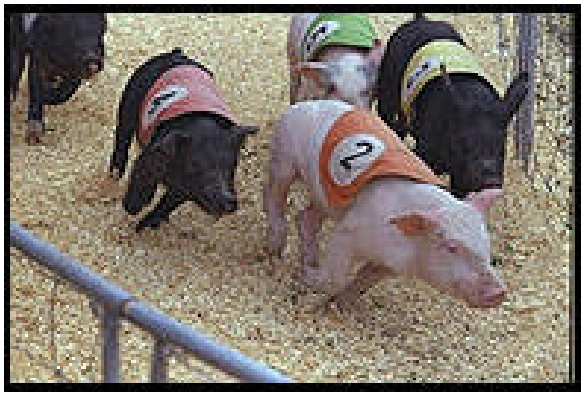
Atlantic SWINE RESEARCH Inc. PARTNERSHIP

‘Feed Competition II’



A Critical Analysis of Feeds Available To Prince Edward Island Pork Producers

Daniel Hurnik Industry - Chair for Swine Research

Friday, February 14, 2003

A Critical Analysis of Feeds Available To Prince Edward Island Pork Producers

Executive Summary

From this study, based on the diets provided and the prices billed the following conclusions can be made:

	FEED 1	FEED 2	FEED 3	FEED 4	FEED 5
COST OF PRODUCTION					
Type of feed	Pellet	Mash	Mash	Pellet	Pellet
Feed used (kg)	32,270	36,100	36,090	33,090	32,550
Feed Cost	$8932.33	$9,101.07	$9,417.82	$9,526.14	$9,349.15
Cost/tonne	$276.80	$252.11	$260.95	$287.87	$287.22
Pork Produced (Kg)	11,654.09	12,012.27	12,272.27	12,162.73	11,702.27
Feed Conversion	2.769	3.005	2.941	2.721	2.781
Feed Cost/kg of pork	$0.766	$0.758	$0.767	$0.783	$0.799
Feed Cost/pig	$65.91	$65.16	$66.00	$67.36	$68.70
Index	109.9	109.8	110.1	110.0	110.6
Revenue/pig	$137.05	$136.92	$137.29	137.17	$137.91
Revenue minus Feed cost	$71.14	$71.76	$71.29	$69.81	$69.21
GROWTH RATE					
Days for 23-109kg	101.7	98.9	97.4	100.8	**106.2**
Average Daily Gain kg/day	0.846	0.870	0.883	0.853	**0.810**
% Light (< 80 kg dressed)	11.2	10.9	5.7	10.8	17.6
MEAT QUALITY					
Lean Yield %	60.4	59.6	60.2	60.1	60.7
Backfat Depth (mm)	18.91	**20.26**	19.29	18.20	18.20
Loin eye Depth (mm)	58.48	56.64	58.68	57.97	58.43
Marbling score	1.9	**2.5**	2.1	1.8	2.1
Fat firmness score	2.7	2.8	2.9	2.5	3.0
Muscle Firmness score	2.7	2.9	3.0	2.4	3.2
Light Reflectance %	54.9	53.1	52.4	51.9	51.1

Numbers that are in bold and underlined are statistically different from others in that row ($p<0.05$)

More detailed results are listed on the next page.

- The pigs grew consistently enough to meet marketing and packer needs with all the feeds.

- Feed 5 grew about 5 % slower than on the other feeds. This difference was statistically significant..
-
- All the pigs grew slower than in previous studies. The barn in this fill was positive for *Mycoplasma hyopneumoniae*, which may have reduced overall barn performance.
- Mash feeds tended to be less expensive, but had a poorer feed conversion
- All the feeds had profitability margins within 3% of each other in this barn and fill of pigs.
- Due to variation in management and genetics in other barns there may not be any difference in profitability between these feeds on other farm operations.
-
- The gilts appeared to grow slower than the barrows by about 6%.
- It appears that feed choice can impact the gilt and barrows differently.
    - Feeds 1 and 2 had the greatest difference in performance between gilts and barrows
    - Feed 3 optimized the gilt performance without loss of barrow performance.
    - Feed 5 had normal gilt performance, but had slowest barrow growth. This resulted in the slower growth overall.
- There was no difference in growth rate between the pigs in the bedded section or the slatted floor portion of the barn, although pigs on feed 4 did grow better on the bedding in this fill.
- Feeds 1 and 2 had a lower risk of barrows being shipped light than the other feeds
- Feed 3 had fewer light gilts than the others, other feeds had an equal risk of having light gilts
- Feed 5 had a higher risk light pigs at market overall compared to Feeds 2 and Feeds 3, and almost statistically different than the other feeds.
- Starting weight of the pigs has a significant effect on growth. Larger pigs at the start of the trial, which likely had a superior growth rate from birth on, maintained that advantage through to market weight. This is a general finding that is independent of any of the feeds fed.
- There were significant differences in meat quality. Pigs fed Feed 2 had more backfat and marbling.
- Feed 5 produced pigs whose fat and pork were firmer than the other feeds
- While pigs raised on bedding tend to be fatter. It appears that only happened to the barrows, it had no significant impact on gilts
- There were no differences in loin depth associated with feed choice, bedding or gender. The loin depth was lower than in other fills which may be associated with the lower growth rate observed in this fill
- Feed had no effect on meat colour, or carcass index .

Introduction

Prince Edward Island pork producers who wished to critically evaluate pig feeds prompted this study. Feed accounts for 70% of the cost of raising a pig to market, and an independent analysis of the feeds available was deemed to be of great value. The establishment of the Industry Chair for Swine Research and the presence of the new AVC research facility has allowed for this analysis to happen. The intent of the study was to evaluate pig feeds in ways that are commercially relevant. Of primary importance were the financial parameters, with the ultimate measure being the revenue minus feed cost calculation. This number determines the profit that can be attained with each feed. Meat quality parameters were measured to determine the impact of the feed to the packer and to the retail market. We hope this second study will be of value to the PEI pork industry as a tool to attain increased profitability.

As with all research there are limits to the interpretation of the information. Our data were generated in one barn at one time. Results may vary in other barns, and at other times of the year. This study compared feed under the same conditions and its greatest strength is the comparisons it provides. The study was undertaken in good faith to compare the value of each feed without bias. Efforts were taken to provide accurate data, but complete freedom from errors or omissions cannot be guaranteed.

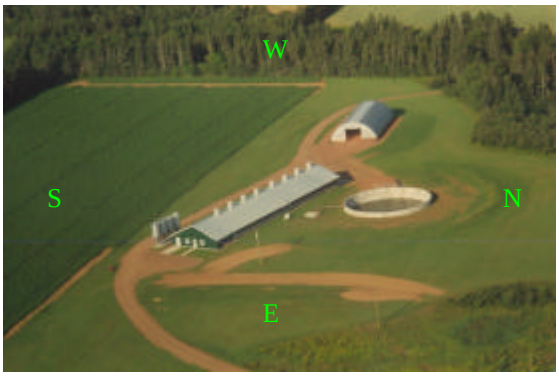
Acknowledgement of the key players to make this project happen is important. They are: Ian Mutch, the late Willard MacPhail and Frank Johnston who comprise the Research Committee of the PEI Hog Commodity Marketing Board; Paul Horne, Melody Perry, Theresa Rogers, Rick Milton, and Lloyd Dalziel who helped to gather the information needed; Shona Whyte , Don Rainnie, Wayne Hooper, Ian Dohoo, Trevor Lank, Maggie Montgomery and Robert Harding who reviewed the report. The feed companies who provided the feed and allowed the comparison are to be commended for their participation and cooperation. The PEI Pork Producers, PEI Agricultural Research Investment Fund, and the PEI Department of Agriculture and Forestry fund the Industry Chair for Swine Research, this support made this study possible.

Figure 1: PEI pig farmers participate in a global market place with their pork products. The ability to maintain a competitive position in that market place is essential if PEI is to maintain a vigorous agricultural economy.

Materials and Methods

- The pigs were housed in the AVC Inc. Pig Production facility (Figure 3 below).

Treatment Allocation



Calendar of Events

Date	Event
March 23 2001	Pig arrival
March 30 2001	Weigh & tag Pigs on Feed 1
March 29 2001	Weigh & tag Pigs on Feed 2
March 28 2001	Weigh & tag Pigs on Feed 3
March 26 2001	Weigh & tag Pigs on Feed 4
March 28 2001	Weigh & tag Pigs on Feed 5
June 20-July 18	Weigh & shipment to market

Figure 2: PPIG Swine Facility - Union Road

South/West

Pens →	02 F3 G	04 F4 G	06 F5 G	08 F1 G	10 F2 G	12 F3 B	14 F4 B	16 F5 B	18 F1 B	20 F2 B	22 E	24 E	26 E	28 F3 B	30 F4 B	32 F5 B	34 F1 B	36 F2 B	38 E	40 S
office	SLATTED FLOOR END										BEDDED END									
	01 F1 B	03 F2 B	05 F3 B	07 F4 B	09 F5 B	11 F1 G	13 F2 G	15 F3 G	17 F4 G	19 F5 G	21 E	23 E	25 E	27 F1 G	29 F2 G	31 F3 G	33 F4 G	35 F5 G	37 E	39 S

North/East

Code	
E	Extra Pigs (non-Study)
B	Barrow
G	Gilt
S	Sick Pen
F1	Feed 1
F2	Feed 2
F3	Feed 3
F4	Feed 4
F5	Feed 5

- The slatted portion of the barn has pens with fully slatted floors over 3 foot deep liquid manure pits.
- The bedded end contains a 3-foot deep bedded section containing a mixture of straw and sawdust.
- Each pen in both sections has a solid white PVC partition and a 4-space wet/dry feeder.

Research Activities

- Pigs were purchased from an SPF source free of the major production diseases except for *Mycoplasma Hyopneumoniae*, utilizing PEI Quality Swine Genetics. Pigs were all born within the same 10-day period and were delivered to the facility on March 23, 2001 when they were approximately 55 days old.
- Each feed company delivered the feed to a designated bulk tank as needed. The volume and value of the feed delivered was recorded. Feed deliveries and prices are noted in Appendix 1.
- Each company was free to choose the number of phases and type of feed to be tested. For example feed company number 4 included a five phase feeding program.
- All study pens received 25 pigs per pen in the slatted, and 24 in the bedding end and allocated in a balanced design according to the diagram above. All feeds started with 148 pigs each and information on each pig is in Appendix 2.
- Feed fed prior to the tag and weigh date was fed by hand and was recorded, as well as any feed fed to the non-study and sick pens. This feed weight was subtracted from the total that was delivered to the barn.
- Daily, each feed was delivered to the designated pens where the pigs had constant access to feed.
- The date and weight of any pigs removed from the study for any reason (sickness or death) were recorded. Details are noted in Appendix 1.
- A feed analysis was taken at random during the study; the results are in Appendix 3.

Formulae

Parameter	Formula
COST OF PRODUCTION	
Cost / Tonne	Feed cost / feed used (kg) x 1000
Feed Used (Kg)	Total feed delivered – (kg leftover in bin at end) –(amount fed before weigh and tag date) – (feed used for non-study pigs)
Feed Cost	Total feed bill –(value of leftover feed) – (value of pre-study feed) - (value of feed for non-study pigs)
Pork Produced (Kg)	Sum of (the finish weight or removal weight of each pig minus the start weight)
Feed Conversion	Feed Used (kg) / Pork Produced (kg) (including mortalities)
Feed Cost / Kg of Pork	Feed Cost / Pork Produced (kg)
Feed Cost/Pig	Feed Cost/kg of Pork x 86 kg of live weight gain
Index	Average index for all pigs more than 80 kg and less than 95 kg dressed weight
Revenue/Pig	$1.45 price x 86kg carcass x (index/100)
Revenue-Feed Cost (Profit After Feed Cost)	Revenue/Pig - Feed Cost/Pig
GROWTH RATE	
Average Daily Gain	(Market weight – start weight)/(days between weighing and shipping) for all pigs with clear identification
Days to gain 86 kg	86 kg of gain/average daily gain
% Light (< 80 kg dressed weight)	Number of pigs < 80 kg/total shipped x100
% Heavy (>95kg dressed weight)	Number of pigs > 95 kg/total shipped x100
MEAT QUALITY	
Lean Yield	Probe output for all pigs dressing more than 80 kg less than 95kg
Backfat Depth	Probe output for all pigs dressing more than 80 kg less than 95kg
Loin eye Depth	Probe output for all pigs dressing more than 80 kg less than 95kg
Marbling	Manual score 1 to 5 with 5 as the greatest marbling
Fat firmness	Manual score 1 to 5 with 5 as the greatest fat firmness
Muscle Firmness	Manual score 1 to 5 with 5 as the greatest muscle firmness
Light Reflectance	Value from Minolta colour meter = % light reflected (higher number means more light reflected , meaning paler pork)

Statistical Analysis

The statistical analysis used a random effects regression model. This method accounted for the variation due to pens, gender, bedding and pig weights so that the effect of the feeds possible interactions could be evaluated without the influence of the other factors. The p-value is reported when relevant. This number refers to the likelihood that the difference noted arose by chance. Generally, a p value of under 0.05 is considered to be statistically significant. The closer the p-value is to 0 the stronger is our confidence that the difference really exists. Values that are statistically different from the others are indicated in this report.

Analysis of Carcass Grading

The entire carcass data from the study pigs was downloaded from the APHIN database, giving the following information was gathered:

- Pen Specific tattoo
- Carcass index
- Carcass weight (dressed warm)
- Loin eye depth
- Backfat depth
- Lean Yield (%)
- Pneumonia prevalence
- Liver spot prevalence
- Adhesion prevalence

To compare the carcass quality, calculations excluded any pigs in the following categories:

- Light pigs < 80kg
- Heavy pigs > 95 kg
- Pigs from pens not on the study
- Pigs from which there were no probe data to calculate a lean yield

Meat Quality Assessment

The quality of the pork was also evaluated using the loins of the pigs examined 24 hours after slaughter. The loin was split where the grading probe was inserted (Figure 3). On the loin muscle and the backfat the following data were recorded:

Figure 3 A cross section of the loin where the meat and fat was examined in detail.

- **Marbling** – a visual score rated 1 to 5 with a score of 5 having the highest amount of marbling
- **Muscle firmness** – a tactile score rated 1-5 with a score of 5 having being most firm.
- **Fat firmness -** a tactile score rated 1-5 with a score of 5 having being most firm.
- **Colour** – a reading with a Minolta colour meter that measured light reflectance as a percentage. The higher the number, the more light was reflected and the paler the meat was.

Results and Discussion

The results of the cost of production analysis are summarized below. The data on which each calculation is based is provided in Appendix 1 for each feed.

Cost of Production

	FEED 1	FEED 2	FEED 3	FEED 4	FEED 5
COST OF PRODUCTION					
Type of feed	Pellet	Mash	Mash	Pellet	Pellet
Feed used (kg)	32,270	36,100	36,090	33,090	32,550
Feed Cost	$8932.33	$9,101.07	$9,417.82	$9,526.14	$9,349.15
Cost/tonne	$276.80	$252.11	$260.95	$287.87	$287.22
Pork Produced (Kg)	11,654.09	12,012.27	12,272.27	12,162.73	11,702.27
Feed Conversion	2.769	3.005	2.941	2.721	2.781
Feed Cost/kg of pork	$0.766	$0.758	$0.767	$0.783	$0.799
Feed Cost/pig	$65.91	$65.16	$66.00	$67.36	$68.70
Index	109.9	109.8	110.1	110.0	110.6
Revenue/pig	$137.05	$136.92	$137.29	137.17	$137.91
Revenue minus Feed cost	$71.14	$71.76	$71.29	$69.81	$69.21

There appear to be only a $2.50 difference in profit between feed choices. The results indicate the value of all the feeds choices appear quite close together compared to the previous study. Due to variation in management and genetics in other barns there may not be any difference in profitability between these feed on other farm operations.

Feed Conversion

Feed conversion was competitive for all the feeds. Feed 2 had the highest feed conversion; this could be due to the physical characteristics of the feed, or the formulation was such that the pigs were fatter at market weight. Feed 4 had the best overall feed conversion, and this was consistent with the previous study. In this study, feed 4 had a 9.4% improvement in feed conversion over feed 2. Fat requires more feed to create than muscle and Feed 2 did have the fattest pigs. For optimum profitability, feed conversion and carcass quality need to be balanced with feed cost.

Growth Rate

The growth rate (kg/day) was calculated by dividing the weight gained by each pig by the length of its stay in the barn. Pigs that were excluded from the calculations were the ones that died or were removed from the study. Also not included were pigs that could not be definitively matched to their start weight. Those would be pigs that lost and changed eartags, or a definite match could not be made. Of the 740 pigs that began the study, good data were obtained from 686 pigs. Deaths and removals are noted on page 22. There was an adequate number to accurately estimate the growth rate of the pigs. The average for each feed was as follows:

Feed	Average kg/day	Days to Market
1	0.846	101.7
2	0.870	98.9
3	0.883	97.4
4	0.853	100.8
5	0.810	106.2

When the same data was put into a model using a Random effect regression that accounted for the variation due to the pen, the gender of the pig, the flooring type and the starting weight, the results indicate the following:

```
Random-effects ML regression                    Number of obs      =       686
Group variable (i) : pen                        Number of groups   =        30


Random-effects ML regression                    Number of obs      =       686
Group variable (i) : pen                        Number of groups   =        30

Random effects u_i ~ Gaussian                   Obs per group: min =        19
                                                               avg =      22.9
                                                               max =        25

                                                LR chi2(16)        =    216.91
Log likelihood  =  557.34931                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         adg |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |   .0284769   .0205547     1.39   0.166    -.0118096    .0687634
    _Ifeed_3 |   .0232141    .020552     1.13   0.259    -.0170671    .0634952
    _Ifeed_4 |  -.0191837   .0206892    -0.93   0.354    -.0597339    .0213664
    _Ifeed_5 |  -.0657869   .0205098    -3.21   0.001    -.1059853   -.0255884
      gender |  -.1208843   .0196087    -6.16   0.000    -.1593166    -.082452
     bedding |   .0172666   .0213641     0.81   0.419    -.0246064    .0591395
_IfeeXgend~2 |   .0239604   .0261506     0.92   0.360    -.0272938    .0752146
_IfeeXgend~3 |   .0757231   .0259721     2.92   0.004     .0248187    .1266276
_IfeeXgend~4 |   .0624373    .026053     2.40   0.017     .0113743    .1135003
_IfeeXgend~5 |   .0989187   .0261753     3.78   0.000      .047616    .1502214
     startwt |   .0046738   .0004804     9.73   0.000     .0037322    .0056154
_IfeeXbedd~2 |  -.0160128   .0275588    -0.58   0.561    -.0700271    .0380016
_IfeeXbedd~3 |   .0143992    .027569     0.52   0.601     -.039635    .0684334
_IfeeXbedd~4 |    .067997   .0275545     2.47   0.014     .0139911    .1220028
_IfeeXbedd~5 |   .0103872   .0278381     0.37   0.709    -.0441744    .0649488
       _cons |   .6567489   .0285311    23.02   0.000      .600829    .7126689
-------------+----------------------------------------------------------------
    /sigma_u |          0   .0083096     0.00   1.000    -.0162866    .0162866
    /sigma_e |   .1073779   .0028989    37.04   0.000     .1016961    .1130597
-------------+----------------------------------------------------------------
         rho |          0          .                              .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

The model is a comparison of the effect of each variable compared to Feed 1. The results indicated that significant effects in growth rate are caused by feed, gender and starting weight. This is explored in more

detail below: Feeding feed 5 resulted in gilts that grew the same rate as other gilts, but the barrows grew about 7 to 12 % slower than the barrow average.

There appeared to be an interaction between feed and gender. This means the difference between gilts and barrows was not the same for all feeds. Please note the table below:

	Gilts		Barrows		Difference %
Feed	Average	Days to Market	Average	Days to Market	Gilts vs. Barrows
1	0.787	109.3	0.902	95.3	-12.8 %
2	0.816	105.4	0.922	92.3	-12.4 %
3	0.862	**99.8**	0.906	94.9	- 4.9 %
4	0.820	104.9	0.881	97.6	-7.0 %
5	0.798	107.8	0.820	**104.9**	-2.7 %

The gilts appeared to grow slower than the barrows by about 6%. This is consistent with what is expected; barrows normally grow faster than gilts, but lay down more fat.

It appears that feeds choice can impact the genders differently.

- Feeds 1and 2 had the greatest difference in performance between gilts and barrows
- Feed 3 optimized the gilt performance without loss of barrow performance.
- Feed 5 had normal gilt performance, but had slowest barrow growth. This resulted in the slower growth overall.

Starting weight had an independent effect from feeds and gender.

In this fill there was no overall growth benefit by the pigs in the bedding. This remained true even though the stocking density was 24 pigs in the pen versus 25 in the slatted portion. This however was not true for all feeds. Feed 4 had significantly faster growing pigs when they were on the bedding. Since it is not readily evident or biologically explainable as to why these pigs grew better, then further investigation may be warranted before considering these results as real. See table below:

	Slats		Bedding		Bedding vs Slats
Feed	Average	Days to Market	Average	Days to Market	Difference
1	0.845	101.8	0.849	101.3	-0.5 %
2	0.871	98.7	0.866	99.3	0.6 %
3	0.875	98.3	0.901	95.4	-2.9 %
4	**0.823**	**104.5**	**0.913**	**94.2**	**-9.8 %**
5	0.803	107.1	0.821	104.7	-2.2 %

Uniformity

Uniformity becomes a key factor in growing pigs. It is particularly important in all-in all-out barns where there is a deadline for emptying the barn. The most practical measure of uniformity is the number of pigs that fall outside the optimal weight range. This was studied in this project and is outlined below:

Light Pigs

	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
# light	15	15	8	15	24
% light	11.2	10.9	5.7	10.8	17.6

The regression model is outlined below with significant effects underlined and in bold.

```
Random-effects logit                            Number of obs      =       686
Group variable (i) : pen                        Number of groups   =        30

Random effects u_i ~ Gaussian                   Obs per group: min =        19
                                                               avg =      22.9
                                                               max =        25

                                                Wald chi2(11)      =     77.58
Log likelihood  = -180.61169                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       light |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |  -.9272045   1.257213    -0.74   0.461    -3.391296    1.536887
    _Ifeed_3 |   .3627114    .879394     0.41   0.680    -1.360869    2.086292
    _Ifeed_4 |   .3160526   .9166168     0.34   0.730    -1.480483    2.112588
    _Ifeed_5 |   1.559918   .8200498     1.90   0.057    -.0473503    3.167186
      gender |   2.714629   .8199785     3.31   0.001     1.107501    4.321757
     bedding |  -.5272361   .3063673    -1.72   0.085    -1.127705    .0732327
     startwt |  -.1639545   .0218331    -7.51   0.000    -.2067466   -.1211624
_IfeeXgend~2 |   .3321977   1.348363     0.25   0.805    -2.310545     2.97494
_IfeeXgend~3 |  -3.249642   1.130756    -2.87   0.004    -5.465884   -1.033401
_IfeeXgend~4 |  -1.708539   1.046808    -1.63   0.103    -3.760245    .3431673
_IfeeXgend~5 |  -2.493807   .9594496    -2.60   0.009    -4.374294   -.6133206
       _cons |   4.214411   1.195371     3.53   0.000     1.871528    6.557295
-------------+----------------------------------------------------------------
    /lnsig2u |        -14   242.9574                     -490.1878    462.1878
-------------+----------------------------------------------------------------
     sigma_u |   .0009119   .1107742                      3.6e-107    2.3e+100
         rho |   8.32e-07    .000202                      1.3e-213           1
------------------------------------------------------------------------------
Likelihood ratio test of rho=0: chibar2(01) =     0.00 Prob >= chibar2 = 1.000
```

The risk of having light pigs was parallel to the effect on growth rate**:**

Again the there was interaction between feed and gender, meaning the risk of light pigs varied between gender and feed choice. The table below indicates the effect:

	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
% Light Barrows	**2.9**	**1.4**	7.8	6.3	**16.4**
% Light Gilts	20.0	20.6	**4.2**	15.5	18.9
Overall average	11.2	10.9	5.7	10.8	17.6

- Feed 2 had a lower risk of barrows going light than Feed 5.
- Feed 3 had fewer light gilts than the others, other feeds had an equal risk of having light gilts
- Feed 5 had a higher risk light pigs overall compared to feeds 2 and feeds 3, and almost statistically different than the other feeds.
- The impact of light pigs can vary. In continuous flow barns where pigs can be held longer the cost is a loss of throughput. In group flow where pigs need to be sold there are substantial penalties for underweight pigs.

Index

For the carcass analysis portion of the study, data from the APHIN data set were used. Excluded animals were those who had no probe reading and those outside the optimal weight window (80-95kg). The reason to exclude the light and heavy pigs is that these pigs are downgraded not due to lean or fat content but for other reasons such as demerits and poor pig weighing. These factors are not associated with the feed. It is logical to work with the pigs that express the carcass attributes clearly. There were 589 pigs that met the criteria.

Parameter	Index	Number of carcasses
Feed 1	109.9	116
Feed 2	109.8	121
Feed 3	110.1	127
Feed 4	110.0	124
Feed 5	110.6	102

```
Random-effects ML regression                    Number of obs      =       589
Group variable (i) : tattoo                     Number of groups   =        30

Random effects u_i ~ Gaussian                   Obs per group: min =        14
                                                               avg =      19.6
                                                               max =        23

                                                LR chi2(6)         =     41.50
Log likelihood  = -1625.0523                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       index |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |  -.1834365   .5408796    -0.34   0.735    -1.243541    .8766681
    _Ifeed_3 |   .0650296   .5363304     0.12   0.903    -.9861587    1.116218
    _Ifeed_4 |   -.064133   .5381684    -0.12   0.905    -1.118924    .9906576
    _Ifeed_5 |   .4653152    .561174     0.83   0.407    -.6345655    1.565196
      female |   1.975451   .3435221     5.75   0.000      1.30216    2.648742
     bedding |  -.9172365   .3646841    -2.52   0.012    -1.632004   -.2024689
       _cons |   109.4211   .4339193   252.17   0.000     108.5706    110.2715
-------------+----------------------------------------------------------------
    /sigma_u |   .3768825      .3059     1.23   0.218    -.2226705    .9764356
    /sigma_e |   3.802192   .1136879    33.44   0.000     3.579368    4.025016
-------------+----------------------------------------------------------------
         rho |   .0097297   .0157601                      .0002128    .1251612
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.47 Prob>=chibar2 = 0.246
```

There was no statistical difference in index between Feeds. There were, however, differences due to gender and flooring type:

	Index	P value
Gilts	111.14	0.000
Barrows	109.23	

Gilts had a significantly higher index than barrows; in this study they were 1.9 index points higher than barrows. Again, this was an expected result.

	Index	P value
Bedding	109.44	0.005
Full Slat	110.40	

The pigs raised in a deep bedding system were approximately 1 point lower in index. When the variation due to gender, pen, feed and starting weight were accounted for, the difference was statistically significant. The reason for this difference is not readily apparent, but the effect is consistent with previous studies.

Lean Yield

Parameter	Lean Yield
Feed 1	60.40
Feed 2	59.64
Feed 3	60.20
Feed 4	60.10
Feed 5	60.68

```
Random-effects ML regression                    Number of obs  =  589
Group variable (i) : tattoo                     Number of groups = 30

Random effects u_i ~ Gaussian                   Obs per group: min =        14
                                                               avg =      19.6
                                                               max =        23

                                                LR chi2(7)         =     47.53
Log likelihood  = -1474.9561                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
       yield |      Coef.   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |  -1.060334   .3875938    -2.74   0.006    -1.820004   -.3006639
    _Ifeed_3 |  -.5197243   .3841296    -1.35   0.176    -1.272605     .233156
    _Ifeed_4 |   -.487415   .3852749    -1.27   0.206     -1.24254    .2677098
    _Ifeed_5 |  -.1491092   .4078874    -0.37   0.715    -.9485539    .6503355
      female |   1.415229   .2501965     5.66   0.000     .9248529    1.905605
     bedding |  -.4899052   .2597102    -1.89   0.059    -.9989278    .0191173
      weight |  -.1560101   .0473064    -3.30   0.001    -.2487289   -.0632913
       _cons |   73.52324   4.059215    18.11   0.000     65.56732    81.47916
-------------+----------------------------------------------------------------
    /sigma_u |          0   .3482276     0.00   1.000    -.6825136    .6825136
    /sigma_e |   2.960125   .0862457    34.32   0.000     2.791087    3.129163
-------------+----------------------------------------------------------------
         rho |          0          .                               .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

Feed did not have an overall significant difference in lean yield.

	Lean Yield %	P value
Gilts	60.89	0.000
Barrows	59.62	

Gilts were much leaner than barrows; this is expected due to the gender effect.

The carcass weight also affected the lean yield in the weight range examined. The lean yield dropped by 0.16% for every kg carcass weight heavier between 80 and 95 kg. This change in lean yield was not enough to change the carcass index and so was of no financial consequence.

Backfat Depth

Parameter	Backfat
Feed 1	18.91
Feed 2	**20.26**
Feed 3	19.29
Feed 4	18.20
Feed 5	18.20

The differences in back fat appear to mirror the differences in lean yield and index. This is not surprising as both lean yield and index are highly dependent on backfat. The reason Feed 2 had a lower lean yield was due to the extra 1.5 mm of backfat present on those pigs.

```
Random-effects ML regression                    Number of obs      =       589
Group variable (i) : tattoo                     Number of groups   =        30

Random effects u_i ~ Gaussian                   Obs per group: min =        14
                                                               avg =      19.6
                                                               max =        23

                                                LR chi2(8)         =     42.14
Log likelihood  = -1640.6141                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         fat |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |   1.544898   .7183748     2.15   0.032     .1369088    2.952886
    _Ifeed_3 |   .6970033   .7135358     0.98   0.329    -.7015011    2.095508
    _Ifeed_4 |  -.6225219   .7153463    -0.87   0.384    -2.024575    .7795311
    _Ifeed_5 |  -.2869004    .735411    -0.39   0.696     -1.72828    1.154479
     bedding |   2.582667   .6698322     3.86   0.000      1.26982    3.895514
      weight |   .2267724   .0626244     3.62   0.000     .1040308    .3495139
  _Ifemale_1 |  -1.886435   .5561282    -3.39   0.001    -2.976426   -.7964437
_IfemXbedd~1 |  -1.929198   .9667923    -2.00   0.046    -3.824076   -.0343196
       _cons |  -.3877912   5.388908    -0.07   0.943    -10.94986    10.17427
-------------+----------------------------------------------------------------
    /sigma_u |   .8852653   .2318146     3.82   0.000     .4309169    1.339614
    /sigma_e |   3.851349   .1153108    33.40   0.000     3.625344    4.077354
-------------+----------------------------------------------------------------
         rho |   .0501835   .0254653                      .0167682     .122912
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    8.33 Prob>=chibar2 = 0.002
```

	Backfat (mm)	P value
Gilts	17.63	0.000
Barrows	20.20	

The gilts were 2.5 mm lower in backfat which explained the difference in lean yield and index. Gilts are expected to be leaner and have a lower backfat level. These results are very consistent with previous trials

	Backfat (mm)	P value
Bedding	19.97	0.000
Full Slat	17.77	

Pigs that grew up in the bedding portion of the barn were 2.2 mm fatter than in the slatted barn. This disparity accounts for the differences in index and lean yield, but the reason for the increased backfat is not clear. However an interaction exists between gender and bedding. This indicates the effect by gender is not equal on bedding vs slatted floor. Please see table below:

	mm Backfat	
	Slatted Floor	Bedding
Gilts	17.2	17.9
Barrows	19.1	21.6

It appears that bedding primarily makes the barrows fat, it has no significant impact on gilts.

The carcass weight had a significant effect on backfat. Back fat increased 0.2 mm for every kg of weight increase from 80 to 95kg. This effect carried through to the lean yield but not the index the pig received.

Loin Depth

Parameter	Loin Depth (mm)
Feed 1	**58.48**
Feed 2	**56.64**
Feed 3	**58.68**
Feed 4	**57.97**
Feed 5	**58.43**

```
Random-effects ML regression                    Number of obs      =       589
Group variable (i) : tattoo                     Number of groups   =        30

Random effects u_i ~ Gaussian                   Obs per group: min =        14
                                                               avg =      19.6
                                                               max =        23

                                                LR chi2(5)         =     13.12
Log likelihood  = -2082.8444                    Prob > chi2        =    0.0223

------------------------------------------------------------------------------
       lmeat |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |  -2.139092   1.084266    -1.97   0.049    -4.264213   -.0139702
    _Ifeed_3 |  -.1657742   1.077234    -0.15   0.878    -2.277113    1.945565
    _Ifeed_4 |  -.8838251   1.080642    -0.82   0.413    -3.001845    1.234195
    _Ifeed_5 |  -.4528523   1.136145    -0.40   0.690    -2.679656    1.773951
      female |   2.024786    .696466     2.91   0.004      .659738    3.389835
       _cons |   57.87183   .7995006    72.38   0.000     56.30484    59.43882
-------------+----------------------------------------------------------------
    /sigma_u |           0   .5658514     0.00   1.000    -1.109048    1.109048
    /sigma_e |   8.308672   .2420399    34.33   0.000     7.834283    8.783062
-------------+----------------------------------------------------------------
```

Loin eye size correlates poorly with index and lean yield, and as such has little financial reward under PEI marketing conditions. In other marketing systems where a premium is paid for loin size, the difference could be more financially significant. There was no significant effect on by feedchoice on loin depth

There was a difference between barrows and gilts, with gilts having a larger loin eye than barrows. This was not the case in the earlier study.

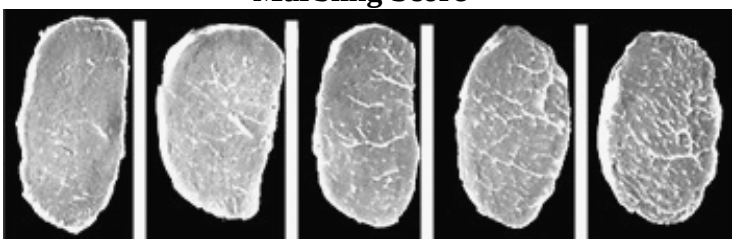
	Slatted Floor
Gilts	59.9
Barrows	57.9

Meat Quality Parameters

For this portion of the study the pork was examined 24hours after slaughter in the cutting room. The tattoo could still be read, so feed, gender, and pen could be traced. One hundred and fifty-four carcasses were examined over 3 weeks. This portion of the study had the smallest sample size, but every pen was represented and the sample size is enough to outline differences in the pork. The results are as follows.

Marbling

Marbling Score



1 2 3 4 5

	Marbling Score/loins examined
Feed 1	1.93 (32)
Feed 2	**2.45 (24)**
Feed 3	2.05 (21)
Feed 4	1.75 (20)
Feed 5	2.13 (23)

Feed 2 had the highest amount of marbling, the other feeds were the same. This is a logical observation as this was the feed that gave a higher backfat. Marbling is an expression of intramuscular fat deposition. In markets where marbling is desired, and a premium is paid for it, the above observation may be of value.

```
Random-effects ML regression                    Number of obs      =       116
Group variable (i) : tattoo                     Number of groups   =        37

Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       3.1
                                                               max =        10

                                                LR chi2(7)         =     48.01
Log likelihood  =   -113.174                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      marble |      Coef.   Std. Err.       z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |   .5591983   .1787637     3.13   0.002     .2088279    .9095687
    _Ifeed_3 |   .2311808   .1894361     1.22   0.222     -.140107    .6024687
    _Ifeed_4 |  -.3138123    .187555    -1.67   0.094    -.6814133    .0537887
    _Ifeed_5 |  -.0174937   .1860713    -0.09   0.925    -.3821867    .3471994
     bedding |  -.0891712   .1465855    -0.61   0.543    -.3764735    .1981311
        date |    .747493   .1871992     3.99   0.000     .3805894    1.114397
        temp |   -.026558   .0895346    -0.30   0.767    -.2020426    .1489267
       _cons |   .9113019   .5137313     1.77   0.076     -.095593    1.918197
-------------+----------------------------------------------------------------
    /sigma_u |          0    .178798     0.00   1.000    -.3504376    .3504376
    /sigma_e |   .6419142   .0421405    15.23   0.000     .5593203    .7245082
-------------+----------------------------------------------------------------
         rho |          0          .                               .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

Fat Firmness

Parameter	Fat firmness
Feed 1	2.71
Feed 2	2.83
Feed 3	2.90
Feed 4	2.5
Feed 5	**3.0**

Pigs fed Feeds 5 had firmer fat. This was statistically different from the other feeds. Fat firmness depends on the type of fat fed to the pigs. More highly saturated fats in the feeds will likely result in harder fat. The type of fat in the diets may have affected the meat quality. In markets like Japan, where a hard white fat is desired, this effect may be of value.

```
Random-effects ML regression                    Number of obs      =       120
Group variable (i) : tattoo                     Number of groups   =        37

Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       3.2
                                                               max =        10

                                                LR chi2(4)         =     11.17
Log likelihood  = -92.103216                    Prob > chi2        =    0.0248

------------------------------------------------------------------------------
         fat |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |   .1145833   .1407691     0.81   0.416     -.161319    .3904857
    _Ifeed_3 |   .1860119   .1464021     1.27   0.204    -.1009309    .4729547
    _Ifeed_4 |    -.21875   .1485955    -1.47   0.141    -.5099918    .0724918
    _Ifeed_5 |     .28125   .1425071     1.97   0.048     .0019413    .5605587
       _cons |    2.71875    .092155    29.50   0.000      2.53813     2.89937
-------------+----------------------------------------------------------------
    /sigma_u |          0   .0966327     0.00   1.000    -.1893966    .1893966
    /sigma_e |   .5213093   .0336501    15.49   0.000     .4553564    .5872622
-------------+----------------------------------------------------------------
         rho |          0          .                              .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

Muscle Firmness

Parameter	Muscle firmness
Feed 1	2.71
Feed 2	2.91
Feed 3	2.95
Feed 4	2.35
Feed 5	**3.17**

Feeds 5 had firmer meat than the other feeds and feed 4 had softer pork; this could be a function of the fat hardness. A certain amount of fat is in the muscle and will contribute to muscle firmness. Again, for markets like Japan where meat firmness is important, the above observations may be important.

```
Random-effects ML regression                    Number of obs      =       120
Group variable (i) : tattoo                     Number of groups   =        37

Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       3.2
                                                               max =        10

                                                LR chi2(4)         =     20.08
Log likelihood  = -111.56778                    Prob > chi2        =    0.0005

------------------------------------------------------------------------------
      muscle |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |   .1979167   .1655587     1.20   0.232    -.1265724    .5224057
    _Ifeed_3 |    .233631   .1721836     1.36   0.175    -.1038427    .5711046
    _Ifeed_4 |    -.36875   .1747633    -2.11   0.035    -.7112798   -.0262202
    _Ifeed_5 |    .455163   .1676027     2.72   0.007     .1266678    .7836583
       _cons |    2.71875   .1083836    25.08   0.000     2.506322    2.931178
-------------+----------------------------------------------------------------
    /sigma_u |          0          .        .       .            .           .
    /sigma_e |   .6131124   .0395759    15.49   0.000     .5355451    .6906797
-------------+----------------------------------------------------------------
         rho |          0          .                              .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

Meat Colour

Parameter	Light reflectance
Feed 1	54.9
Feed 2	53.1
Feed 3	52.4
Feed 4	51.9
Feed 5	51.1

Feed in this study had no effect on meat colour.

```
Random-effects ML regression                    Number of obs      =       120
Group variable (i) : tattoo                     Number of groups   =        37

Random effects u_i ~ Gaussian                   Obs per group: min =         1
                                                               avg =       3.2
                                                               max =        10

                                                LR chi2(6)         =      7.24
Log likelihood  = -383.29953                    Prob > chi2        =    0.2989

------------------------------------------------------------------------------
           l |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    _Ifeed_2 |  -1.672911   1.610625    -1.04   0.299    -4.829677    1.483856
    _Ifeed_3 |  -2.262053   1.674774    -1.35   0.177    -5.544549    1.020443
    _Ifeed_4 |  -2.908012   1.709589    -1.70   0.089    -6.258745      .44272
    _Ifeed_5 |    -3.6772   1.676391    -2.19   0.028    -6.962866   -.3915331
     bedding |   .9456729   1.269149     0.75   0.456    -1.541814     3.43316
        date |   1.049955   1.192902     0.88   0.379     -1.28809    3.388001
       _cons |   52.87567   2.342668    22.57   0.000     48.28412    57.46721
-------------+----------------------------------------------------------------
    /sigma_u |          0   1.495086     0.00   1.000    -2.930315    2.930315
    /sigma_e |   5.901604   .3809329    15.49   0.000     5.154989    6.648219
-------------+----------------------------------------------------------------
         rho |          0          .                               .           .
------------------------------------------------------------------------------
Likelihood ratio test of sigma_u=0: chibar2(01)=    0.00 Prob>=chibar2 = 1.000
```

Animal Health

The pigs in the study were from a minimal disease source, free of the major pathogens of swine but positive for *Mycoplasma hyopneumoniae*. There were no animal health differences noted in this study that could be significantly attributable to the feeds. A breakdown of the health parameters is as follows:

	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Treated and removed to sick pen	3	3	3	4	4
Died	11	8	5	6	9
Treated and deaths combined	14	11	8	10	13
Remained on trial	134	137	140	138	135

The APHIN health data gave the following information:

APHIN Data	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Number of lungs and Livers examined	16	17	17	20	29
Lung with pneumonia	4 (25%)	2(12%)	5(29%)	6(30%)	14(48%)
Livers with Spots	0	0	0	0	0
Lungs with adhesions	2(12%)	2(12%)	1(6%)	2(10%)	7(24%)

Conclusions

- The pigs grew consistently enough to meet marketing and packer needs with all the feeds.
- Pigs fed Feed 5 grew about 5 % slower than on the other feeds. This difference was statistically significant.
- All the pigs grew slower than in previous studies. The barn in this fill was positive for *Mycoplasma hyopneumoniae*, which may have reduced overall barn performance.
- Mash feeds tended to be less expensive, but had a poorer feed conversion
- All the feeds had profitability margins within 3% of each other in this barn and fill of pigs.
- The gilts appeared to grow slower than the barrows by about 6%.
- It appears that feed choice can impact the gilt and barrows differently.
    - Feeds 1 and 2 had the greatest difference in performance between gilts and barrows
    - Feed 3 optimized the gilt performance without loss of barrow performance.
    - Feed 5 had normal gilt performance, but had slowest barrow growth. This resulted in the slower growth overall.
- There was no difference in growth rate between the pigs in the bedded section or the slatted floor portion of the barn. however pigs on feed 4 did grow better on the bedding in this fill.
- Feeds 1 and 2 had a lower risk of barrows being shipped light than the other feeds
- Feed 3 had fewer light gilts than the others, other feeds had an equal risk of having light gilts
- Feed 5 had a higher risk light pigs at market overall compared to Feeds 2 and Feeds 3, and almost statistically different than the other feeds.
- Starting weight of the pigs had a significant effect on growth. Larger pigs at the start of the study, which likely had a superior growth rate from birth on, maintained that advantage through to market weight.
- There were significant differences in meat quality. Pigs fed Feed 2 had more backfat and marbling.
- Feed 5 produced pigs whose fat and pork were firmer than the other feeds
- While pigs raised on bedding tend to be fatter. It appears that only happened to the barrows, it had no significant impact on gilts
- There were no differences in loin depth associated with feed choice, bedding or gender. The loin depth was lower than in other fills which may be associated with the lower growth rate observed in this fill
- Feed had no effect on meat colour, or carcass index .