Effect of using heavier carcass weight in Canadian purebred pigs

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Abstract

There is a need to increase the slaughter weight as required by some packing plants. It is therefore important to know how this will affect the efficiency of production and quality of the pork. A study was therefore conducted to evaluate the effect of increasing slaughter weight on various performance traits such as growth, feed efficiency, carcass characteristics and meat quality. Two batches of purebred pigs consisting of Duroc, Lacombe, Yorkshire and landrace pigs were tested at the Deschambault test station of CDPQ, Quebec. A total of 520 pigs from 27 participating breeders from across Canada were received at the test station. Out of them 445 pigs completed the entire test duration. The pigs were divided into two slaughter groups: Current slaughter weight (about 107 kg) and heavier slaughter weight (about 125kg). There were significant increases in the hot carcass weight (16kg) and in the total feed intake (61.4 kg) to achieve the higher slaughter weight. The increase in live weight was 17% while the increase in feed intake was 32%. The feed conversion rate during the later part of growth (75 to slaughter weight) increased from 2.78 to 2.97 suggesting especially poor feed conversion for the extra live weight. The backfat thickness measured with Destron probe increased by 1.8 mm (11%) while the muscle depth increased by 2.2 mm (3.6%). There was some disproportionate muscle deposition in the primal cuts being higher in the loin than in the leg. There was no significant effect on most of the meat quality traits.

Considering the Québec payment grid as an example, it is estimated that increasing the slaughter weight from 107 to 125kg would lead to $3.25 less revenue per hog if we consider the difference between hog sales and production costs. The loss could have been $23.83 considering the payment grid at the time of the test.

1. Introduction

There has been increased demand from the packing industry for a higher carcass weight in the pork production sector, with more and more incentives coming from some of the new grading grids put in place in the past year across the country. This can be a challenging issue as increasing weight could have unfavorable consequences on muscle quality, fat deposition, feed efficiency, etc. This issue has been investigated in many countries for several years, since this trend in increasing slaughter weight exists almost everywhere and required cost-efficiency analyses in different production systems (BPEX, 2002; Aubry 2004; Minvielle et al, 2003; Latorre et al, 2004; Cisneros, 1996; ACMC, 2005). In Europe, where castration is not used in all countries, there were also concerns expressed about the possible increase in boar taint in the meat, which might be off-putting the consumers (Allen et al, 2001; Lawlor, 2004).
Commercial tests were carried out at Deschambault test station in 2002 (tests #14 and 15), giving background information about what to expect in commercial hogs. It was shown that increasing slaughter weight from 107 kg to 115 or 125 kg did not affect growth rate, lean/fat ratio or meat quality, but led to lower feed efficiency and higher carcass yield.

In 2004 and 2005, purebred pigs from the Canadian Swine Improvement Program were tested at the Deschambault station in Quebec, to study the impact of increasing slaughter weight on traits of growth, feed conversion, carcass and meat quality.

2. Material and methods

2.1. Animals

Two batches of pigs were tested at the test station of the Centre de Développement du Porc du Quebec in Deschambault. In total, 516 purebred piglets were sent by 27 breeders from across Canada. Table 1 shows the numbers of pigs received and processed through the different stages of the test. In total, 426 pigs of 3 different breeds had performances recorded from nursery to slaughterhouse. Within each breed, there was a balanced number of females, intact males and castrates.

Table 1 – Number of pigs received and tested

	Duroc	Landrace	Yorkshire	**All breeds**
First batch (Test #17)				
# piglets received	74	66	142	**282**
# pigs starting test	69	65	130	**264**
# pigs at the end of the test	64	63	118	**245**
# pigs with carcass data	63	61	118	**242**
# pigs with meat quality data	61	60	116	**237**
Second batch (Test #18)				
# piglets received	42	78	114	**232**
# pigs starting test	37	63	102	**202**
# pigs at the end of the test	34	63	102	**199**
# pigs with carcass data	34	62	102	**198**
# pigs with meat quality data	31	60	98	**189**
Total pigs received	116	144	256	**516**

2.2. Data recorded

Pigs were received at about 10 days of age at the station. After a period in nursery, they entered the testing barn at about 30 kg live weight. They were individually identified with an electronic tag used to monitor their feed intake in the electronic feed dispensers. Pigs were grouped by sex within pen, and divided into two groups of equal size. One group was slaughtered at about 107kg live weight and the other around 125kg. The list of all traits measured on the pigs since their arrival at the station to the day after slaughter is given in Appendix 1.

2.3. Statistical model

The data were analyzed with the mixed model procedure of SAS (2000). The effects used in the model were the fixed effects of breed, sex, slaughter group and their interactions, and the random effects of sire and dam within breed, pen within sex and pen within slaughter group. For meat quality traits, the fixed effect of slaughter day was added to the model.

3. Results and discussion

The main results on growth, feed consumption and conversion, fat and lean depths, carcass and meat quality traits are presented in the following section, with an emphasis on the effect of a standard (107kg) versus higher (125kg) live weight at slaughter. Detailed results by breed and sex are also shown in Appendix 2.

3.1. Growth

Table 2 shows the least square means for the main growth performances. As expected, significant differences were found for final weight, with a difference of 18 kg between the standard and heavier groups, as targeted in the project. On average, pigs slaughtered at a heavier weight were 19 days older than the other group. There was no significant difference on overall growth rate or growth rate on different periods between both groups. These results are consistent with what was observed on crossbred pigs at Deschambault previously. Several authors (Latorre et al, 2004; Cisnero et al, 1996) found a decrease in ADG with increasing slaughter weight, while in this study only a trend was observed.

Table 2 – Effect of higher slaughter weight on growth traits – Least-squares means.

	Slaughter weight group		Difference	
Trait	107 kg	125 kg	(%)	Signif
Initial weight (kg)	27.2	27.3	+0.4%	NS
Final weight (kg)	**106.5**	**124.8**	**+17.2%**	*****
Final age (d)	**156**	**174**	**+11.5%**	*****
Days on test (d)	**82**	**99**	**+20.7%**	*****
ADG (g/day)	919.8	929.2	+1.0%	NS
ADG 30-50 kg (g/d)	903.5	913.8	+1.1%	NS
ADG 50-75 kg (g/d)	894.4	906.1	+1.3%	NS
ADG 75-end kg (g/d)	994.7	969.6	-2.5%	NS

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

3.2. Feed consumption and feed conversion

As shown in Table 3, pigs slaughtered at a heavier slaughter weight required on average 61.4kg more feed (+31.7%) to reach 125kg live weight. Their average daily feed intake was significantly higher on the overall period, due to the extra time in fattening units, and a higher feed conversion ratio in the last phase of growth (from 75kg till slaughter). Average daily feed intake by period was not significantly different between groups, but overall average daily feed intake was higher (+160g) for the heavier group. This is in line with results from most studies (Cisnero et al, 1996; Aubry, 2004, Lawlor, 2004), except for Latorre et al (2004), where no change in ADFI was found when slaughter weight increased. The poorer feed efficiency in late finishing phase is related to the fact that as pigs get older they start to lay down more fat and less lean. Fat deposition is more costly in energy, which might explain both higher feed intake and higher FCR to maintain a constant growth rate.

Table 3 – Effect of higher slaughter weight on feed consumption and feed conversion ratio – Least-squares means.

Trait	Slaughter weight group		Difference (%)	Signif
	107 kg	125 kg		
Total feed intake (kg)	**193.3**	**254.7**	**+31.7%**	***
Average daily feed intake (kg/j)	**2.28**	**2.44**	**+7.0%**	**
Food conversion ratio (kg/kg)	**2.39**	**2.57**	**+7.5%**	**
Average daily feed intake 30-50 kg (kg/d)	1.70	1.73	+1.8%	NS
Average daily feed intake 50-75 kg (kg/d)	2.34	2.40	+2.6%	NS
Average daily feed intake 75-end (kg/d)	2.70	2.85	+5.6%	NS
FCR 30-50 kg (kg/kg)	1.84	1.88	+2.2%	NS
FCR 50-75 kg (kg/kg)	2.43	2.47	+1.6%	NS
FCR 75-end (kg/kg)	**2.78**	**2.97**	**+6.8%**	*

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

3.3. Probe measurements

During the testing period, repeated weighing and probing were performed on all pigs at about 50kg live weight, and every two weeks from 75kg till slaughter. Performances around 50kg, 75kg and at the end of test are presented in table 4. As expected, there is a significant difference for the weight at the last probing between both groups (105.7kg vs 122.7kg live weight) as well as for backfat thickness at the last probing. There was about 4 mm (+29.8%) more fat for heavier pigs. The difference found for backfat at the second feed change (around 75kg), is probably due to sampling. No significant difference was found in lean depth, although there is a trend for higher lean depth in heavier pigs. This illustrates the fact that here is a change in the fat/lean ratio deposition in heavier pigs. This has been well documented earlier, with studies about the changes in growth and maintenance requirements as pigs become more mature. There are also strong sex effects for these traits (see Appendix 2), suggesting a potential role of sexual hormones in this process.

Table 4 – Effects of higher slaughter weight on fat and lean depths – Least-squares means

Trait	Slaughter weight group		Difference (%)	Signif
	107 kg	125 kg		
Initial weight (kg)	27.2	27.3	+0.3%	NS
Weight at first feed change (kg)	50.7	51.9	+2.4%	NS
Weight at second feed change (kg)	78.6	78.9	+0.4%	NS
Weight at last probing (kg)	**105.7**	**122.7**	**+16.1%**	***
Backfat at first feed change (mm)	8.8	9.4	+6.4%	NS
Backfat at second feed change (mm)	**10.9**	**12.7**	**+16.5%**	*
Backfat at last probing (mm)	**14.1**	**18.3**	**+29.8%**	***
Muscle depth at first feed change (mm)	45.4	45.7	+0.7%	NS
Muscle depth at second feed change (mm)	53.7	52.7	-1.9%	NS
Muscle depth at last probing (mm)	61.2	62.9	+2.8%	NS

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

3.4. Carcass traits

Table 5 shows statistics about the main carcass traits measured in this project. Significant differences were found for all carcass traits measured in the project, except for loin eye area. Pigs in the heavier slaughter weight group have a carcass which is about 15.7 kg heavier and 4.1 cm longer. Their carcass dressing yield was 1.6% higher due to higher slaughter weight, but lean yield was slightly lower, as a consequence of a higher backfat (+1.82mm) and in spite of a higher lean depth (+2.15mm). However let us keep in mind that the heavier slaughter weight group was a bit fatter on average (see Table 4).

Table 5 – Effects of heavier slaughter weight on carcass traits – Least-squares means

	Slaughter weight group		Difference	
Trait	107 kg	125 kg	(%)	Signif
Hot carcass weight (kg)	**83.2**	**98.9**	**+18.9%**	***
Length (cm)	**80.9**	**85.0**	**+4.8%**	***
Carcass Yield (%)	**78.0**	**79.3**	**+1.6%**	*
Backfat Destron (mm)	**15.98**	**17.80**	**+11.4%**	***
Muscle Destron (mm)	**60.32**	**62.47**	**+3.6%**	*
Lean Yield (%)	**61.8**	**61.1**	**-1.1%**	**
Loin eye area (cm^2)	44.44	46.68	+5.0%	NS
Average grading index	**110.6**	**100.8**	**-8.9%**	***

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

These results are in agreement with live measurements presented in Table 4, an with what was found on commercial pigs at Deschambault station previously, except for loin eye area which was significantly increasing with slaughter weight, whereas we have only a trend here.

3.5. Primal cuts

As shown previously, higher carcasses lead to higher dressing percentage but lower lean yield. It is interesting to look how the different parts of the carcass behave when carcass weight increases. Table 6 presents the weight and proportion of leg, loin, shoulder and belly in the carcass in both slaughter groups. The proportion of leg is lower (-5.1%) and the proportion of loin is higher (+5.4%) as carcass weight increases. The proportion of shoulder tends to be higher, and the proportion of belly tends to be lower, but the differences were not significant. Results for leg, loin and shoulder yields are consistent with what was reported by Latorre on Spanish pigs slaughtered at 116, 124 or 133 kg, and by Cisneros et al (1996).

Table 6 – Effect of heavier slaughter weight on the weight of primal cuts and their proportion in the carcass – Least-squares means

	Slaughter weight group		Difference	
Trait	107 kg	125 kg	(%)	Signif
Half-carcass weight (kg)	**36.30**	**42.75**	**+17.8%**	***
Weight of leg (kg)	**9.96**	**11.09**	**+11.3%**	***
Weight of loin (kg)	**9.35**	**11.60**	**+16.5%**	***
Weight of shoulder (kg)	**10.60**	**12.22**	**+15.3%**	***
Weight of belly (kg)	**6.41**	**7.81**	**+21.8%**	***
% Leg in half-carcass (%)	**27.4**	**26.0**	**-5.1%**	***
% Loin in half-carcass (%)	**25.7**	**27.1**	**+5.4%**	**
% Shoulder in half-carcass (%)	29.2	28.7	-1.7%	NS
% Belly in half-carcass (%)	17.7	18.2	+2.8%	NS

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

3.6. Meat quality (loin and ham)

The only significant effect of a higher slaughter weight on meat quality was the one on drip loss in the loin, in favour of the higher weight class. There is also a trend for darker colour and higher marbling in the loin for higher slaughter weights. In the literature, the effects of slaughter weight on meat quality traits are very variable, with many authors reporting higher marbling and lower tenderness, but conflicting results on other traits, which might come from different breeds or lines used in research projects. In our study, there were significant interactions between breed and slaughter weight for meat quality traits, especially on drip loss and marbling. Duroc was found very different from the white breeds on these traits.

Table 7 – Effect of heavier slaughter weight on meat quality of the loin and ham – Least-squares means

Trait	Slaughter weight group		Difference (%)	Signif
	107 kg	125 kg		
Loin quality				
Ultimate pH	5.57	5.61	+0.7%	NS
Reflectance (Minolta L*)	52.57	51.27	-2.5%	NS
Color (Japanese scale)	2.45	2.67	+9.0%	NS
NPPC Marbling	1.91	2.10	+9.9%	NS
Drips loss (%)	**5.84**	**4.47**	**-23.5%**	*****
Ham quality				
Ultimate pH	5.57	5.60	+0.5%	NS
Reflectance (Minolta L*)	49.57	49.79	+0.4%	NS
Color (Japanese scale)	2.90	2.81	-3.1%	NS
Technol. yield (%)	127.61	127.18	-0.3%	NS

*NS=No significance; *=P<0.05; **=P<0.01; ***=P<0.001*

3.7. Cost/revenue analysis

Given the results found for the effect of slaughter weight on different traits economically important such as feed efficiency, feed intake and carcass traits, it was interesting to look at an approximate cost efficiency analysis in order to know whether increasing slaughter weight to 125kg is a viable option. Our sample was composed only with purebred pigs, from which more than 75% were from white breeds and about one third were intact males, so it is not representative of a commercial situation, but it can still provide some valuable comparison elements. Slaughter data collected in this project was loaded into the PigGrid tool on CCSI website, in order to visualize hogs' distribution in the grid, and calculate revenue from the slaughter pigs. Table 8 shows a summary of this information, using Quebec previous and current grids (when these pigs were slaughtered, the new grid was not in place yet). Feed costs and overhead costs are also included in the analysis, in order to compute estimated profits per hog. The cost of producing the weaned pig from the breeding herd is assumed to be the same.

Table 8.- Feed costs and other costs vs value of slaughter pigs – Deschambault tests #17-18

	Quebec old grid		Quebec new grid		OlyWest grid	
	107kg	125 kg	107kg	125kg	107kg	125kg
1. Feed cost/pig* (30kg to slaughter)	$48.33	$63.68	$48.33	$63.68	$48.33	$63.68
2. Other costs **	$22.14	$26.73	$22.14	$26.73	$22.14	$26.73
3. Slaughter value/hog***	$138.49	$134.60	$137.20	$153.89	$136.30	$159.24
Change in margin/hog (hogs sales–costs) when switching from 107 to 125kg	-$23.83		-$3.25		+$3.00	

** assuming feed price = $250/tonne; ** assuming housing costs and care = $0.27/pig/day;*
**** computed from real commercial value of this group of pigs in PigGrid*

Table 8 shows that using the old grid system, pigs in the lighter weight group had a higher slaughter value than the heavier group, because most heavy pigs (>95kg carcass) fall into 92 or 96 index classes. With the new Quebec grid, heavy pigs are much less penalized compared to earlier, and get a much higher slaughter value on average, despite they have a poorer index on average (104 vs 109). However, even with a better commercial value, in the new grid system, 125 kg pigs cost $3.25/pig to be produced, because of extra feed and housing costs.
This analysis was done on a limited number of pigs, with strong assumptions on feed costs, hog prices and overhead costs. Moreover it is obvious from Table 8 that the grading grid has a huge impact on the comparison of these two samples.

4. Conclusions

From this analysis, it appears that increasing slaughter weight from 107 to 125kg has a significant effect at several levels of pig performance during growth and at the slaughterhouse. Feed conversion ratio increases at the end of the finishing period for pigs slaughtered at a heavier weight. At the carcass level, pigs slaughtered at the heavier weight have a higher dressing percentage, backfat and lean depth, as shown in several previous studies, but a lower lean yield than pigs slaughtered around 107kg. There was very little effect of higher slaughter weight on loin and ham meat quality, except trends on drip loss, marbling and color favourable to higher weights.
These results are in agreement with most of the studies where slaughter weight was increased to a value as high as 125kg, including previous Deschambault projects on crossbred pigs, however the effects on some traits (especially growth and meat quality) seem to depend on sexes and breeds/breed crosses tested. In this study, the sample of pigs used is not representative of commercials hogs since it is composed of only purebreds, including three quarters of white breeds, and one third of intact males. But it gives an idea about how improved genetics behave at heavier weights, keeping the same feed and management conditions.
A cost benefit analysis is necessary in any case in order to evaluate the interest of increasing slaughter weight, however other aspects have to be considered, such as the need for additional space, potential changes in facilities, need for adapting feed formulation in late finishing, grading grid in place, etc.

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APPENDIX 1

DEFINITION OF VARIABLES

Variables	Abbreviations (units)	Description
Nursery – Growth performance		
Initial age	*IAN (d)*	Age when entering the station
Final Age	*FAN (d)*	Age at the end of the adaptation period (nursery)
Duration	*DURN (d)*	Difference between final date of the adaptation period and admission date
Initial weight	*IWN (kg)*	Weight when entering the station
Final weigh	*FWN (kg)*	Weight at the end of the adaptation period
Average daily gain	*ADGN (g/d)*	For the total period and for each feeding period
Daily feed intake*	*DFIN (g/d)*	Daily feed intake per pig For the total period and for each feeding period
Total feed intake per piglet*	*TFIN (g/piglet)*	Total feed intake per pig For the total period and for each feeding period
Feed efficiency (for live animal weight gain)*	FEN (live weight gain)	Feed intake for all the pigs / Total live weight gain of all the pigs For the total period and for each feeding pedriod

Test period – growth performance		
Age at beginning of test	*IAT(d)*	Age at beginning of test
Age at end of test	*FAT (d)*	Age on slaughterhouse shipment day, before starving
Duration of test	*DURT (d)*	Difference between date of end of test and date of beginning of test
Weight at beginning of test	*IWT (kg)*	Weight at beginning of test
Weight at end of test	*FWT (kg)*	Weight on slaughterhouse shipment day, before starving phase
Average daily gain	*ADGT (kg/d)*	Final weight – Initial weight / number of days pig stayed in station For the total period and for each feeding phase
Repeated measurements		
Backfat thickness	*BFT (mm)*	Measurement of back fat between 3rd and 4th last ribs on live animals Frequency: at 50 kg, 75 kg, and every other week after 75 kg until slaughtering. Instruments: A mode and B mode Operators: at least two operators for each instrument.
Loin depth	*LD (mm)*	Measurement of loin depth between 3rd and 4th last ribs on live animals Frequency: at 50 kg, 75 kg, and every other week after 75 kg until slaughtering. Instruments: A mode and B mode Operators : at least two operators for each instrument.
Intramuscular fat	%IMF	Measurement of intramuscular fat content using a mode B ultrasonic equipment
Loin eye area	LEA	Measurement of loin area using a mode B with a transversal measurement.
Feed intake performance		
Total feed intake per pig	*TFI (kg)*	Total feed intake of pig during test
Daily feed intake per pig	*DFI (kg/d)*	Total feed intake of pig during test / duration of test For the total period and for each feeding phase
Feed efficiency (on live animal weight gain)	FE (kg/kg)	Feed intake of pig / weight gain (live weight) For the total period and for each feeding phase

Carcass traits		
Hot carcass weight	*HCW (kg)*	Hot carcass weight after exsanguination and evisceration, including the head, tongue, leaf fat, kidneys, and front and hind feet
Carcass yield	*CY (%)*	(Hot carcass weight / live weight at end of test) x 100
Classification index	*Average index*	Index calculated from the carcass sorting grid
Classification Index 80-91,9 kg	*Index 80 – 91.9 kg*	Index defined for this weight range
% pigs in the 80-91.9 kg range	*% pigs 80-91.9 kg*	% pigs in this weight range
Classification Index 80 – 84,9 kg	80 - 84,9 kg Index	Index defined for this weight range
Classification Index 85 – 91,9 kg	85 - 91,9 kg Index	Index defined for this weight range
Lean yield	*LY (%)*	Lean yield of the carcass calculated from the prediction equation established by Agriculture and Agri-Food Canada
Carcass length	CL (cm)	Measured on the cold carcass, from the cranium edge of the first rib to the anterior tip of the aitchbone (using a Foster Gauge ruler)
Fat thickness - ruler		Measurement taken on the loin, after cutting, between 3rd and 4th last ribs
Muscle thickness - ruler		Measurement taken on the loin, after cutting, between 3rd and 4th last ribs

* Feed intake in the nursery section is measured for all the pigs and not on an individual basis.

Variables	Abbreviations (units)	Description
Primary carcass cut		
Half-carcass weight	HCW (kg)	Half-carcass weight calculated from the 5 primary cuts and of other parts (jowl, tail, hock, front and back feet), without adding weight of leaf fat, kidney, or head. The weights of the jowl, tail and the front and back feet are subtracted.
Loin eye area	*LEA (cm²)*	Surface measured with a planimeter
Weight of ham	*HAMW (kg)*	Cut perpendicular to the lower part of the leg. Cut line 4.5 cm (1 ¾ in.) from the internal apex of the pubian bone. Without rear foot or tail.
Weight of loin	*LOINW (kg)*	The loin is separated from the belly by sawing along a line starting 4.5 cm (1 ¾ in.) from the base of the ribs, reaching 10 cm (4 in.) out at the middle of the loin and ending parallel to the tenderloin at the top of the leg, at a distance of 2 cm (3/4 in.).
Weight of shoulder	*SHW (kg)*	To be measured as the primal-cut shoulder (bone in, skin and fat on). Shoulder is removed by cutting at right angles to the back through the joint between the 3rd and 4th thoracic vertebrae.
Weight of hock	*HOW (kg)*	Withdrawn by making a cut parallel to the top of the belly side of the shoulder at the centre of the joint to expose the figure of 8 bone. The front foot is cut away through the middle of the joint.
Weight of picnic ham	*PICW (kg)*	Anterior part of the shoulder. The shoulder is cut away from the loin and the belly along a line perpendicular to the back. The shoulder is then separated in two parts by cutting 2 cm (3/4 in.) away from the backbone. Without hock or front foot.
Weight of shoulder butt	SHBW (kg)	Dorsal part of the shoulder. Without jowl.
Weight of belly	*BEW (kg)*	Same description as for loin.
% of ham weight in the half carcass	*HAM% (%)*	(Weight of leg / weight of ½ carcass) x 100
% of loin weight in the half carcass	*LOIN% (%)*	(Weight of loin / weight of ½ carcass) x 100
% of shoulder weight in the half carcass	*SH% (%)*	(Weight of shoulder/ weight of ½ carcass) x 100
% of belly weight in the half carcass	*BE% (%)*	(Weight of belly / weight of ½ carcass) x 100

Variables	Abbreviations (units)	Description
Meat quality traits		
Loin: measured on longissimus dorsi *between the 3rd and 4th last ribs, 18 to 24 hours after slaughtering*		
Ham: measured on different muscles, 18 to 24 hours after slaughtering		
Ultimate pH (loin and ham)	pHu	Measured at two points in the loin muscle using a pH meter. The ham measurement is taken at the level of the *gluteus superficialis* muscle.
Minolta color (loin and ham)	*L*, a*, b**	Measurement of the reflectance taken at two points in the loin muscle using a Minolta 300CR instrument. The ham measurement is taken at the level of the *gluteus superficialis* muscle.

Visual evaluation of the colour (loin and ham)	*COL*	Evaluation by comparing to colour spots of the Japanese scale (from 1 to 16). For the ham, this evaluation is carried out in *gluteus superficialis* muscle.
Visual evaluation of intramuscular fat in the loin	*MARB*	Measurement of the amount of marbling according to the scale (from a to e) defined by Agriculture and Agri-Food Canada and/or the NPPC scale (from 1 to 10).
Loin Drip loss	*LDL (%)*	Measurement taken on a sample of muscle from the front part of the loin, after letting it drip 24 to 48 hours. (Drip loss of the muscle / weight of the fresh muscle) x 100
Ham technological yield	*HTY (%)*	Estimated from a prediction equation using variables describing the colour and reflectance (L*, a* and b*) of the ham muscles. Measurements made on *gluteus superficialis* and *gluteus profondus* muscles.

Evaluation of loin muscular fibres	Number, size, type	Histochemical evaluation of the number, size and type of muscular fibres (cost to be defined)
Visual evaluation of steatosis in leg	*STEAT*	Measurement of the degree of steatosis using the CDPQ scale (from 0 to 5) conducted inside the leg at the level of the *semi-membranous*, *semi-tendinous* muscles and of *biceps femoris* (cost to be defined)
Evaluation of fat content	*FA (%)*	Evaluation of the fatty acid profile of sub-cutaneous fat, using solvent extraction and gas chromatography (cost to be defined)

Halothane genotype		Analysis carried out on a blood sample
RN genotype		Analysis carried out on a blood sample

Analysis of meat quality : sample of 108 pigs (12 pigs per breed and sex for the slaughtering weight of 107 kg)

Number, size and type of fibres (loin)
Enzymatic activity (loin)
Glycolytic potential (loin)
Total soluble protein*
Muscle composition (loin)*
Shear force*
Micro-ham (semi-tendineux)

* these measurements will be done for both slaughtering weights (107 and 125 kg)

Evaluation of fat tissue quality	Fatty acids (%)	Measurement of fatty acid composition of back fat after solvent extraction and chromatography

Variance analysis on test#17 and #18 data (lsmeans)

Appendix 2

	Breed				Sex				Slaughter weight			Pvalues Interactions			
	DDDD	LLLL	YYYY	Pvalue	C	F	M	Pvalue	107 kg	125 kg	Pvalue	B x S	B x Weight	S x Weight	B x S x Weight
Growth															
Final age (d)	165.00	160.65	164.90	0.662	156.49	161.13	157.63	0.197	155.56	174.18	**0.000**	0.260	0.602	0.608	0.436
Days on test (d)	95.87	97.84	90.45	0.073	92.43	92.86	97.15	0.509	81.48	98.74	**0.000**	0.084	**0.028**	0.625	0.369
Initial weight (kg)	28.27	28.99	27.42	0.140	29.23	29.43	27.67	0.886	27.20	27.28	0.958	0.620	**0.010**	0.687	0.206
Final weight (kg)	114.54	115.50	115.24	0.559	115.32	115.56	114.61	0.912	106.53	124.75	**0.000**	0.510	0.270	0.962	0.443
ADG (g/day)	966.78	926.68	928.41	0.527	965.42	914.56	959.68	**0.028**	919.82	929.24	0.729	0.114	0.934	0.690	0.326
Final backfat (mm)	14.70	15.54	14.89	**0.047**	17.95	17.09	13.63	**0.000**	14.11	18.33	**0.000**	**0.011**	**0.004**	0.119	0.098
Final lean depth (mm)	63.40	62.09	61.80	0.051	61.28	63.69	61.20	0.131	61.21	62.91	0.250	0.808	0.783	0.106	**0.004**
Feed consumption															
Total feed intake (kg)	211.62	224.65	220.53	0.673	229.74	222.24	206.49	**0.005**	193.31	254.66	<.0001	0.977	0.192	0.524	0.507
Feed intake/day (kg/j)	2.25	2.32	2.26	0.534	2.44	2.31	2.13	**0.009**	2.28	2.44	**0.031**	0.508	0.120	0.833	0.440
FCR	2.51	2.49	2.47	0.721	2.56	2.53	2.37	**0.000**	2.39	2.57	**0.001**	**0.020**	0.540	0.846	0.402
Carcass traits															
Hot carcass weight (kg)	90.78	90.46	90.64	0.822	91.63	92.14	90.07	0.211	83.16	98.93	<.0001	0.708	0.202	0.970	0.370
Carcass Yield (%)	79.13	78.37	78.68	0.078	79.03	80.57	77.36	<.0001	78.04	79.34	**0.017**	0.186	0.372	0.935	0.656
Backfat Destron (mm)	17.11	17.32	16.24	0.210	19.02	16.51	15.13	**0.000**	15.98	17.80	**0.000**	0.465	0.510	0.832	0.116
Muscle Destron (mm)	61.16	61.53	61.500	0.926	60.57	63.07	60.55	**0.008**	60.32	62.47	**0.019**	0.534	0.482	0.958	0.472
Lean Yield (%)	61.34	61.26	61.78	0.192	60.43	61.69	62.25	<.0001	61.83	61.09	**0.002**	0.510	0.318	0.877	0.127
Average grading index	106.14	104.66	106.32	0.148	104.16	106.51	106.45	**0.048**	110.56	100.84	<.0001	0.796	0.303	0.563	0.494
Length (cm)	81.96	83.88	83.47	0.097	82.36	82.95	83.74	0.116	80.93	84.98	**0.000**	0.595	0.865	0.971	**0.026**

Variance analysis on test#17 and #18 data (lsmeans)

Appendix 2

	Breed				Sex				Slaughter weight			Pvalues Interactions			
	DDDD	LLLL	YYYY	Pvalue	C	F	M	Pvalue	107 kg	125 kg	Pvalue	B x S	B x Weight	S x Weight	B x S x Weight
Weights and depths															
Initial weight (kg)	28.27	27.17	28.61	0.140	29.23	29.43	27.67	0.886	27.20	27.28	0.958	0.620	**0.010**	0.687	0.206
Weight at first feed change (kg)	52.36	54.14	51.98	0.505	55.95	50.55	54.97	0.772	50.68	51.94	0.564	0.256	**0.039**	0.538	0.164
Weight at 2nd feed change (kg)	76.05	74.34	78.47	**0.003**	80.58	76.73	74.77	0.570	78.60	78.88	0.926	0.527	**0.010**	0.798	0.512
Final weight (kg)	116.28	113.62	115.24	0.895	115.32	115.56	116.04	0.929	105.71	122.65	**0.000**	0.514	0.719	0.898	0.156
Backfat 50 kg (mm)	9.28	7.76	8.73	0.131	9.39	8.48	7.88	0.299	8.77	9.41	0.272	0.109	**0.035**	0.645	0.471
Backfat 75 kg (mm)	10.50	10.69	10.47	0.110	12.36	11.85	10.47	**0.008**	10.92	12.73	**0.015**	0.194	**0.040**	0.876	0.462
Final Backfat (mm)	14.72	15.54	14.54	**0.047**	17.95	17.09	13.90	**0.000**	14.11	18.33	**0.000**	**0.011**	**0.004**	0.119	0.098
Muscle depth 50 kg (mm)	45.15	44.68	43.24	**0.000**	44.52	45.87	42.65	0.344	45.41	45.73	0.808	0.404	0.443	0.516	**0.029**
Muscle depth 75 kg (mm)	53.33	51.06	50.91	**0.002**	53.61	51.79	51.93	0.472	53.68	52.66	0.538	0.613	0.730	0.721	0.062
Final muscle depth (mm)	63.40	62.09	61.80	0.051	60.63	63.69	60.60	0.131	61.21	62.91	0.250	0.808	0.783	0.106	**0.004**
Performances per period															
Average daily feed intake 30-50 kg (kg/d)	1.84	1.57	1.62	**0.021**	1.68	1.62	1.49	0.132	1.70	1.73	0.709	0.184	0.054	0.507	0.735
Average daily feed intake 50-75 kg (kg/d)	2.18	2.32	2.22	0.394	2.39	2.27	2.07	**0.015**	2.34	2.40	0.580	0.242	0.339	0.753	0.421
Average daily feed intake 75-fin kg (kg/d)	2.70	2.70	2.71	0.792	2.98	2.63	2.56	**0.020**	2.70	2.85	0.163	0.954	0.466	0.586	0.586
ADG 30-50 kg (g/d)	855.11	882.18	866.93	0.064	905.07	893.99	831.27	0.339	903.49	913.80	0.791	0.281	0.524	0.245	0.529
ADG 50-75 kg (g/d)	900.94	883.69	911.98	0.593	949.14	843.27	908.31	0.060	894.40	906.07	0.781	0.386	0.491	0.336	0.251
ADG 75-fin kg (g/d)	992.38	943.27	983.03	0.766	1021.42	936.77	977.28	0.239	994.69	969.57	0.531	0.436	0.893	0.876	0.881
FCR 30-50 kg	1.90	1.85	1.88	0.387	1.86	1.92	1.80	0.073	1.84	1.88	0.464	0.509	0.533	0.799	0.794
FCR 50-75 kg	2.45	2.48	2.43	0.801	2.55	2.54	2.30	**0.006**	2.43	2.47	0.630	0.269	0.439	0.629	0.064
FCR 75-end kg	2.84	2.90	2.89	0.661	3.03	2.87	2.72	**0.007**	2.78	2.97	**0.047**	0.242	0.332	0.814	0.851

Variance analysis on test#17 and #18 data (lsmeans)

Appendix 2

	Breed				Sex				Slaughter weight			Pvalues Interactions			
	DDDD	LLLL	YYYY	Pvalue	C	F	M	Pvalue	107 kg	125 kg	Pvalue	B x S	B x Weight	S x Weight	B x S x Weight
Primal Cuts															
Half-carcass (kg)	39.40	39.15	39.53	0.983	39.75	39.66	38.67	**0.023**	36.30	42.75	**0.000**	0.870	0.445	0.964	0.354
Loin eye area (cm²)	46.02	44.94	46.69	0.227	44.34	48.21	45.03	**0.000**	44.44	46.68	0.109	0.689	0.325	0.627	0.468
Leg (kg)	10.68	10.28	10.51	0.196	10.57	10.66	10.22	**0.006**	9.96	11.09	**0.000**	0.307	0.080	0.781	0.382
Loin (kg)	10.23	10.65	10.53	0.060	10.60	10.81	10.01	**0.009**	9.35	11.60	**0.000**	0.578	0.440	0.394	0.339
Shoulder (kg)	11.46	11.13	11.35	0.174	11.36	11.09	11.67	**0.024**	10.60	12.22	**0.000**	0.341	0.125	0.545	0.298
Belly (kg)	7.04	7.19	7.14	0.732	7.22	7.38	6.72	**0.020**	6.41	7.81	**0.000**	0.433	0.557	0.435	0.638
% Leg in half-carcass (%)	27.23	26.26	26.59	**0.002**	26.62	26.89	26.47	0.214	27.38	25.95	**0.000**	0.205	**0.002**	0.398	**0.015**
% Loin in half-carcass (%)	25.99	26.98	26.62	**0.009**	26.49	26.89	25.92	0.247	25.73	27.14	**0.010**	0.668	0.358	0.407	0.423
% Shoulder in half-carcass (%)	29.13	28.40	28.79	**0.008**	28.70	27.96	30.20	**0.000**	29.18	28.68	0.123	0.388	0.431	0.528	0.711
%Belly in half-carcass (%)	17.83	18.21	18.02	0.527	18.14	18.32	17.34	0.097	17.65	18.22	0.235	0.090	0.498	0.254	0.867
Loin quality															
Ultimate pH	5.67	5.60	5.56	**0.000**	5.58	5.59	5.63	0.124	5.57	5.61	0.172	0.568	0.269	0.431	0.133
Luminosity	50.93	51.60	52.65	**0.001**	52.72	52.51	50.53	**0.020**	52.57	51.27	0.140	0.070	0.103	0.596	0.227
Color	2.90	2.43	2.53	0.068	2.52	2.46	2.74	0.150	2.45	2.67	0.186	0.081	0.054	0.383	0.560
NPPC Marbling	2.52	2.05	1.88	**0.000**	2.37	1.82	1.83	**0.000**	1.91	2.10	0.232	**0.033**	0.196	0.331	0.588
Drips loss (%)	2.20	5.58	5.48	**0.000**	5.55	3.84	4.71	0.273	5.84	4.47	**0.019**	0.157	**0.020**	0.669	0.159
Ham quality															
Ultimate pH	5.62	5.58	5.57	**0.044**	5.57	5.56	5.63	0.061	5.57	5.60	0.476	0.210	0.602	0.520	0.971
Luminosity	49.50	49.05	50.61	0.176	50.23	49.49	48.18	**0.024**	49.57	49.79	0.827	0.932	0.253	0.628	0.390
Color	2.67	2.68	2.57	0.177	2.79	2.65	2.83	0.255	2.90	2.81	0.621	0.101	0.960	0.602	0.228
Technol. yield (%)	128.10	127.00	125.67	0.391	125.34	127.47	126.20	0.806	127.61	127.18	0.568	0.264	0.878	0.394	0.209