# FEEDING MARKET BOARS FOR PORK PRODUCTION

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## INTRODUCTION

By tradition, except for Peru, in the Americas pork production is from gilts and castrated males (barrows); this practice resulted from the need to ease management and to produce an acceptable male pig yielding more desirable pork. Because of boar taint, an off odor and flavor mainly from an androstenone and skatole (Bonneau et al., 2000; Weiler et al, 2000; Lanthier et al., 2006), there is a strong resistance from packers to market boars' carcasses, being in many instances condemned to lower value products or destroyed. The interest in producing entire males lies in their superior lean growth and feed efficiency; these traits were identified after an extensive review by Seideman et al. (1982), but characteristics of current pigs, practices of production and economics, call for a revision of the documented differences (Table 1).

Table 1. Summary of advantages, disadvantages and research needs for utilizing boars for pork production (adapted from Seideman et al., 1982).

| | Advantages[a] | | Research needs | |
|---|---|---|---|---|
| Variable (in reference, or in contrast to barrows) | Seideman et al., 1982 | Current estimates | Seideman et al., 1982 | Current estimates |
| Growth rate | 6 | 5 | Minor | Minor |
| Feed efficiency | 6 | 9 | Minor | Minor |
| Breed effects | n/a[b] | n/a[b] | Major | Minor |
| Animal behavior | 3 | 4 | Major | Minor |
| Type of feed, nutrition | 5 | 4 | Major | Major |
| Carcass yield | 4 | 3 | Minor | Minor |
| Carcass lean | 7 | 8 | None | None |
| Carcass conformation | 6 | 7 | None | Minor |
| Carcass fat | 7 | 7 | None | None |
| Pork tenderness | 5 | 4 | Minor | Minor |
| Pork flavor and odor | 1 | 1 | Major | Minor |
| Pork juiciness | 5 | 5 | None | Major |

[a] 10 = major advantage; 5 = no advantage; 1 major disadvantage.
[b] n/a = not available or very little information.

The main issue averting entire male production is boar taint, even in countries where carcasses from market boars are well accepted, because harvest weight is usually low (to a slaughter age around 21 weeks, before sexual maturity), thus preventing the advantages of producing modern leaner animals to heavier weights (Andersson et al., 1997; Aldal et al., 2005). Among the many alternatives to prevent boar taint (Acta Veterinaria Scandinavica, 2006), avoiding surgical castration, active immunization against gonadotropin-releasing hormone (GnRH) is preferred because of effectiveness, animal productivity, wellbeing and humane reasons (Killian et al., 2006; Zamaratskaia, et al., 2008).

Sexual development is inhibited by vaccination against GnRH, blocking production of testosterone and consequently boar taint (Caraty and Bonneau, 1986; Meloen et al., 1994; Dunshea et al., 2001; Font i Furnols, 2009). A commercial vaccine (Dunshea et al., 2001; Improvac, Pfizer Animal Health) is available and has been approved for use in about 40 countries; correct application of this anti-GnRH biologic is totally effective to reduce androstenone and skatole below the most exigent threshold levels. Once the boar taint problem is solved, the raising of entire males also comprises some problems related to growth performance, particularly in those areas where no experience is available for the management and feeding of these pigs. First, it is necessary to adopt a separate sex feeding system and the maintenance of age groups identity; secondly one must accept that boars eat and grow differently, resulting in a distinctive conformation. Ample information and experience are available elsewhere to take advantage on the efficiency and animal welfare issues behind entire male pork production; herein is an account of our efforts on the development of production systems, to produce market boars.

ENERGY AND PROTEIN FOR GROWTH.

Not only due to economics, efficiency of energy utilization for growth is of fundamental importance. Energy is a key nutrient as it enables chemical interaction between metabolism and the environment (Brown et al., 2004); entire males have a greater metabolizable energy (ME) need for maintenance ($ME_m$), produce more heat and eat less than barrows or gilts. The peculiar $ME_m$ demand of boars is a consequence of a larger visceral mass, rather than of the muscular size, but also the contribution of a greater rate of protein synthesis must be taken into account (de Greef and Verstegen, 1995; Noblet et al., 1999; van Milgen and Noblet, 2003): Lean strains of boars seem to maintain a constant partitioning of energy during growth (20 to 100 kg of live weight), while gilts and barrows decline linearly in protein deposition as they gain weight; as a consequence the latter deposit more fat (van Milgen and Noblet, 1999). The choice of an appropriate function to describe change and variation in protein deposition rate is still a matter of debate, but it should be apparent that the linear-plateau model, that assumes that the slope of the ratio of nitrogen retention and energy intake, declines exponentially with body weight (modeling approach by the NRC, 1998), either is not entirely suitable for intact males, or the plateau is reached at a much greater age or weight, as barrows (and gilts) mature earlier (Seideman et al., 1982).

Campbell and Taverner (1988) clearly illustrated the superior and sustained capacity of entire males to use energy for protein deposition, particularly if the animals are from a lean strain, for which, maximum rate of protein deposition was attained at above 185 g/d vs. about 130 for boars at the break point of the curve, and 80 g/d for barrows of a fatter progeny. Divergence between strains of boars was augmented as they gained weight or ate greater amounts of energy, but leaner intact males linearly increased protein deposition with energy intake and a plateau was not found in the range of 45 to 90 kg of body weight, suggesting that the selection process (under ad libitum feeding) raised the protein deposition limit further than the feed intake capacity.

Moreover, energy intake increased protein deposition up to 85 kg of body weight and maximal protein deposition was constant (at 170 g/d) for entire males which was 16% higher than for gilts, but above 85 kg, maximal protein deposition was no longer a constant for either sex (Moughan et al., 2006). Measuring the partition of retained body energy between lipid and protein in pigs of high lean tissue growth potential, Weis et al. (2004) found that whole body protein deposition responded linearly to energy intake, thus controlling protein deposition and a maximum is not achieved if energy availability is restricted: Between 15 and 90 kg of body weight, at energy intakes of 3.85, 5.00, 6.02, and 6.88 Mcal of DE/d body weight gains were 502, 731, 899 and 951 g/d, respectively. Proportion of carcass protein increased with pig weight and decreased at greater energy intake, whereas distribution of lipids between carcass and viscera was unaltered by weight or energy intake.

It is now accepted that body weight effects on the maximum rate of protein deposition are very small for boars before 90 kg (similar to younger pigs), and a greater proportion of protein in growth is expected, but it is primarily energy dependent. In congruence, a compensatory gain after an amino acid restriction occurs only within the energy-dependent phase of lean tissue growth (Martínez-Ramírez et al., 2008). Interestingly by time of manifestation of the of anti-GnRH vaccine effects, pigs expectedly are over 90 kg of body weight and off the energy dependent phase of growth, but a greater protein synthesis may still occur, because vaccination does not affect growth hormone expression, but only a small drop in plasma IGF-I (Metz and Claus, 2003). Overall these arguments are in favor of the proposed technology to use the anti-GnRH vaccine, as the possibility exists to maximize the life of the boar and to reach heavier slaughter weights, but also depict the need to support boar's growth with the appropriate dietary density of nutrients.

Protein deposition follows the same rules in entire males: Protein synthesis is an energy dependent trait, but arguments above imply that boars' energy partitioning is in favor of protein deposition; deleterious effects of reduced nutrient intake are possibly diminished in these pigs because of the relative importance of their maintenance needs, thus preventing fat deposition and, perhaps, a greater proportion of protein synthesis may be sustained in the event of lower energy consumption.

## APPLICATION OF THE ANTI-GNRH VACCINE IN A TROPICAL ENVIRONMENT.

In hotter environments feed intake and protein deposition are limited, thus the greater heat production of boars may upset the advantages of producing these animals, but the negative effects of a high environmental temperature, may be partially controlled by lower feed intake and a move towards maintenance to lower heat production; in these conditions, the benefits of producing entire males, because of their superior (to barrows) ability to drive energy for protein synthesis, perhaps will be as evident as in temperate climates. To challenge the idea, productive performance and product merit of barrows and boars was compared in hot areas (Alfonso-Navarrete et al., 2007; Castañeda et al., 2007; Velázquez et al., 2007) using in one case barrows (surgically castrated at 3d of age) and entire males, treated with the anti-GnRH vaccine 63d prior harvest. A total of 544 pigs were used in a commercial operation at the Yucatan Peninsula (a tropical hot and humid climate; maximum temperature during the experimental period was 44C, at 90% or more relative humidity) to randomly form 32 experimental units, being pens of 17 pigs; housing was in an open front type building of thermically isolated roofing and fully concrete-slotted flooring, for an available space of 19m$^2$; wet-feeders were used and 2 extra nipple watering devices were available per pen; water sprinklers were automatically operated for cooling purposes after week 14 of age, in two daily 1-h intervals as air temperature reached 32C. Feeders were manually fed and inspected twice a day to ensure ad libitum feeding; leftovers were collected on a weekly basis to calculate average daily feed intake. Pigs were weighed by pen at 67, 100, 128, and 163 days of age; at d-128 and 163 of age, a sub-sample of 4 pens per treatment (barrows and boars) was used to individually assess body weight and composition (by real time ultrasound measuring of backfat and longissimus dorsi depths).

Diets were formulated to match the nutrient density resulting from the application of the NRC (1998) Model, with lean gain curves before calculated for gilts and barrows of the population (the gilt curve was used for boars), at an average (20 to 120 kg) fat-free lean gain of 310 g/d for barrows and 360 g/d for boars; mean energy density was 3.34 Mcal of ME/kg, adjusting to the average energy intake, as it was previously measured for barrows and gilts (feed intake of gilts was used for boars). Differential feeding was started at 100 d of age, for 5 weeks, because during the last 28 days all pigs were fed the same diet containing Ractopamine·HCl (Paylean™) at an average of 7.5 ppm. All diets were fed in a pelleted form.

The anti-GnRH vaccine used was Improvac, which was applied in two shots (2 ml/pig), the first injection at d-100 of age, and a booster 28 days later, to allow a full immunity period of 35 d prior to harvesting. Consequently, boars' response between days 128 and 163 corresponds to the expression of the immunizing effect of Improvac.

Pigs were harvested at 163 days of age to directly measure carcass traits and merit, as fat and muscle depths were also recorded with an optical grading probe (Anitech PG-100). Before cooling, carcass boar taint was subjectively evaluated by 8 untrained persons, while parotid salivary glands were extracted and microwave cooked for verification. Carcasses were cut and the total weight of deboned and fat-trimmed primal cuts (boston butt, picnic, loin, tenderloin, ham and belly) was recorded. Ten loins per treatment were collected to assess subjective color and marbling (NPPC); objective color was measured as Minolta L*, a*, b*, placing the instrument at a D65 reflection angle. Drip loss was quantified after 48 hours at 4 C, and the loin eye was chemically analyzed; from other chops a tasting panel evaluated aroma, juiciness, flavor and texture of the cooked meat.

Productive performance results of this trial are summarized in Table 2. Over the experimental period, feed intake of barrows was about 8.5% higher, but it should be noted that differences in favor of a significantly lower consumption of boars, was before the immunizing effect of the anti-GnRH vaccine: for the initial 61d, entire males feed consumption was about 83% of the castrates' intake. This pattern of feed intake resulted in parallel effects on body weight gain, thus a divergent body weight (by 8%) was equalized after the 35 days of the Improvac effect. Nevertheless, gain efficiency was always better by boars: over the entire period, 0.37 vs. 0.41 g/kg (P<0.003), and 0.42 vs. 0.46 (P<0.004), up to d-128 of age. Rate of fat-free lean gain was similar among treatments, but better in boars if calculated as a percentage of body weight gain, except during the last 35d of the fattening period (during the response to the vaccine). In turn, although the entire males behaved as barrows for the final lapse (as noted by Dunshea et al, 2001; Cronin et al., 2003; Zamaratskaia et al., 2008), backfat depth was thinner and fat-trimmed primal cuts represented a greater proportion of the boars' carcasses. However, estimated lean merit of carcasses (by the plant optical probe apparatus and standard equation) was statistically better for entire males (50 vs. 51%, P<0.02), but the difference was not as noticeable as it was calculated from the fabricated carcasses; most likely the standard equation negatively biased the approximation to the boars' leaner carcasses.

Table 2. Productive performance of barrows and boars treated with the anti-GnRH vaccine during the last 63 days of the finishing period.

| | Body wt., kg [a] | | Feed intake, kg/d [b] | | Weight gain, kg/d [c] | | Fat-free lean gain, kg/d [d] | |
|---|---|---|---|---|---|---|---|---|
| Days of age | Barrows | Boars | Barrows | Boars | Barrows | Boars | Barrows | Boars |
| 67 | 30.9 | 29.1 | - - | - - | - - | - - | - - | - - |
| 100 | 61.8 | 57.1 | 1.93 | 1.63 | 0.92 | 0.84 | - - | - - |
| 128 | 89.3 | 82.7 | 2.69 | 2.21 | 0.98 | 0.91 | 0.37 | 0.36 |
| 163 | 122.9 | 120.7 | 3.03 | 3.16 | 0.96 | 1.09 | 0.36 | 0.36 |
| Final backfat, at $P_2$ (cm) [e]: | | | | | | | 1.94 | 1.81 |
| Trimmed primal cuts, % of carcass wt. (head and feet on) [f]: | | | | | | | 44.60 | 46.11 |

[a] SEM < 1.011; P<0.05, except at d-163, P>0.11.
[b] SEM < 0.035; P< 0.02.
[c] SEM < 0.009; P<0.01.
[d] SEM < 0.004; P>0.20.
[e] SEM = 0.039; P<0.02.
[f] SEM = 0.299; P< 0.13.

For detailed carcass studies and for pork quality evaluations, a random sample of 80 carcasses (40 per treatment), were individually fabricated following also the packing plant standard procedures. Average hot carcass weight (head and feet on) of this sample was 97.74 ± 5.964 kg. Hot carcass yield was 1.7% lower (P<0.01) for intact males, yet all primal cuts and trimmings, except for the bellies, resulted in a similar (P>0.20) weights. Thus, proportion of lean cuts (as % of the cold carcass) was better in carcasses from boars (Table 2). Packed belly-bacons were 0.90 kg heavier for barrows (P<0.001), as bacons length and thickness were 6.5% smaller for boars, but bacon flexion indexes (frontal and reverse) were identical (P>0.21).

Given that production of entire males treated with Improvac changed the proportion between lean and fat, equations were generated for the electronic device for carcass grading (from carcass weight, fat and muscle depths between 10 and 11$^{th}$ ribs), to estimate primal cuts yield for barrows (Equation 1), and entire males treated with Improvac (Equation 2); variables order of importance to control variation were: hot carcass weight (CW), carcass backfat (BF), and loin depth (L):

Equation 1. Barrows' primal cuts, kg = $11.180 + 0.469 \cdot CW - 0.228 \cdot BF + 0.052 \cdot L$ ($R^2 = 0.72$).

Equation 2. Boars' primal cuts, kg = $8.881 + 0.499 \cdot CW - 0.212 \cdot BF + 0.081 \cdot L$ ($R^2 = 0.64$).

The main differences between equations are on the relative weighting of backfat and loin depth for calculation of primal cuts: For intact males the slope for the loin was 0.081 (81 g of primal cuts/mm of loin depth) and for castrates only 0.052; backfat, due to the smaller relative slope values, was of lesser importance. In this manner, the equations would be of help in practice to discern differences in conformation to prevent biases in the carcass grading system of the enterprise.

In general, meat quality was good; not a single carcass or meat sample exhibited a boar taint or any disgusting odor or flavor. Severe problems such as pale, soft and exudative, or dark, stiff and dry meat were not detected in any of the carcasses. Sampled loins did not differ in surface area at the 10$^{th}$ rib ($P>0.70$), and color evaluations did not differ between treatment groups, but there were noticeable differences in marbling, which was lower ($P<0.05$) by 20% in entire males, also, chemical extracted fat was 23% lower ($P<0.005$) for intact males. However, after the untrained taste panel, no significant differences were found in meat aroma and juiciness ($P>0.20$), confirming the effectiveness of Improvac in preventing boar taint, although some minor differences in perception of meat texture (5.7 vs. 4.8, $P<0.05$) and flavor (5.9 vs. 4.8, $P<0.005$) were in favor of loin chops from barrows, almost certainly as a consequence of the different fat content in the loin chops.

In this trial boars grew slower than barrows before effective immunization vs. GnRH and, whatever estimates of protein deposition are used from this data, there was not a true advantage in producing entire males; rates of fat-free lean gain were similar for castrated and non-castrated males, perhaps in consequence of the lower feed intake of boars, but it is clear that ingested nutrients efficiency of utilization was notably better in boars, therefore we suspect an energy partitioning in favor of lean growth. However, in practical terms, the proposed benefit of greater lean production from boars could only be accounted in this case as the proportion of muscle after harvesting in the carcass.

It also should be acknowledged that all of the pigs were fed Ractopamine for the last 28 d of the trial, by the time that the anti-GnRH antibodies exerted the blocking of testosterone production, and boars behaved and ate like barrows, which resulted in improved performance as it was described before (Dunshea et al., 2001; Metz et al., 2002; Oliver et el., 2003), equalizing body weights and total production of lean tissue at harvest. It is quite possible that the β-adrenergic acted similarly in castrated or intact males, which is apparently in contrast to the inferences (for growth performance) by Dunshea et al. (1993) but, at this time, boars were behaving like barrows; the huge drop in feed efficiency, although still significantly better than for barrows, confirms the value of Improvac to inactivate sexual activity, enabling production of entire males to heavier weights by preventing boar taint, while having the advantage of better feed efficiency for the majority of the pigs' productive life, in this case, 128 vs. 35 d; this response will be greater the longer the period of expression of the boar traits, i.e., the later the immunization the better response (Moelen, et al., 1994; Metz et al., 2002; Turkstra et al., 2002).

Body weight of boars was lighter before Improvac use, thus the later redeeming response was critical to make the practice competitive, inferring that the longer the period after the second vaccination the greater the response in terms of total weight and lean production; also, because of the improvements in feed efficiency, lean deposition and carcass dressing, it is suggested a possible additive effect of Ractopamine upon the Improvac treatment of boars.

USE OF THE ANTI-GNRH VACCINE AND RACTOPAMINE.

A field trial was conducted at Querétaro State, México, to compare productive performance of gilts, barrows and entire males (treated with the anti-GnRH vaccine, Improvac – Pfizer, Animal Health), with the addition or not of Ractopamine·HCl (Paylean™, Elanco, México) at 5 ppm (Muñoz et al., 2007). The experiment location is an "all in-all out" wean to finish facility, located in a temperate area of the Mexican highlands plateau, at an altitude of 1,995 m above mean sea level; mean daily temperature during the experiment and at the site was 17.2 ± 7.93 C and relative humidity, 43.9 ± 12.47 %.

A total of 1,018 pigs were used, 520 gilts, 232 barrows and 266 entire males, that were housed by size and gender in 45 pens of 22 to 24 pigs per experimental unit during the growing-finishing period. Pens are in an open front type building, have solid concrete flooring for a space allowance of 30 $m^2$, providing in each a dry self feeder (1.85 m openings), 3 nipple watering devices, and a shallow pool (≈12% of the surface) for self-cooling purposes. Pigs were received at 28 ± 4.73 d of age (7 to 14 d post-weaning) with a mean weight of 8.0 ± 1.31 kg, and were initially housed in enclosed and temperature controlled buildings (nurseries) and moved to the open front facility 35 d later. While at the nurseries, pigs were weighed and feed intake measured in 7 d intervals; during the growing-finishing period feed intake was measured every week, and body weight was recorded after 14 to 35 d periods. Fat-free lean gain was calculated after real time ultrasound measurements of $P_2$ backfat and loin depths at the $10^{th}$ and last ribs and at harvest (at 154 d of age), 24 random pigs per treatment were used to assess carcass merit and meat quality as was described above.

According to gender and Ractopamine use, there were 6 treatments: gilts, barrows and boars, all fed or not Ractopamine at 5 ppm during the last 28 d of the finishing period, to include 23 experimental units of gilts, 10 of barrows and 12 of boars; randomization resulted in sequence, and for the interaction, in 11 and 12 pens of gilts, 5 and 5 of barrows, and 6 or 6 pens for boars.

Entire males were appropriately treated with Improvac, vaccinating at d-98 and 126 of age, to result in two intervals of 28 d. Thus, the feeding of Ractopamine to boars was coincident with the period of active immunization against GnRH.

Diets were sorghum-soy-canola, and were calculated as it was described before; lean gain equations for the NRC (1998) model were previously developed and validated for the population. Table 3 shows a description of feed formulation constraints; main differences were in amino acids concentration; total lysine to protein ratios were kept in between 5.9 and 7.2% (lower for older pigs), and vitamins and minerals provision was equal among genders within feeding phase. Considering that the Ractopamine effect will overcome gender differences, diet was the same at this stage for all pigs; all diets were pelleted.

Table 3. Rations main formulation constraints.

| Feeding phase | Days of age | Feeding phase, d | BW range, kg | ME, Mcal/kg | Digestible Lysine, % * | | |
|---|---|---|---|---|---|---|---|
| | | | | | Gilts | Barrows | Boars |
| Late nursery | 28-63 | 35 | 8 – 28 | 3.43 | 1.27 | 1.27 | 1.27 |
| Early grower | 63-98 | 35 | 28 – 55 | 3.40 | 0.90 | 0.90 | 0.90 |
| 1st Improvac | 98-126 | 28 | 55 – 85 | 3.37 | 0.80 | 0.80 | 0.85 |
| 2nd Improvac | 126-154 | 28 | 85 – 115 | 3.30 | 0.76 | 0.67 | 0.76 |
| Ractopamine | 126-154 | 28 | 85 – 115 | 3.30 | 0.85 | 0.85 | 0.85 |

* The appropriate Ideal Protein amino acids ratios (true ileal digestible) were applied for the 5 limiting.

Most relevant results are presented as the main effects of gender and the Ractopamine by gender interaction, although in none of the variables Ractopamine and gender interacted (P>0.23). Table 4 presents the pigs' response to 98 d of age, time of the first Improvac injection. Boars were initially lighter than barrows (13%) or gilts (9%), but the difference disappeared by d-98 of age: Gilts, 56; barrows, 58 and boars, 55 kg (5% max. difference). Feed intake of boars was 11% lower during the first 35 days, but only by 8% between d-63 and 98 of age; the slight proportional increase in feed intake of boars was sufficient to match daily weight gains of gilts or barrows during this second 35 d period, resulting in an evident advantage in feed efficiency.

Table 4. Growth performance to 98d of age, before the first anti-GnRH vaccine injection.

| | Gilts | Barrows | Boars | SEM |
|---|---|---|---|---|
| Initial body weight, kg | 8.15[a] | 8.53[a] | 7.44[b] | 0.227 |
| Feed intake 28-63 d g/d | 873[a] | 912[a] | 796[b] | 16.12 |
| Body weight gain 28-63 d, g/d | 567[b] | 609[a] | 547[b] | 11.49 |
| Feed efficiency (Gain/Feed) 28-63 d | 0.65 | 0.66 | 0.68 | 0.010 |
| Feed intake 63-98 d, kg/d | 1.75[ab] | 1.85[b] | 1.65[a] | 0.133 |
| Body weight gain 63-98 d, kg/d | 0.81 | 0.82 | 0.81 | 0.031 |
| Feed efficiency (Gain/Feed) 63-98 d | 0.46[a] | 0.44[a] | 0.49[b] | 0.011 |

[a, b] Values with different superscripts on the same row are statistically different (P<0.01).

The animals' response following the injection of the anti-GnRH vaccine to boars, days 98 to 154 of age, is depicted in Table 5. Over the 56 d period, feed intake of gilts was similar to boars, and greater by barrows, but average of daily gain was superior by boars, although castrates had a matching outcome; within males, there was a similar response to Ractopamine, but in terms of feed efficiency, the best response was of boars fed Ractopamine; across sex groups, responses in feed efficiency and fat-free lean gain had a parallel trend, but it should be noted that boars were more efficient and exhibited greater fat-free lean gains. Results and inferences are very similar to those derived from the work discussed above, and show the superiority of boars for feed efficiency and lean gain, but also confirm the capacity of response by boars, treated with the anti-GnRH vaccine, to Ractopamine; in turn the additive response to Improvac and Paylean could overcome the observed difference in final body weight between barrows and entire males, while maintaining the improved feed efficiency.

Table 5. Growth performance 98 to 154d of age, after the first anti-GnRH vaccine injection; use of Ractopamine was only during the last 28d.

| | Gilts | Gilts | Barrows | Barrows | Boars | Boars | |
|---|---|---|---|---|---|---|---|
| Ractopamine, ppm | 0 | 5 | 0 | 5 | 0 | 5 | SEM |
| Body weight 98d, kg | 54.9 | 57.8 | 59.0 | 58.1 | 55.3 | 55.0 | 1.48 |
| Feed intake, kg/d | 2.58 [c] | 2.82 [ab] | 2.98 [a] | 2.97 [a] | 2.73 [b] | 2.72 [b] | 0.076 |
| Daily weight gain, kg | 0.89 [c] | 1.00 [ab] | 0.95 [b] | 1.02 [ab] | 0.98 [ab] | 1.04 [a] | 0.024 |
| Gain / Feed, kg/kg | 0.34 [b] | 0.35 [b] | 0.32 [c] | 0.34 [b] | 0.36 [b] | 0.38 [a] | 0.007 |
| Fat-free lean gain, kg/d | 0.33 [c] | 0.38 [b] | 0.33 [c] | 0.38 [b] | 0.36 [bc] | 0.41 [a] | 0.011 |

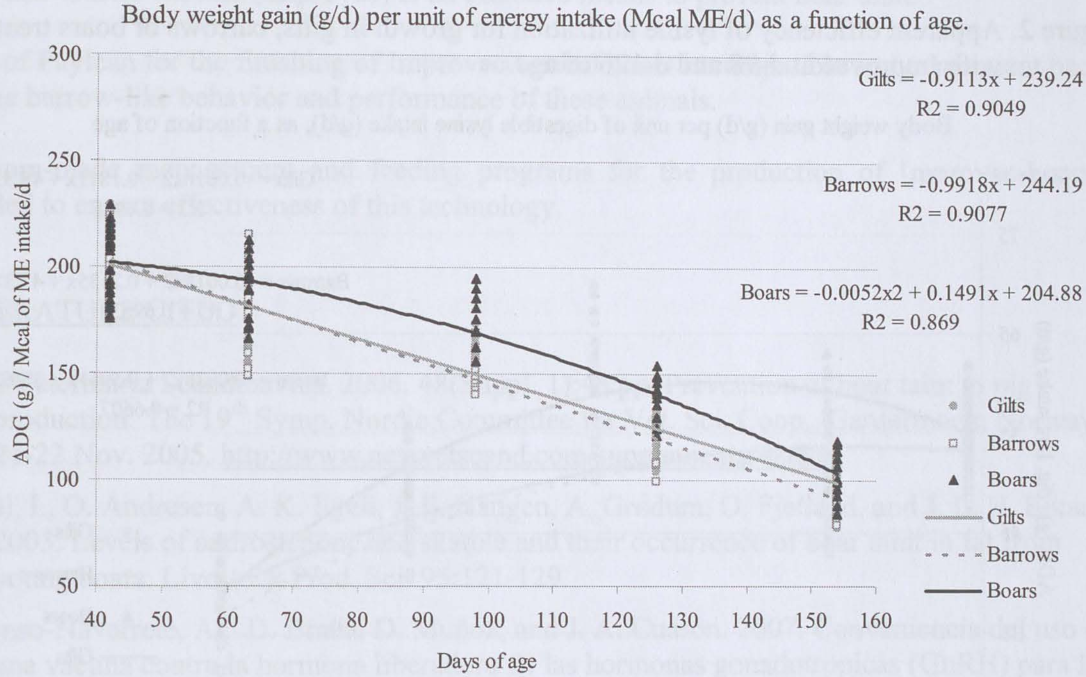
[a, b, c] Values with different superscripts on the same row are different ($P<0.05$).

For the 126 d of these observations, and averaging over the response to Ractopamine, boars treated with Improvac ate 25.2 and 4.8 kg less feed than barrows or gilts respectively, while total live weight produced resulted in a difference of -1.1 and 2.7 kg correspondingly.

From 28 to 154 d of age (and a final body weight mean range of 105 to 115 kg) feed conversion rates were: Gilts, 2.40; Barrows, 2.50 and, Boars, 2.29 kg; the difference in favor of entire males was clear after 63 d, and sustained to 154 d, irrespectively of the anti-GnRH vaccine effects on feed intake.

Boars' advantages in growth and, perhaps also true for the lower rate of feed intake, most probably were a direct consequence of their metabolic use of nutrients. Body weight gain and lean deposition are energy intake dependent, but as it was discussed, boars are much more effective in using energy for these functions. Figure 1 shows the apparent efficiency of ME utilization for body weight gain, calculated as unit of body weight gain, per unit of energy intake, and shown as a function of age, at the end of each feeding phase. Gilts and barrows had a linear trend to decrease efficiency of energy utilization with age (slopes were, respectively, -0.911 and -0.992); barrows were divergent to gilts and less efficient from d-98. In contrast, boars showed a quadratic tendency, being more energy efficient than gilts or barrows from d-63 to 126 of age; in the last 28 d, the barrow-like behavior in feed intake or, perhaps in addition, because the pigs were beyond the point of maximum protein deposition (Moughan et al., 2006).

Figure 1. Apparent efficiency of energy utilization for growth in gilts, barrows or boars treated with Improvac at d-98 and d-126 of age.

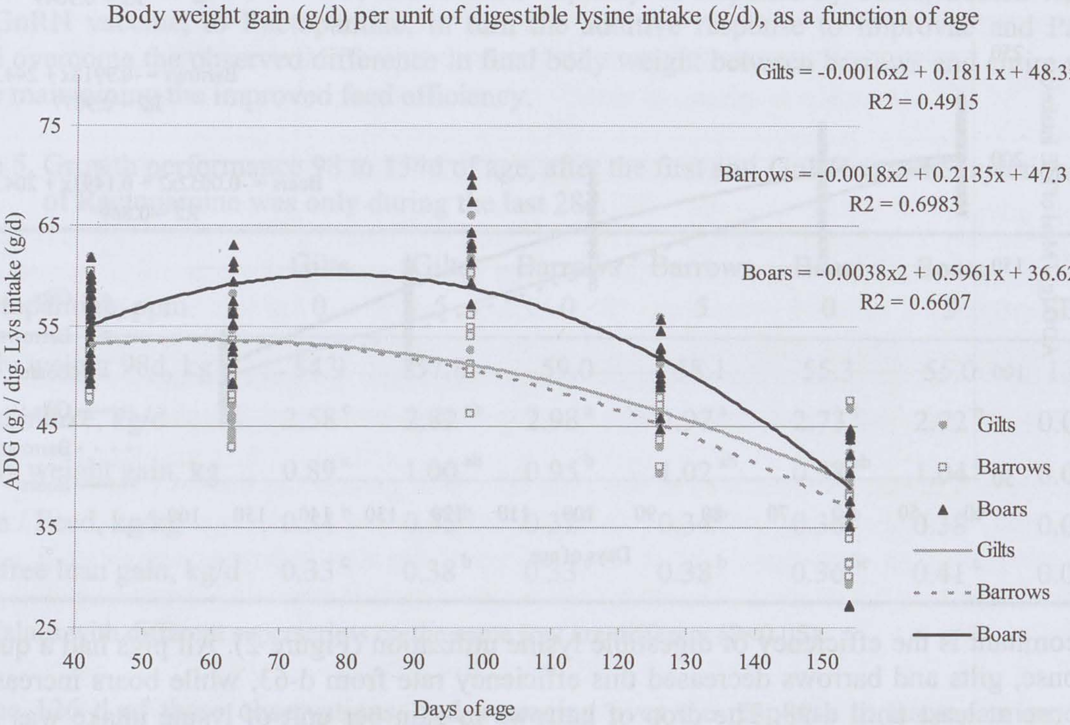



Concomitant is the efficiency of digestible lysine utilization (Figure 2). All pigs had a quadratic response, gilts and barrows decreased this efficiency rate from d-63, while boars increased the response at least until d-98. The drop of barrows in gain per unit of lysine intake was greater than for gilts after d-98, and coinciding with the first anti-GnRH injection, efficiency of lysine utilization by boars descended rapidly after d-98, but it was until d-126 that values approached those of gilts.

Because of the lower feed intake of boars (as well as in gilts), higher lysine concentrations may be necessary during early growth, but requirements were calculated very similar to those of barrows or gilts, and response to lysine will be limited by feed intake (van Milgen, J., and J. Noblet, 1999; Martínez-Ramírez et al., 2008), but it is clear that boars can overcome the problems of a lower feed consumption because of their greater energy efficiency, at least to 98 days of age or about 55 kg of body weight.

Also working under field conditions, Andersson et al. (1997) found very similar results to what was proposed by us in the projection of the feeding program for this trial. Working with pigs from 26 to 105 kg of body weight, the response to diets containing 0.85, 0.95 or 1.05% total lysine was measured. Gilts, barrows or boars grew better at the higher lysine level (digestible lysine of about 0.90% of the diet), in the live weight range from start to 60 kg. Particularly entire males, fed the highest total lysine level (1.05%), and from 60 to 105 kg of body weight, had a slightly better gain, showed better feed efficiency, and produced greater proportions of lean (4 units %, by dissection) than barrows, but lysine level had no effect on carcass lean yield. Thus, in agreement with these observations, and according to our estimates, only slightly higher levels of amino acids will be required for boars, and the greater differences with gilts will be after 98d of age, and before inactivation of the GnRH function.

Figure 2. Apparent efficiency of lysine utilization for growth in gilts, barrows or boars treated with Improvac at d-98 and d-126 of age.




In this trial, as in the previous, none of the carcasses or pork samples exhibited a disgusting odor or flavor. Carcass and meat quality issues and results were almost identical to the previous study and show that the problem of a lower carcass dressing in boars, could be solved in part by Ractopamine, but also potential benefits are suggested in this trait by extending the period after the second vaccination with Improvac.

Entire males compensate by a relative greater lean yield; consequently, the possible differences in the final weight favoring barrows are surpassed by a matching or higher total lean production by boars. Andersson et al. (1997) stated that gross margin per pig place was identical between genders, but significantly superior for entire males if payment was based on percentage lean yield. Under particular conditions these numbers could be used to project profit from entire male production, but it is our belief that in presence of high energy costs, as they are and will be, the benefits of boars for pork production are commensurable.

TAKE HOME MESSAGES

Production of entire males is attractive because of their better feed efficiency and lean yield.

The anti-GnRH vaccine (Improvac) is an effective means to prevent boar taint.

Use of Paylean for the finishing of Improvac-treated boars is compatible and convenient because of the barrow-like behavior and performance of these animals.

Custom-made management and feeding programs for the production of Improvac-boars are needed to ensure effectiveness of this technology.

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