals, coupled with regular and clear lines of communication, that have the best overall results from their vets. The medicine, science, production and disease side is the easy part. It is the relationship and trust between the vet and the producer that make the largest overall impact.

Keys to Successful Working Relationship - Producer Point of View

In this competitive pig industry, producers need the very best from the people that they work with in order to benefit from today's technology and yesterday's experience. The veterinarian is a vital part of your business and not just from a disease point of view.

The Ontario pork industry has a very good infrastructure, thus a producer does not need to go very far from his own doorstep to find an expert in almost any aspect.

In our experience over the years, in order for your vet to be of value, he must be open-minded and upfront in his assessment of the current situation facing you. This means that you need to be prepared for the honest truth and not just what you want to hear. If you're paying for his advice, why not listen to him.

Your vet should be someone that you get along with and that understands you. This is a long term working relationship that you are building. If you don't get along with him then why look to them for advice.

Your vet should be a swine specialist in order to be able to provide up-to-date and science-based information and advice. He needs knowledge of not only the science and diseases but also the production and management of pig farming. It is then the producer's responsibility to take his advice and information, balance it with his own experiences and priorities and create a viable approach and solution to the problem at hand.

Your vet must be willing to acknowledge this procedure since it is the producer who is ultimately responsible for the economic outcome of the operation. Vets are consultants and should be able to adjust according to your needs and work toward a mutual resolution for the best possible outcome.

Often, the best results come from open, honest communication and ultimately a compromise between all the parties involved. At the end of the day, the people you surround yourself with in business have a large impact on the overall success of your operation. Make sure you pick these people wisely.

TOPICS FOR DISCUSSION

Our goal for this presentation is to take these basic principles and show you, with specific examples, how they were applied in real life. This is an open presentation where both of us will give you our point of view and explain how and why we made specific choices. We encourage the audience to ask questions throughout the presentation. The following are topics with examples to illustrate specific points:

- Depopulation of nursery – Using production records to make decisions
- Staffing issues – Using the different approaches to get to the end result – staff get it done

- Making the most of your CQA – Taking the CQA as an opportunity to take stock and re-assess what and why we are doing things
- On farm trials – Having trials that allow us to assess in our own farm if it works or not
- PRRS Outbreak – how we came to a resolution
- Making big decisions – talking through all the options and openly stating opinions
- Vaccine decisions – How we make vaccine decisions for our farm

WHAT IS MY COST OF PRODUCTION?

John Molenhuis
Ontario Ministry of Agriculture, Food and Rural Affairs
95 Dundas Street East, Brighton, Ontario K0K 1H0
E-mail: john.molenhuis@ontario.ca

WHAT IS YOUR COST OF PRODUCTION?

Cost of production information is an essential ingredient for farm level decision making. Knowing your cost of production is the first step in controlling them. Good cost of production information starts with good farm records. This presentation will outline the process and use of COP budgeting for farm-level decision-making.

ANATOMY OF A COP BUDGET

While the format of COP budgets can vary they typically include the following sections.

- **Revenue:** the gross revenue from crop or livestock sales before any expenses have been deducted.
- **Direct Variable Costs:** expenses for the production of a specific commodity. These change depending on the level of production (i.e. feed, livestock purchases, vet/medicine, crop inputs).
- **Indirect Variable Costs:** expenses used in producing all commodities on the farm (i.e. fuel, labour and utilities). These also change depending on the level of production.
- **Fixed Costs:** expenses that remain the same regardless of the level of production (i.e. property taxes, fire insurance and depreciation).
- **Net Profit (loss):** revenue minus all variable and fixed costs.

THREE STEPS TO COP

Step # 1 - Turn Cash Records into Accrual Records

This is a critical first step in developing accurate COP. The main goal of accrual adjustments is to match the revenue you received with the expenses you incurred to generate that revenue.

What Will You Need to Turn Cash into Accrual?

- Cash income and expenses (including prepaid expenses) for the year
- Beginning and ending crop and livestock inventories and their \$ values
- Beginning and ending accounts receivable – what people owe you
- Beginning and ending accounts payable – what you owe to other people

Step # 2 - Break it Down by Enterprise

Identify your enterprises. Pick the enterprise(s) that mean the most to you - usually those are the ones you expect to make a profit from. These are sometimes referred to as profit centres. There are some enterprises, like home-grown feed crops, that are used by other enterprises and are not intended to be sold for profit.

The difficulty many farmers have in COP budgeting is allocating costs to the specific enterprise. And the more enterprises there are, the more difficult the allocation process.

Common allocation methods:

- Percent of enterprise gross margin
- Percent of sales
- Percent of total expenses
- Number of Hectare (Acre)-trips per crop
- Hours spent in an enterprise

An allocation worksheet taken from the OMAFRA Factsheet “Guide to Cost of Production Budgeting” has been provided at the end of this presentation summary.

Step # 3 – Concentrating on individual or groups of costs

Once you have the COP by enterprise you can start to concentrate on individual or groups of costs that affect it. For example, livestock enterprises can focus on purchased and home-grown feed costs, or with machinery you can start to drill down to the individual field operations within each crop.

THREE MAIN AREAS TO LOOK FOR COP IMPROVEMENTS

Focusing on costs is obviously concentrating on the cost side of the equation but COP budgeting has to consider both sides: cost and revenue. Do not do anything on the cost side that will negatively affect the revenue side. Cost of production, as the term implies, is driven by **production**. Maintaining or increasing your production is one of the best defences against rising COP.

Direct Costs

In cases where decreasing costs also decreases revenue it is usually a result of a loss in production but it could also be a lower price due to lower quality. This depends largely on the direct inputs used. The costs of each input should be weighed against their potential benefits. As a risk management strategy, if you are ready to lock in prices for inputs you should also be looking at locking in market prices to cover it. In the short term direct input costs can be the easiest to address and are addressed by many of the topics at this conference!

Feed costs. Feed costs play a big role in swine profitability. Purchased feed is relatively straightforward to allocate to the different livestock enterprises. Knowing what your home-grown feed costs are can be more challenging since the costs can be embedded across several expense lines like seed, fertilizer, fuel, repairs, interest and depreciation.

With calculating the home-grown feed cost for your swine operation, or any livestock enterprise for that matter, there are two common approaches; using your actual cropping costs or using a market value approach. The first has you keeping all the cropping costs you had for the crops that were fed in the livestock enterprise budget. Using your own on-farm records will also accurately reflect the actual costs on your farm.

The second method extracts all your crop costs out of the livestock enterprise and then “sells” the home-grown feed crops back to the livestock at market value. Transferring the crop costs at market value back to the swine operation can be fairly abstract to wrap your head around. It introduces the concept of opportunity cost which can be equally mind numbing. What this transfer value represents is the value for the crop that you could have received if you sold it instead of fed it. Opportunity cost is what you could have earned with those crops in the next best alternative.

The transfer method is helpful if you have crops that are grown for cash crops as well as crops to be fed. Allocating all the crop costs (feed and cash crops) out and then adding only those costs for the crops that are fed back into the livestock enterprise can give you a purer glimpse of the home-grown feed costs.

Feed costs are a significant percent of the total costs. So regardless of the method you use for your operation it is well worth the effort of pencilling it out.

Capital Costs

Longer term investment decisions in capital like land, machinery and buildings need to be made with COP in mind. For many farms there is more room for improvement in COP on the capital cost side, especially machinery costs, than the direct costs. One approach is to calculate all your other costs so you know what you can afford to pay for capital items like land and machinery.

Overhead Costs

Overhead costs like utilities, accounting, office and motor vehicle expenses, etc. are not directly attributable to a single enterprise, but all enterprises share the cost. One thing to keep in mind is that there are no home runs; it can take incremental changes in many areas to add up to significant savings. This area would not be where you start to look for cost savings as the other areas have the potential to have a greater impact on your COP.

KEY COST OF PRODUCTION MARGINS

Gross Margin = Gross Farm Revenue – Variable Costs

Use the gross margin to determine if the variable inputs are being used effectively. Optimum efficiency realized from investment in variable inputs is a key factor to profitability. Gross margin is the dollars leftover to pay the ownership costs (or fixed costs) of your capital assets. It can help you decide if it makes sense to continue to invest in capital assets for this enterprise.

Profit Margin = Gross Farm Revenue – Variable and Fixed Costs

Without long-term profit, a farm business is not sustainable. Sustainability depends on every enterprise covering all costs and providing a return to management. It is possible to have farms that generate sustained and excellent margins over variable costs, but report unacceptable net profit. In these situations, it is likely that fixed costs as measured on a per unit of production basis are too high. Farm managers must either reduce the fixed costs, or increase production and therefore reduce the fixed costs per unit of production. Either tactic, or a combination of both tactics, should be explored as ways in which to increase profitability.

COP INFORMATION AND RESOURCES

OMAFRA Factsheets

- Guide to Cost of Production Budgeting, Order No. 08-055
- 2010 Field Crop Budgets – Publication 60
- Guide to Custom Farmwork and Short-Term Equipment Rental, Order No. 07-019
(2009 rates coming soon)
- Leasing Farm Equipment, Order No. 01-003
- Budgeting Farm Machinery Costs, Order No. 01-075
- Lease Agreements for Farm Buildings, Order No. 03-095
- Cash Lease Agreements for Cropland, Order No. 01-071

Internet Resources

Swine Enterprise Budgets – OMAFRA Swine Team

The monthly OMAFRA Swine Budgets provides a guide and format to estimate the cost of production for a swine enterprise.

www.omafra.gov.on.ca/english/livestock/swine/finmark.html

Ontario Enterprise Budgets – OMAFRA Business Management

Enterprise budgets for crop and livestock enterprises in Ontario available in Excel and HTML format.

www.omafra.gov.on.ca/english/busdev/bear2000/Budgets/oeb.htm

Farm Business Decision Calculators – OMAFRA Business Management

Downloadable computer spreadsheet tools to assess the costs of various management decisions, perform financial analysis and evaluate investment decisions.

www.omafra.gov.on.ca/english/busdev/downtown.htm

Canadian Farm Budget Database – Canadian Farm Business Management Council

This database has over 2,000 budgets and financial data pages from across Canada.

www.farmcentre.com/farmbudget/

Budget Library – University of Minnesota

The Budget Library includes current enterprise budget information and software throughout the United States.

www.agrisk.umn.edu/Budgets/

Farm Enterprise Allocation Record				
Farm Name:		Allocations: Year 20 (use \$ or %)		
	Whole Farm	Enterprise	Enterprise	Enterprise
REVENUE				
Commodity sales	\$			
Program Payments	\$			
Other farming revenue	\$			
Total Revenue:	\$			
VARIABLE EXPENSES				
Seed, livestock, feed grain	\$			
Fertilizers and soil supplements	\$			
Pesticides and chemical treatments	\$			
Prepared feed, minerals and salts	\$			
Custom feeding	\$			
Vet fees, medicine, AI fees	\$			
Insurance premiums (production)	\$			
Other crop and livestock supplies	\$			
Labour	\$			
Agricultural Contract work	\$			
Freight and shipping	\$			
Commissions and levies	\$			
Machinery fuel	\$			
Machinery repairs	\$			
Motor vehicles expenses	\$			
Small tools	\$			
Containers and twine	\$			
Soil testing	\$			
Building and fence repairs	\$			
Utilities (electricity, telephone,	\$			
Storage/drying	\$			
Office expenses/legal and accounting	\$			
Advertising and promotion costs	\$			
Memberships/subscriptions/licenses/	\$			
Interest (operating)	\$			
Total Variable Expenses	\$			
Gross Margin (Revenue minus Variable expenses)	\$			
FIXED EXPENSES				
Property taxes	\$			
Rent (land, buildings, pastures)	\$			
Interest (term)	\$			
Machinery lease/rental	\$			
Motor vehicle interest and leasing	\$			
Depreciation (bldgs and mach)	\$			
Other insurance premiums	\$			
Other (specify):	\$			
Total Fixed Expenses	\$			
Total Expenses (Variable + Fixed)	\$			
Profit (loss) Margin (Revenue minus Total expenses)	\$			

TRENDS TOWARD OLDER WEANING AGE: HEALTH AND NUTRITIONAL IMPACTS

Hans Rotto
Innovative Agricultural Solutions LLC
Ames, Iowa 50010
E-mail: rotto.hans@gmail.com

ABSTRACT

Swine production systems that have moved to an older weaning age have found a myriad of advantages in the wean to finish phase of production. They have found that minor adjustments to vaccination and medication timing should be considered for strategic diseases such as *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumonia*, or Porcine Circovirus. Consideration should also be given to what inputs can be adjusted to lower costs or stopped altogether due to the older wean pig. Great care must be given to sow/gilt conditioning and feeding to sustain them for the increase in lactation length. Other nutritional and supplemental adjustments for the pig should be examined to maximize the benefits of older, heavier pigs at weaning.

INTRODUCTION

It is important to evaluate health and nutritional management protocols for pigs and sows when farms move to older weaning age and longer lactation lengths. This paper will briefly review some basic considerations in health and management in the context of an increase in weaning age and lactation length.

HEALTH

Older weaning ages have generally been positive for swine production systems in many aspects of health. Most of these benefits have been realized in wean to finish barns. The older, bigger wean pigs start on feed better. There has been less enteric disease in the first weeks post weaning. Some have seen less disease in general. It is actually an opportunity to STOP doing vaccinations and medication regimes that you were before with younger, smaller wean pigs. Diets can be less expensive and less complex. Vaccinations can be adjusted due to a more mature immune system post weaning.

Before considering adjustments in health management protocols, there are epidemiologic disease considerations that are important to review. Many diseases are vertically spread from the sow to the piglets in farrowing. This is via exposure to the sow skin, underline, and excretions such as saliva, manure or urine. The longer in the farrowing crate, the more potential for exposure to diseases the sow may shed. There is also an increased dose of pathogen exposure to the piglets when they are with the sow longer. Diseases that need special consideration when increasing the

wean age are pathogens where the length and duration on the sow increases the exposure/dose to the piglets and there will be an increase in clinical disease. You may have to consider medication and/or vaccination timing changes. Medication to the sow can impact the shedding of disease to the piglets. Immunization through vaccination of the sow may also impact the shedding to piglets. Medication of the piglets at strategic times can also minimize the clinical signs and if and when they are seen post-weaning. The following are specific examples to consider:

- *Mycoplasma hyopneumoniae*
 - Intervention changes or considerations
 - Switch from one dose to two dose program.
 - Two dose program may be initially started at weaning and booster is a minimum of two weeks post weaning and often even later.
 - Medication of the lactation feed with some products such tetracycline will impact the vertical spread of *M. hyo*.
 - Vaccination of sows with *M. hyo* vaccine four to six weeks prior to farrowing has been reported to be helpful in minimizing vertical shedding.
- *Actinobacillus pleuropneumonia*
 - Intervention changes or considerations
 - The use of antimicrobials can limit the passage from sows to piglets; however, will not eliminate the vertical spread unless piglets and sows are treated and pigs weaned earlier, not later.
- Porcine Circovirus
 - Intervention changes or considerations
 - The timing of the vaccination may change, especially if done post-weaning. If pigs are older at weaning the age of vaccination may change but protocols that say “3 weeks post weaning” are now vaccinating pigs that are 7 to 10 days older and it may be too late. It is important to work with a veterinarian to know when circulation of PCV is going on in your production flows.

Do not look past the many important health considerations which have greater impact on disease management than wean age. The relative impact of increased wean age on health should be viewed in the context of the stability of the sow/gilt herd for any of the respective diseases. The potential increase in disease exposure and disease dose risk to piglets in farrowing are influenced as much or greater by other factors involved with the vertical spread of disease. Poorly acclimated and vaccinated gilts tend to pass on more disease exposure than sows. A sow farm without even immunity through the sow herd tends to create post-weaning challenges with diseases. This will still happen with an increased wean age. Unstable herds will have pathogens or diseases that are passed in utero if the sow or gilt is undergoing infection at certain stages of gestation. The herd health status for a given disease and the immunity of the herd is important to any strategies for health management.

The difference in unstable herds with older wean age is the potential manifestation of these diseases while still on the sow in the farrowing house. Unstable farms for swine influenza or Porcine Reproductive and Respiratory Virus will occasionally see some piglets present with respiratory signs such as thumping, cough, sneezing and fever while still on the sows prior to

weaning. Piglets tend to experience and go through diseases better while on the sow versus post weaning. This is one of the advantages of an older wean age.

SOW / GILT MANAGEMENT CONSIDERATIONS

Gilt and sow conditioning prior to being loaded into farrowing becomes more important with the increased days of lactation. In farms where the lactation length has increased it is common to bring gilts into farrowing one-half to one body condition score higher. Some farms will also condition sows slightly heavier than previously. It is rare to find skinny sows late in gestation in farms that are weaning above 25 days. Breeding gilts too young and/or small risks many of them not making it to second parity. The body mass change in the first lactation for gilts is only magnified with the increased number of lactation days. Lactation intake must be consistent and steady for gilts and sows to maintain their body mass and be ready to wean. It is critical to know when gilts or sows are off-feed. Later in lactation, they can lose body mass rapidly if not eating as expected. Lastly, the condition of sows in lactation must be monitored daily with great care. Sows that are too thin must be kicked out to gestation.

OTHER MANAGEMENT CONSIDERATIONS

Nutritional changes should be reviewed and supplementation can be considered. This should be in consultation with your nutritionist.

With the increased wean age and lactation days, pigs are weaning up to two to four lbs. heavier on average than before. The pigs are flat out bigger and take up more space. The farrowing crates get tight for space and this should be considered in new builds where wean age is set higher. Split weaning some pigs can alleviate the space concerns and energy draw down on the sow if these concerns are seen.

Some systems have seen more anemic pigs in the oldest pigs in the farrowing house or post weaning. Consideration may be given to going from a one dose to a two dose iron program; 75 mg given 14 days apart or giving 150 mg one time but in a pig that is 5 to 6 days old vs. 1 to 3 days old pigs may be beneficial. A number of systems will search out the anemic pigs and re-inject them with iron prior to weaning. With an older pig in farrowing, some systems have implemented creep feeding to try and supplement the pigs and transition the pigs to feed. These feeds generally have iron and also may work to minimize anemic pigs from showing up.

CONCLUSIONS

The overall benefits of weaning an older, heavier pig are being adopted in many swine production systems. People are adding farrowing crates or changing their herd inventory to increase the days in lactation. The longer lactation increases the length of exposure and subsequent increase in dose of some pathogens. With this consideration, timing and vaccination of the piglet may be adjusted. Also consideration should be given to how you prepare the sow

for passage of maternal protection or minimization of shedding to piglets to try and decrease the dose from sow to piglets. Medications can be used on sows and piglets directed at specific diseases that may minimize their impact in wean to finish production. Sow and gilt conditioning are generally heavier and or bigger when farrowing. If building a system for an older wean age, you may want extra space in the farrowing crate.

ACKNOWLEDGEMENTS

Thank you to all the swine producers who allow me to learn and grow through providing support services to them.

REVIEW OF WEANING AGE EFFECTS ON WEANED PIG PERFORMANCE

**Mike Edwards
Jones Feed Mills Ltd
1024 Alfred St, Linwood, Ontario N0B 2A0
E-mail: mike@jfm.on.ca**

INTRODUCTION

The trend towards later age weaning carries with it some management, nutritional and performance considerations. There are pros and cons to switching to a later weaning age, however overall it can be done successfully and there are many benefits to making the change. This presentation reviews some of the data available on this topic, tries to draw some conclusions based on data, and compares the research data with results obtained with the Humane Certified Pork Production system Jones Feed Mills works with.

WEANING AGE EFFECTS ON WEANED PIG PERFORMANCE

Effects on Nursery Pig Performance

Trials comparing the nursery pig performance of piglets weaned at 12, 15, 18 and 21/21.5 days show an increase in average daily gain (ADG) from 0 to 42 days. The response is linear and significant.

Effects on Finisher Pig Performance

Trials also examined the performance of the finishing pigs from day 42 post weaning until day 154 post weaning. Although not as significant, there would appear to be a continued growth response in later weaned finisher pigs. When the nursery and finisher data are pooled, the result is an overall significant response to later weaning age as it pertains to ADG in nursery/finisher pigs.

The limitation of this data is that it only spans 12 to 21/21.5 day weaning ages. I was not able to find much data that evaluated pigs weaned at later dates. The response to even later weaning is likely linear as well, but would likely drop off at some point, the question is when and how much.

Effects on Nursery Mortality

The same trials mentioned above also measured mortality in the nursery and the finisher phases. Again, there was a significant decrease in nursery mortality when pigs were weaned later. The results at all ages were acceptable, and the linear trend would not likely continue with even later weaning ages, due to the fact that the mortality is very low already for pigs weaned at 21/21.5

days in these trials.

Effects on Finisher Mortality

While not as pronounced as in the nursery, there was a general trend toward lower mortality in the finisher phase with later weaned pigs.

Similar to the data for performance, the mortality data suggests an improvement in later weaned pigs when comparing 12, 15, 18 and 21/21.5 day old pigs. However, it is hard to speculate whether the linear response would continue if the weaning age was further extended.

Table 1. Biologic and economic responses: change/day increase in weaning age.

Response Criterion	Rate/d increase in wean age	SE
Weaning wt, lb	0.6	0.01
d 42 post-weaning wt, lb	2.0	0.04
d 154 post-weaning wt, lb	3.0	0.18
Weight sold/pig weaned, lb	4.0	0.26
Days to a common slaughter wt	-4.1	0.2
Wean-to-finish cost/cwt, \$	\$-0.20	0.02
Margin/pig weaned, \$	\$0.59	0.05

Nursery and Finisher Response Summary

Increasing weaning age from 12 to 21/21.5 days predictably improved wean-to-finish performance. Not only was the growth improved and mortality decreased, but overall there was more weight sold per pig weaned and a total lower cost per pig wean-to-finish. These trials suggest there is not an economic cost to later weaning, but in fact there is an economic benefit per pig sold. Once again, this data compares 12 to 21.5 day weaning, and we are left to assume that there is some linear effects as weaning ages are increased, the question is at what point do we begin to add cost and lose performance?

LATER WEANING AGE: EFFECTS ON SUBSEQUENT SOW PERFORMANCE

The other part of the performance equation for looking at later weaning is the effects on sow performance. The two studies used in this presentation represent the combined data of over 27,000 farrowing records with weaning records from 8 to 31 days in length, taken from 55 farms.

Wean-to-Estrus

Wean to estrus interval decreased as lactation length increased. At around 4 weeks weaning, the

wean to estrus interval plateaued and increased slightly by 6 weeks weaning age. Sows returning to estrus within 6 days after weaning were also documented. The highest frequency of sows returning to estrus in 6 days post weaning was the 4 week weaning group. The 1, 2 and 3 week weaning groups were significantly lower than the 4 week group, and there was a slight decreasing trend in the 5 and 6 week weaned group.

Farrowing Rate by Lactation Length

Farrowing rates of sows based on previous lactation lengths seemed to show a linear response which trended upwards as previous lactation length was lengthened. Data includes lactation lengths from 8 to 28 days, with the highest farrowing percentage occurring in the last group, the 23 to 28 day group.

Pigs per Litter and Weaning Weight

The data indicates a definite increase in total pigs born and total pigs born alive per farrowing based on increased previous lactation length (Figure 1). However, there appears to be a drop in productivity when the previous lactation is extended to 5 and 6 weeks (Figure 2).

Figure 1. Total born and born alive by previous lactation length. (Xue et al., 1993)

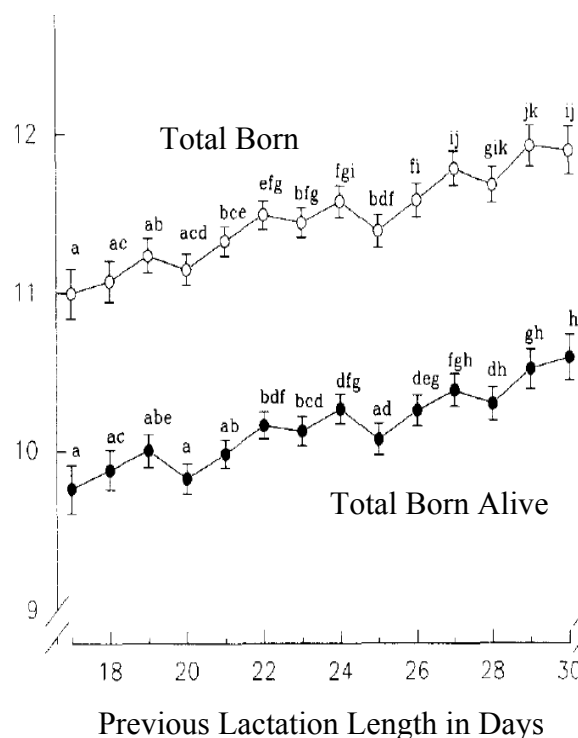
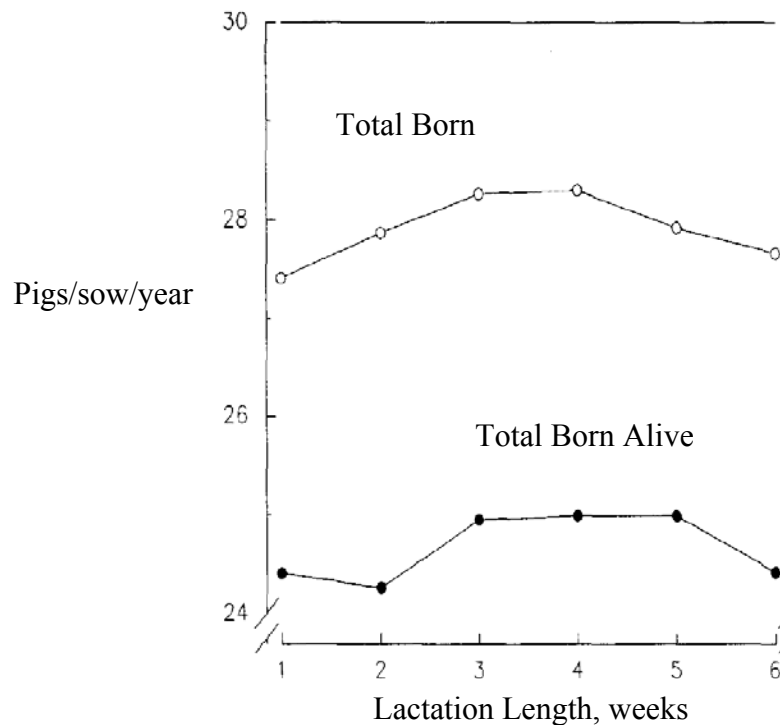


Figure 2. Sow productivity. (Xue et al., 1993)



Options to Increase Weaning Age

There are several options available to producers wanting to increase their weaning age. These include:

1. Reduce the number of litters farrowed per week.
2. Increase the lactation space utilization through decreased loading and cleaning times between farrowings.
3. Increase number of farrowing crates.

CONCLUSIONS

Increasing sow lactation length / weaning age of piglets can have many positive effects for not only the sows, but the weaned pigs as well. Benefits for the sow include decreased wean to estrus interval, increased farrowing rate, increased pigs per litter and increased litter weaning weights. Benefits for the piglets include increased ADG in the nursery and grower-finisher stage and decreased mortality.

When comparing the research results with the results obtained with the Humane Certified Pork Production system, the result in the Humane system fall in line with what is expected. Breeding in the Humane system is excellent with very few problems. Also, litter size has been greater than expected with piglet viability on the sow satisfactory as well. Larger piglets at weaning have

allowed for simpler/less expensive diets during the early phase in the nursery, lowering the cost per pig in the nursery. Grow-finish pigs are growing well, going to market about 10 days ahead of their “cousins” in a conventional system in Quebec.

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