UPDATE ON THE MANAGEMENT OF THE GILT AND FIRST PARITY SOW

(Actualidades sobre el manejo de la hembra de reemplazo y primeriza)

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Introduction

Further improvements in gilt development programs can lead to major increases in breeding herd efficiency. Whether gilts are reared in 'in-house' gilt multiplication systems, or supplied by a breeding company, proper selection and management of replacement gilts in purpose-built Gilt Development Units (GDUs) has a proven impact on lifetime non-productive days (NPD). However, the full economic benefit of improved GDU management goes beyond a simple reduction in NPD. The trend towards larger breeding sow herds seems to be decreasing the efficiency of breeding herd management. PigChamp data for 2002 showed that on larger breeding sow farms in the USA and Canada, annual herd replacement rates were often between 60 and 70 %, with a number of important consequences.

- A larger pool of replacement gilts is needed to meet increased replacement requirements
- Breeding herd parity distribution is unstable and biased towards lower parity females
- Chronic over-crowding of pens in the gilt development area is needed to meet replacement needs
- Negative impacts on health and welfare result
- Pressure to meet breeding targets results in less fertile gilts being bred using pharmacological interventions
- Gilts are bred below target weights
- General performance and morale of GDU staff declines and staff retention is low.

To reverse these trends, effective gilt management programs are urgently needed that will meet replacement targets from a smaller pool of gilts, and with gilts with improved lifetime breeding performance. This will ultimately reduce annual replacement rates (target for top 30% of breeding herds should be <50%), improve sow "fitness", decrease sow death losses, and increase labor efficiency and space utilization. Cost-benefit analysis strongly favors improved efficiencies within the GDU, but implementation of effective GDU programs is still not widespread in the pig industry. Therefore, we will again review the key elements of good GDU management.

Defining measurable and meaningful indicators of breeding herd performance? When measuring the success of management programs within the GDU and mature sow herd, the key indicators of breeding herd performance need to be carefully defined, and should reflect the most meaningful measures in terms of overall economic performance. Our producers are trying to make money, and should not be encouraged to see a simplistic measure of productivity like maximal numbers of pigs produced, at any cost, as a worthwhile goal. If a production system is not fully integrated, the terms of contracts at each level of the production chain should reflect the value of the pigs produced. Indeed, recognition of the need for a correct balance between the quality and the number of weaned pigs produced is not always apparent in the contracts agreed. Consequently, this is often also not reflected in the priorities given to improving breeding herd performance. In terms of producing a reliable supply of weaned pigs at the critical nursery stage of production, the most important breeding herd key performance indicators (KPI) are probably; 1) uniform numbers of pigs weaned per week, 2) the weight and age of the pigs weaned, and 3) the least variation possible in age and weight at weaning. In turn, if properly rewarded, these KPIs determine the key factors that will be the focus of the breeding herd. As has been repeatedly emphasized in the assessment of key determinants of the number of pigs born and weaned per week, the single biggest factor needing attention is meeting breeding targets, with the second largest risk factor being farrowing rate. These factors normally outweigh the impact of achieving overall increases in the number of pigs born/litter, or variations in pre-weaning mortality. Thus, the primary focus of the breeding herd should be identifying the gilts and sows available on a weekly basis to meet projected breeding targets and to improving the breeding management of these gilts and sows.

In the "push" concept of breeding herd management, a focus on establishing a well managed Gilt Development Unit (GDU) ensures a constant supply of gilts per week, and at the same time improves breeding management within the GDU. A constant input of high quality gilts into the breeding herd, with increased longevity, in turn stabilizes the parity structure of the breeding herd. This helps in preventing the somewhat erratic contribution that weaned sows are often seen to make to weekly breeding targets. A constant input of "select" gilts to the breeding herd also prevents the tendency for a reduction in the voluntary culling of sows to achieve weekly breeding targets. All these factors will prevent breeding farms from entering the "death spiral" that is frequently seen in many of our larger production systems.[1] The key management practices that will best serve our industry, and the characteristics of the dam-lines that best suit these practices, will be the focus of the rest of this discussion.

By making gilt management more efficient, we improve both the utilization of space and labor, and actually achieve a flow of eligible (service-ready) gilts within the design specifications of the gilt facility. The main purpose of this review is 1) to define the phenotypic characteristics of commercial dam-line gilts and sows, as the basis for developing appropriate recommendations for improved gilt management, 2) to discuss the type of management strategies that allow effective implementation of effective gilt Development Units (GDU) as an essential driver of breeding herd productivity, and 3) describe a commercial breeding farm project in which all these principles of improved GDU management have been successfully applied.

Understanding the phenotype of commercial dam-line sows

Changes in lean tissue growth rates in dam-line females. The major changes in the lean growth potential, and associated changes in the overall tissue metabolism of contemporary dam-line sows is not adequately recognized. Compared to selection for reproductive merit, the much greater heritability of growth traits has resulted in improvements lean growth performance in terminal line pigs that is the very basis of a competitive pork production industry in world meat markets. Inevitably, existing dam-lines carry these same traits to a greater or lesser degree. In the major dam-lines used in contemporary pork production in North America, inadequate attention is paid to the changes in basic sow metabolism resulting from this increased potential for lean tissue deposition and an associated lack of fatness in our current dam-lines. Traditional management practices that were established even 20 years ago need to be re-evaluated, if we are to capture the full economic potential of the modern breeding sow and her offspring, in terms of greatly improved nutrient utilization. In terms of the threshold growth rates needed to sure that growth rate per se is not limiting the onset of sexual maturation in the gilt, the earlier data of Beltranena, *et al.*[2] suggested that only when growth rate was below 0.55kg/day from birth to onset of boar stimulation at 160 days of age, was there any delay in onset of pubertal estrus.

The more recent data presented in Figure 1, from a study of Genex grandparent females and their F1 progeny at the University of Alberta, support these conclusions. This leads to the generalization that with unrestricted feeding during the grow/finish phase, and recommended space allocations to gilts during development, it is unlikely that growth rate in commercial dam-line gilts will limit age at the onset of first estrus. Furthermore, the data in Figure 1 emphasize that age at first estrus is very largely dependent on the age at which effective stimulation with boar pheromones and direct boar contact is applied. Recent comments that pubertal estrus is occurring at older ages in today's commercial dam-lines seems to us to have little substance, unless of course boar stimulation is delayed. Indeed, as seen in the data in Figure 1, if gilts are exposed to effective pheromonal stimulation from, and allowed direct physical contact with, mature, high libido, boars (by definition in this situation meaning effective production of salivary pheromones) from an early age, then age at pubertal estrus is almost normally distributed. Some gilts reach puberty within days of first boar contact, whilst other gilts may not show pubertal estrus after 50 days of continuous boar contact. However, the data in Figure 1 seem to support the curvilinear "best fit" to earlier data[2], suggesting a tendency for the highest growth rates to be associated with a marginal delay in pubertal estrus. This may be problematic, in that late maturing and fast growing gilts may become overweight by the time they are bred, and as discussed later, this is one of the major risk factors for poor retention in the breeding herd[1]. The data in Figure 2 show comparable data from a gilt re-population study conducted in collaboration with the Prairie Swine Centre Inc., involving PIC Camborough 22 gilts, provided good boar contact from a pen average of 140 days. These data also serve to demonstrate the total lack of any relationship between growth rate and the population of gilts that did, or did not, have a recorded pubertal estrus within 40 days of commencing boar stimulation.

Finally, because of the considerable variability in growth performance within a group of gilts, it is wrong for producers to assume that some arbitrary age will effectively define the physical development of gilts at stimulation or breeding. Gilt pool managers often ignore the enormous variation in growth rate among groups of gilts, and also the rather uncertain relationship between weight and back-fat. The extremes of growth rate and age at first estrus, and the independent effects that these characteristics can have on age v. weight at first recorded estrus are indicated in Figure 2. The extremes of age at sexual maturity and growth rate, result in gilts with induced first estrus soon after commencing stimulation with mature boars at around 140 days of age but only a threshold growth rates to first estrus of < 0.55 kg/d, compared with gilts with first recorded estrus at > 170 days of age and the higher growth rates of > 0.70 kg/d. These extremes are typical of those seen in earlier experiments[3] result in first estrus gilts differing in body weight by as much as 60 to 70 kg. In terms of gilt conditioning for physical fitness and longevity in the breeding herd, early maturing/slower growing gilts would need to be provided with high energy "fattening" diets to achieve 135 kg body weight and at least 18 mm of back-fat at breeding. In contrast, late maturing/fast growing gilts probably need to be subjected to restrict feeding during development to prevent excessive growth being a cause of lameness and eventual culling. The unavoidable conclusion from these data is that age is not a good measure of weight or fatness, and the only way to be certain that gilts are at target weight for breeding is to weigh them!

As age at sexual maturity can also vary from 130 to over 200 days, it is impossible to set some arbitrary age and assume that this defines some general level of sexual maturity. Clearly, by starting to assess whether gilts will show a standing heat in response to boar contact at over 200 days of age, there is little opportunity to determine the relative sexual maturity of individual females. The only benefit from introducing boar contact at such a late stage is the very short period over which pubertal estrus will be observed. However, as discussed later, very efficient boar stimulation programs can involve relatively little labor input per gilt bred, and yet increase the lifetime performance of truly "select" gilts substantially.

The lack of any reliable association between age, and onset of sexual maturity or body weight, implies that these essential benchmarks must be assessed independently in a well-managed GDU and used to allocate gilts to appropriate breeding groups. The aim should be to have gilts as sexually mature as possible before target breeding weight is reached, with the minimal requirement that breeding occurs at least at second estrus.

The question of fatness as a meaningful marker of breeding fitness. Interestingly, the earlier studies of Beltranena, *et al.*[4] already indicated that the fatness of the gilt was unrelated to the rate of sexual maturity, and this conclusion has also been supported in subsequent experiments. Moreover, in most gilt pools, there is usually a very weak association between a particular weight and measured back-fat, as shown in Figure 3. Equally, back-fat can in no way be interpreted as indicating the likely body weight of replacement gilts.

Consideration of differences among dam-lines (genotypes). Breeding companies producing a wide variety of high index dam-line gilts, have generally failed to provide adequate data about the key performance characteristics of even major commercially used dam-lines. Based on recent collaborative studies with two major commercial dam-lines, we conclude that the phenotype of the gilts and first parity sows clearly reflects the extent to which selection for increased lean tissue gain is reflected in these terminal dam-lines. As can be seen in Figure 3, the level of fatness (back-fat measured at the P2 position in both cases) during gilt development tends to be different. Furthermore a maternal weight gain of 50 kg from breeding to farrowing results in a very different response in back-fat gain. The critical question then becomes, to what extent is this relative leanness of the terminal dam-line likely to affect lifetime productivity of the sow? From existing data, it is hard to suggest that there are any inherent differences in lifetime reproductive performance that can be ascribed to the relative fatness of the sows per se[1]. The lack of a consistent relationship between overall sow body weight and back-fat thickness is also seen in data collected over three parities from the gilts shown in Figure 3a. As can be seen in Figure 4, because gilts were bred by design at third estrus, and there was a lack of any relationship between body weight and rate of sexual maturity once the critical threshold has been passed, this resulted in a wide range of body weights at breeding at immediately after these gilts farrowed their first litter. In general, the pattern of increase in lean body mass over successive parities would meet most conventional targets (Figure 4a), and the changes in measured back-fat were variable and lower that would be suggested as ideal even for the Camborough sow (Fig. 4b). However, as discussed later in these proceedings, the lower than targeted levels of back-fat do not seem to be critical for sow longevity in the breeding herd, or for sow lifetime productivity.

Another notable feature of the data shown in Figure 4a is the persistent difference in sow body weight over three parities, despite the fact that management practices in this herd would allow feed intake in gestation to vary with respect to perceived weight and body condition of the sows after breeding. This emphasizes the need to focus on entering gilts into the breeding herd at known and recorded weights, as probably the only reliable way of insuring that lifetime changes in sow weight will be consistent with longevity and good lifetime productivity.

Therefore, in terms of the phenotypic characteristics of contemporary commercial dam-lines, implementation of effective gilt pool management strategies will allow producers to meet targets for body condition (weight, back fat) and physiological maturity (age at first estrus, and estrus at breeding), to reduce annual replacement rates (target for top 30% of breeding herds should be <50%) by improving sow "fitness" and reducing sow death losses, and increase labor efficiency and space utilization. However, a comprehensive understanding of the characteristics of specific dam-lines is essential when developing the "optimized" breeding management programs of the future.

The next section of this paper will consider other biological characteristics of sexual maturity and relative fertility in gilts, and how these can also be taken into account to improve overall breeding herd performance All these advantages can ultimately be achieved whilst maintaining the economic efficiencies of smaller, well managed, gilt pools.

Understanding the basis of effective gilt management programs

Taking into consideration our current knowledge of gilt development, and incorporating the above key points, we suggest the in-house gilt management system shown in Figure 5. Identifying "select" gilts at an early age is a critical part of a successful gilt development program. This selection process will involve three steps.

Pre-Select 1.

Pre-Select 1" occurs at the time the gilts leave the nursery. At this time gilts must have good conformation, 12-14 teats and be free of hernias or ruptures. As more data become available, it may also be appropriate to exclude gilts with inadequate growth rate at this stage. After gilts leave the nursery an opportunity exists to "condition" gilts to achieve adequate weights and body condition at puberty to sustain lifetime performance. As discussed above, available data consistently show that at commercially acceptable growth rates (0.55 – 0.80 kg/d from birth to 100 days of age), there is no relationship between growth rate and age at puberty. Experience in commercial practice suggests that specific gilt "conditioning" diets can be used to increase general physical fitness of gilts, particularly in some of the leaner dam-lines. In studies in which we attempted to slow growth in gilts with high fiber diets from 50 kg until puberty induction, we had very little impact on bodyweight at first estrus.[5]

Pre-Select 2.

"Pre-Select 2" will occur at 140 days of age. Ideally, gilts will be assessed for weight, growth rate and backfat depth at this time. Gilts must achieve a lifetime growth rate of at least 0.6 kg/d. If gilt NPD are to be minimized, it is important to remove gilts with low growth rates. For example, a slow growing (< 0.6kg/d) but early maturing gilt (first estrus at 160 days) would weigh approximately 96 kg at first estrus. If this gilt was bred in the appropriate weight range (135 – 150 kg body weight), she would need to be bred at 4th or 5th estrus and would accumulate nearly 84 NPD in the gilt stimulation/pre-breeding area. The lack of inherent growth performance, the accumulated NPD involved, and the real risk of such gilts being bred below target weight when breeding targets are not being met, all suggest that exclusion of lower growth rate gilts is the preferred management option. Even a slow growing (<0.6 kg/d) and late maturing (190 days) gilt would accumulate 30 days in stimulation and an additional 42 days to reach minimum breeding weight. Therefore, at Pre-Select 2, gilts not achieving a growth rate of 0.6 kg/d at 140 days of age would not be permitted to enter the stimulation phase. In a study conducted at the University of Alberta, 13% of 228 gilts would have been culled because they did not meet the minimal growth criteria. This percentage may be higher if gilts are subjected to vaccination programs for PRRS and other diseases. In this case it may be necessary to adjust our benchmarks for entry-to-service interval to acknowledge the reality of the situation.

At "Pre-Select 2" gilts will be further examined to ensure that all gilts have good conformation, locomotion, 12-14 teats and are still free of hernias, ruptures and other ailments. Again, conformation data obtained at "Pre-Select 2" can be used to set up gilts on "fattening" diets if needed. The number of gilts required to enter the stimulation phase will depend on the breeding requirements of the herd. In a trial recently completed at Prairie Swine Centre, the results indicated that approximately 125% of breeding gilt requirements should enter the stimulation phase (expecting 22% not to cycle and 3% to be culled) to obtain the required number of gilts that are naturally cyclic within 40 days. If the target number of gilts needed to enter the gilt pool cannot be met with gilts that meet minimal growth targets at "Pre-Select 2", an appropriate number of "Non-Select" gilts can enter the puberty induction phase, as a last resort, accepting that these gilts will either tend to be bred below target breeding weight, or will accumulate excessive NPD before breeding.

Final selection – puberty induction.

The age to begin puberty stimulation will depend on a number of factors. Generally, a younger age at stimulation corresponds to a decreased age at puberty, but requires more days in stimulation; conversely, older gilts at stimulation are typically older at puberty, but require fewer days of stimulation. However, stimulating gilts at an earlier age (as shown in Figure 6) has several benefits.

- Stimulation at a young age enables the producer to identify gilts that are most sexually mature.[6]
- Stimulating gilts early would permit a producer to cull non-cycling gilts as market animals, reducing the number of gilt NPD and the financial cost to the producer.
- Gilts can be better managed to achieve a target weight (135 – 150 kg) and body condition.

- Early stimulation allows a producer to synchronize estrus in gilts using products like Regumate (Matrix in the USA) and thus meet breeding requirements from a smaller pool of select (service eligible) gilts.
- Finally, early stimulation of gilts permits producers to take advantage of the increased productivity of gilts bred at second or third estrus.

It is important to understand that stimulation of early onset of puberty does not mean that these gilts have to be bred at first estrus, or at a light weight. As previously mentioned, puberty induction at an early age serves to identify the precocious animals. In a recent experiment, out of 508 gilts stimulated with direct daily boar contact from 140d of age, 77% of gilts were pubertal within 30 days of stimulation. By comparison, when stimulation is delayed to at least 160 days (Figure 7), 84% of gilts had a recorded first estrus by the same 30-day cut-off. If a large proportion of gilts are required to reach a synchronous puberty, commencing boar exposure at an older age is desirable.[7] This is also probably most efficient in terms of labor and space utilization – increasing eligible gilts/pen space/day.

It is becoming increasingly important to identify the 75 to 80% of gilts that respond earlier to boar stimuli, because there are sound biological reasons, and increasing amounts of production data, to support the suggestion that later- maturing gilts will have reduced lifetime fertility. Data from a gilt development study conducted at the Prairie Swine Centre, Saskatoon, is examining the relationship between age at puberty and lifetime performance in Camborough 22 and L42 gilts. The gilts were housed in groups of twenty and received 20 minutes of direct daily exposure to an epididiectomized boar, starting at 140.0 ± 4.7 days of age. Gilts attaining puberty by 180d of age were deemed to be "select" gilts and classified as Early (EP), Intermediate (IP) and Late (LP) with respect to age at first estrus. Gilts were deemed to be "Non-select" (NP) if first estrus was not shown by 180 d of age. "Select" gilts were bred at third estrus, regardless of age or weight. "Non-select" gilts were added to the gilt pool by production staff using available techniques (i.e. mixing, additional boar contact and treatment with PG 600) after entry to the sow farm. To determine sow lifetime performance, data on sow body weight, loin and backfat depth at farrowing and weaning, total litter size born alive, dead and mummies, weaning-to-estrus interval and reason for culling were collected over three parities. Some initial results are presented in Figure 8.As a percentage of the total number of gilts on inventory at the start of stimulation in each group, fewer "Non-Select" gilts were bred than any of the classes of "Select" gilts. Consequently for NP gilts, pregnancy rate, farrowing rate, weaning rate and the percent rebred after weaning after first parity (expressed as a % of gilts originally on inventory) were lower than for EP, IP or LP gilts. Furthermore, considering only those gilts successfully weaned as parity 1 sows, class of gilt affected ($P < 0.02$) the percentage of animals pregnant as parity 2 sows (EP: 94.2; IP: 87.2; LP: 91.0; and NP: 76.6 %). Similarly, breeding herd efficiencies (Non-Productive Days/pig born) declined as age at puberty increased, when gilts were bred at third estrus irrespective of weight or age. Taken together, these data lead to the obvious suggestion that response to a standardized protocol of boar stimulation can be used to identify the 75-80% of gilts that are likely to be most fertile.

As illustrated in Figure 8, to meet breeding targets, or in start-up situations, it may be necessary to retain Non-Select gilts as part of the breeding herd. However, retention of "Non-Select" gilts within the herd would;

- Incur costs of unknown numbers of additional NPD
- Represent less efficient use of pen space within the gilt pool
- Still not guarantee that gilts would eventually cycle.

It is also important to emphasize that even if these gilts are bred, their expected fertility would be low. It may be good management practice to already designate these "Non-Select" gilts at parity 1 culls, if they are included in the herd to meet initial breeding targets.

Taking these factors into account, and considering expected cost-benefits of efficient use of space and time, we recommend that the puberty induction phase begins when gilts reach 160 days of age and continue until they exhibit their first estrus or until 190 days of age, whichever comes first.

Further refinements to standardize breeding weight of gilts. As shown in Figure 9, the results of the study at Prairie Swine Centre for which data are shown in Figure 6, indicate that early exposure (135 - 140 days of age) of gilts to boars resulted in a large variation in weights and ages at puberty, ranging from 75.8 to 151.4 kg, and 132 to 190 d, respectively. Because all gilts were bred at third estrus in this study, this variation in weight at puberty resulted in weights at breeding ranging from approximately 100 to 190 kg. These large ranges present several problems to the producer.

- Gilts that are heavy at breeding incur increased lifetime feed costs for maintenance and may cause welfare problems because of potentially larger physical size as mature sows

- Conversely, gilts that are lightweight at breeding may lack the necessary body reserves to sustain body condition through several parities.

Recent studies at the University of Alberta, and elsewhere, suggest that a minimum body weight after farrowing of 175-180 kg may be necessary to protect against excessive loss of protein mass during the first lactation.[8,9] As suggested by Foxcroft[10], a body weight of 135-140kg at breeding, assuming a 35-40 kg weight gain during the first gestation, would theoretically result in body weight after farrowing being 175 kg or greater. Development and implementation of gilt management strategies that ensure that all gilts achieve adequate body tissue reserves at farrowing are necessary.

To overcome the problems associated with large variations in weight, a stricter selection program should be implemented, stipulating that all gilts weigh between 135 – 150 kg at breeding. If the gilts for which data are presented in Figure 9 had been bred according to a desired target weight of 135-150kg, they would have bred at their 1st through 7th estrus. However, 1) if during Pre-Select 1 and Pre-Select 2 the slowest growing gilts were already culled, and 2) an upper limit of 3rd estrus for breeding was stipulated, the number of non-productive days would be dramatically reduced. Using these tighter selection criteria, it was predicted that 10, 32 and 58% of gilts would be bred at their 1st, 2nd and 3rd estrus, respectively, to meet the target weights at breeding.

Cost-benefit analysis of gilt management programs. The next real challenge is to develop comprehensive economic analyses of different gilt replacement programs to demonstrate the net cost/benefits of particular systems. One component of this analysis will be to provide a cost benefit analysis of the capital costs of retrofitting existing facilities or including additional costs in GDU designs against the increase in labor efficiency and use of space. Although we have not reached this point in our own program, we believe that many concerns about extra labor requirements to implement more efficient GDU protocols are unfounded.

Basic requirements of good estrus induction programs are well defined in research literature and relatively simple to understand. Practical implementation requires effective interaction between high libido boars with pre-pubertal gilts that have achieved a minimum growth performance at the time of stimulation. "Adequate interaction" requires attention to the boar:gilt ratio and the amount of contact time allowed. In an ideal system, these programs can still result in around 85% of gilts being recorded in pubertal estrus within three or four weeks of initial boar contact. This system also triggers a management decision about the fate of the 15 to 20% of non-responders. Based on several recent studies and assuming around 20 minutes per day of boar stimulation on a pen basis, it will be possible to identify the manpower needed to run this intensive-type GDU system. The critical "next step" is to compare the economic inputs v. outputs of such systems against equally well audited but less labor-intensive GDU systems, taking account of the same key performance indicators in each case.

In situations where inadequate boar contact occurs, often with boars showing low libido and being managed by frustrated staff in overcrowded facilities, the success of the estrus-induction process can rapidly fall to 40% or less over the same three to four week period. In terms of the number of eligible gilts/pen space/per day, this constitutes a very inefficient use of the gilt facility. In labor terms this doubles the labor budget to around per eligible gilt. Presented in these terms, we start to appreciate the inherent futility of poor gilt management programs, with over 50% of the time spent in gilt stimulation being non-productive. The economic cost of such inefficiency is then further compounded by the need for extra pen space to house the non-responsive gilts beyond the 28-day stimulation period until they are eventually bred. Considered in terms of a 50% v. 85% farrowing rate, with the same amount of time spent breeding sows over a four-week period, our inability to internalize the relative efficiency of gilt management programs is perhaps more obvious.

Other more complex cost/benefit analyses are needed before the true value of specific gilt management programs will be clearly established. For example, we know from the literature that ovulation rate, and therefore, litter size increase with breeding estrus. If we supposed a 0.7 pig increase in litter size in gilts bred at 2nd rather than at 1st estrus, the extra cost of this 0.7 pig benefit will depend on the housing (capital depreciation) and feed costs and could vary from approximately $13 to $20 . Similarly, if we consider that the increase in litter size between the 2nd and 3rd estrus would be only 0.2 pigs, the extra cost of achieving this 0.2 pig benefit might be unacceptable in some housing situations. However, consideration should also be given to the potential economic benefit that increased weight and fatness resulting from delaying breeding estrus may have on sow lifetime productivity, offsetting the cost of improving first litter size by breeding at 2nd or 3rd estrus. Similarly, if early induction of 1st estrus can be an outcome of more efficient boar stimulation programs applied at a younger age, then the benefits of increased first litter size can be achieved without increased housing costs within the GDU. These and other variables will eventually be integrated into a full economic model to determine the relative cost benefits of GDU options.

Ultimately, these economic models must include a full risk/benefit analysis that recognizes the impact of GDU management on overall production efficiency. Weekly variability and lack of uniformity (weight, age and health status) in weaned pigs moved to nurseries, is a key benchmark of breeding herd efficiency and is largely related to efficiency in meeting GDU breeding targets. Therefore, not only the relative costs of producing a bred gilt, but the economic value in meeting breeding targets must be assessed in determining the GDU as a critical cost centre within the overall production system. We have no doubt that such analyses will confirm the role of improved GDU management in efficient pork production systems.

Successful implementation of improved GDU management

Objective. The objective of this collaborative study was to demonstrate that efficient gilt development unit (GDU) management would improve reproductive efficiency of a 3200 farrow-to-wean sow farm. In this study, the overall primary targets of the GDU were to achieve:

1) 80% *heat-no-serve* (HNS) gilts within a 28-day selection window (85-90% including opportunity gilts);
2) 100% of gilts bred at > 2nd estrus;
3) 100% gilts bred at target weight (135 kg or 300 lb).

28-day GDU "Selection" Program. A selection program involving a 28-day stimulation period was implemented in the GDU:

1) d 1-13; direct (and fenceline) contact with vasectomized boars in a BEAR (Boar Exposure ARea);
2) d 14; remix and re-pen remaining non-cycling gilts;
3) d 23; all "opportunity" (known non-cyclic and proper weight) gilts without HNS receive PG600®;
4) d 28; all eligible gilts are identified and all gilts without HNS are culled.

To aid in achieving these goals, the impact of PG600® and MATRIX™ on reproductive efficiency in the GDU was evaluated. PG600® is a combination of eCG and hCG that mimics the natural reproductive hormones FSH and LH, and can be used to induce heat in prepuberal gilts. MATRIX™ is an orally active progesterone-like compound that can be used to effectively synchronize estrus in sexually mature (known cyclic) gilts and can aid in maximizing farrowing crate utilization by reducing the variation in services per week, increasing the number of pigs weaned per week, reducing variation in weekly weaned pig output and increasing overall breeding herd productivity (Intervet Inc., Millsboro, Delaware).

Synchronization of Breeding Groups using MATRIX™. Once recorded as HNS, gilts were considered service eligible and were candidates for MATRIX™ treatment. Service eligible gilts were individually housed for daily MATRIX™ administration in the stall section of the GDU. MATRIX™ was applied at a rate of 6.8 ml/hd/day using the supplied dosing gun (Intervet) and applied directly onto the feed in drop boxes each day for 14 consecutive days. It was essential that each gilt consumed her daily dose for product efficacy. During the 14-d treatment period, all gilts were permitted fenceline contact with a mature vasectomized boar for at least 1 hour per day. Following treatment, gilts were checked for estrus daily by placing active, mature boars in front of the females. Breeding was carried out in gilt stalls using standardized AI protocols. For analysis, gilts were classified as HNSMAT (natural cycle) or PGHNSMAT (PG600 induced cycle) prior to Matrix treatment.

Results

For groups of gilts where the protocol as outlined was adhered to, Figure 10 illustrates the breakdown of the percentage of gilts with a natural or PG600® induced HNS, less than or greater than 30 days after the initiation of boar exposure. On average, 76.5% of gilts were identified as HNS within 30 days. Additionally, this particular sow farm experienced severe health issues during the study period; it is likely that without PG600®, weekly HNS and service targets would not have been met.

Results indicate PG600® was an effective tool for inducing estrus in "opportunity" (known non-cyclic) gilts. From a total of 1,124 non-cyclic gilts treated with PG600®, 91.5% of gilts exhibited a HNS, 83.7% exhibited a HNS within 7 days of treatment (4.0 ± 0.03 d (range: 1-7 d)) (Figure 11).

Matrix was effective in synchronizing estrus in gilts (Figure 12). Considering only gilts bred within 10 days of Matrix withdrawal, PGHNSMAT were slower to return to estrus than HNSMAT gilts (6.4 ± 0.04 d vs. 6.2 ± 0.04 d after withdrawal), respectively (*$P<0.05$*). As illustrated in Table 1, a larger percentage of gilts were served within 10 days for

HNSMAT compared to PGHNSMAT gilts. No differences were detected in farrow rate between HNSMAT or PGHNSMAT gilts. As illustrated in Table 2, there were no differences in total born, born alive, stillborn, or mummies for HNSMAT or PGHNSMAT gilts.

Table 1. The percentage of gilts bred, returned and farrowed for HNSMAT and PGHNSMAT after Matrix treatment.

	HNSMAT		PGHNSMAT		*P*-Value
All gilts served					
No. with HNS	814		661		
Served (%)	96.7	0.6	91.8	1.0	0.0001
No. served	787		607		
Farrow rate (%)	93.1	0.9	93.7	1.0	0.6541
All gilts served within 10 days					
No. with HNS	814		661		
Served (%)	88.1	1.1	81.5	1.5	0.0005
No. served	717		539		
Farrow rate (%)	93.3	0.9	94.2	1.0	0.4940

Table 2. Total born, born alive, stillborn and mummies for HNSMAT and PGHNSMAT after Matrix treatment.

	HNSMAT		PGHNSMAT		*P*-Value
All gilts served					
No. farrowed	736		569		
Total Born	13.2	0.1	13.0	0.1	0.1713
Born Alive	12.0	0.1	11.7	0.1	0.1348
Stillborn	0.7	0.05	0.8	0.06	0.8832
Mummies	0.5	0.04	0.5	0.04	0.8386
All gilts served within 10 days					
No. farrowed	672		508		
Total Born	13.2	0.1	13.0	0.1	0.2211
Born Alive	12.0	0.1	11.7	0.1	0.1557
Stillborn	0.7	0.5	0.7	0.5	0.9342
Mummies	0.5	0.04	0.5	0.05	0.6009

Conclusions. The combination of the implementation of an effective GDU program, the use of PG600 to induce HNS in gilts, and the use of MATRIX™ to synchronize and schedule estrus in known cyclic gilts, are effective tools in GDU management.

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Figure 1: Effect of puberty stimulation in the gilt commencing either at 160d (closed squares) or 135d (open diamonds) of age. Both sets of data indicate that the highest growth rates achieved by feeding gilts ad libitum with diets aimed to maximize lean growth potential may result in a delay in the onset of first estrus. (Patterson, 2001).

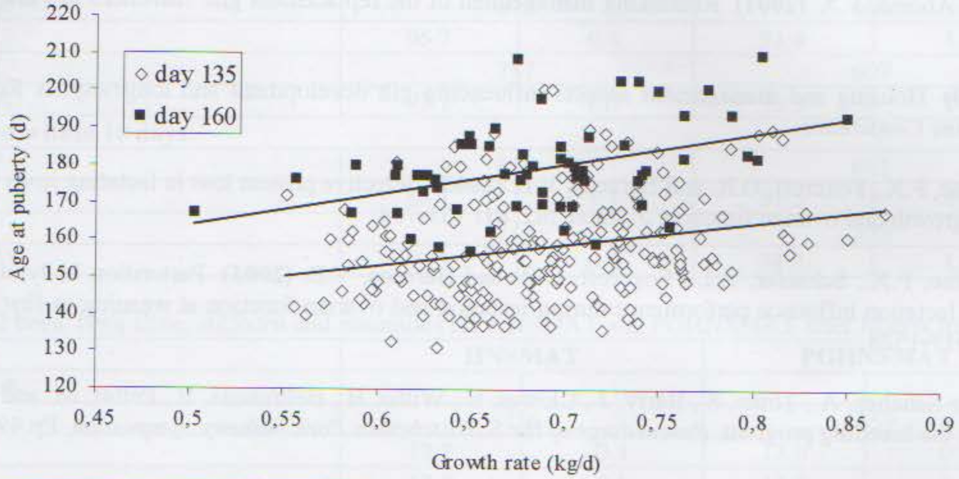


Figure 2: Relationship between growth rate and age at pubety in response to daily boar stimulation from 140 days of age (open diamonds). Gilts not recorded in estrus by 180 days were designated Non-Responders (closed diamonds). Prairie Swine Centre and University of Alberta, Swine Research & Technology Centre, unpublished data, 2003.

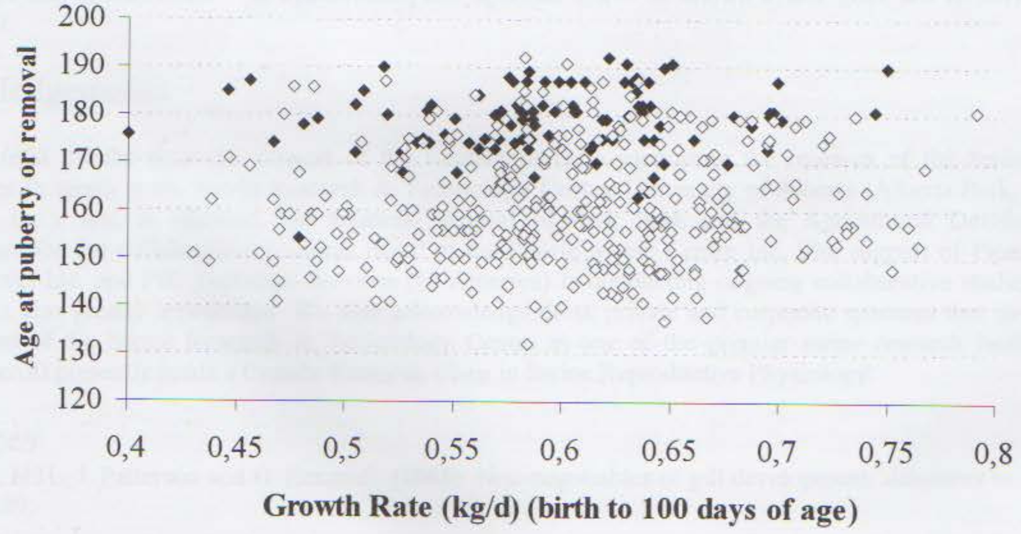


Figure 3a. Associated changes in body weight and backfat depth between breeding and farrowing for naturally cyclic Camborough 22 gilts bred at third estrus, irrespective of age, weight or backfat. Dashed and solids lines indicate average weight and backfat at each time, respectively (unpublished data, University of Alberta, 2005)

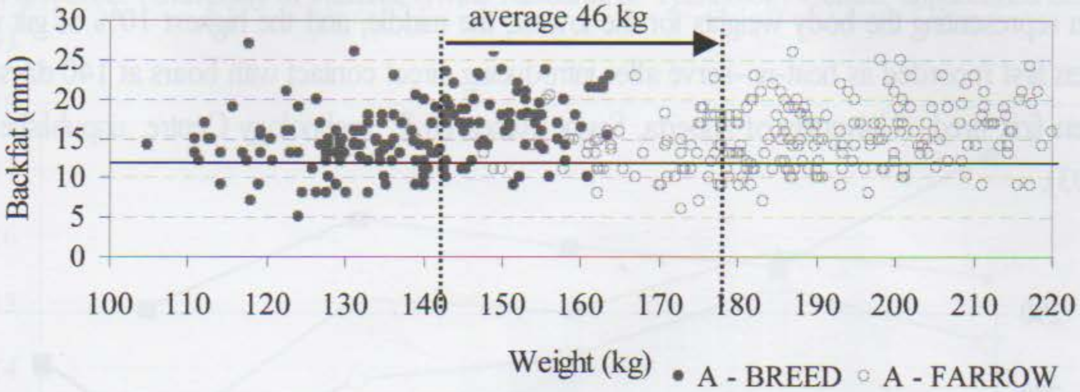


Figure 3b. Associated changes in body weight and backfat depth between breeding and farrowing for naturally cyclic Hypor gilts bred at first or second estrus, irrespective of weight or backfat. Dashed and solids lines indicate average weight and backfat at each time, respectively (unpublished data, University of Alberta, 2005)

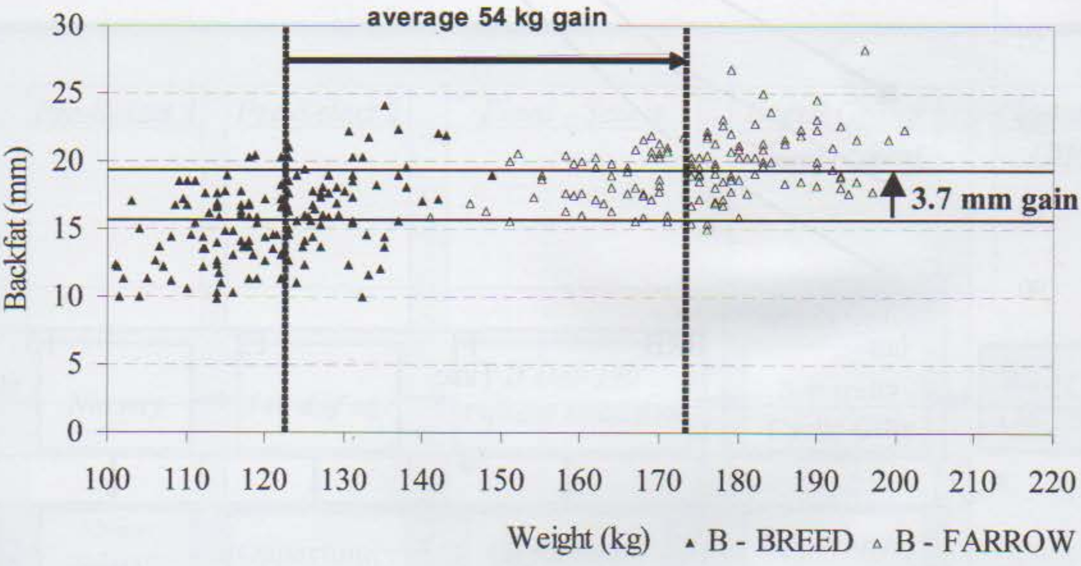


Figure 4a: Mean body weights of gilts bred at third estrus, regardless of body weight, with the data representing the body weights for the lowest, the middle, and the highest 10% of gilt weights when first recorded as heat-no-serve after introducing direct contact with boars at 140 days of age when first bred. (University of Alberta, Swine Research & Technology Centre, unpublished data, 2003).

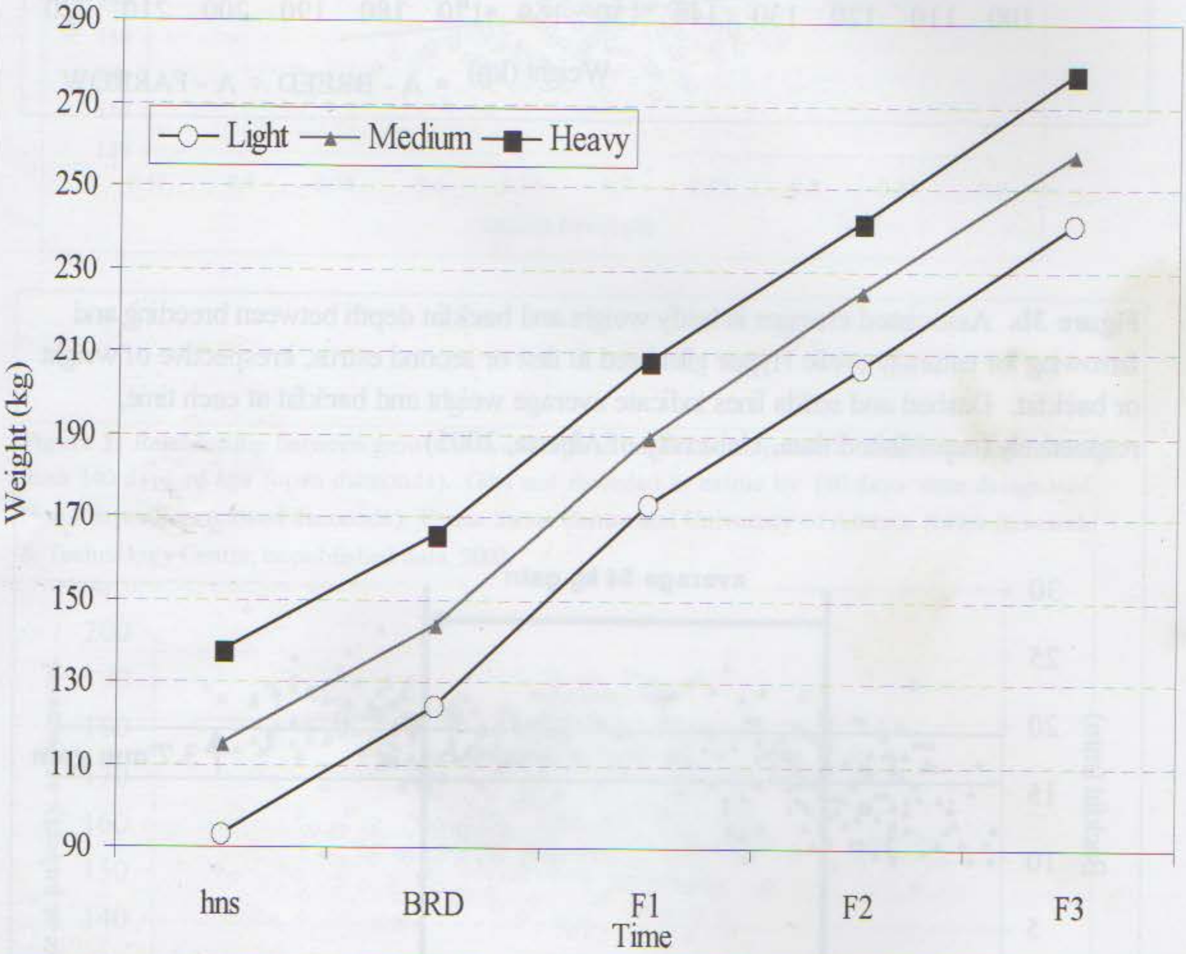
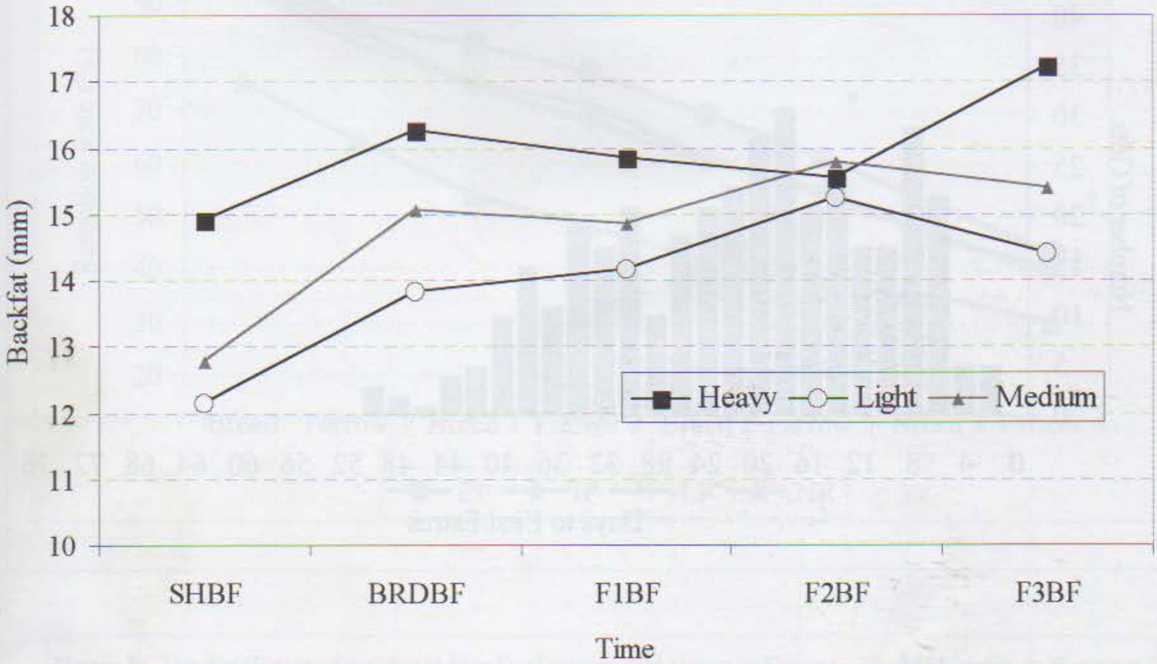


Figure 4b. Mean body weights of gilts bred at third estrus, regardless of body weight, with the data representing the backfat for the lowest, the middle, and the highest 10% of gilt weights when first recorded as heat-no-serve after introducing direct contact with boars at 140 days of age when first bred. (University of Alberta, Swine Research & Technology Centre, unpublished data, 2003).



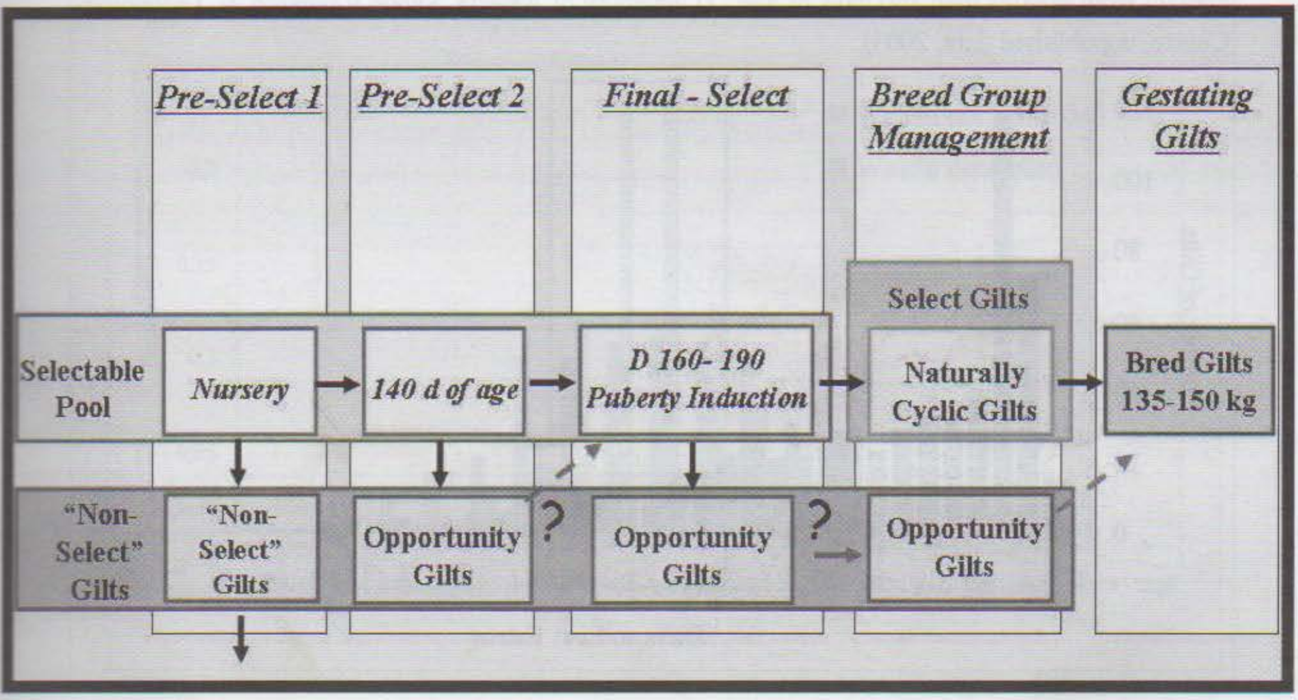


Figure 6: Number of gilts per day showing pubertal estrus after stimulation with direct boar contact from approximately 140 days of age. 112 gilts out of 509 (22%) did not exhibit first estrus. Prairie Swine Centre and University of Alberta, Swine Research & Technology Centre, unpublished data, 2003.

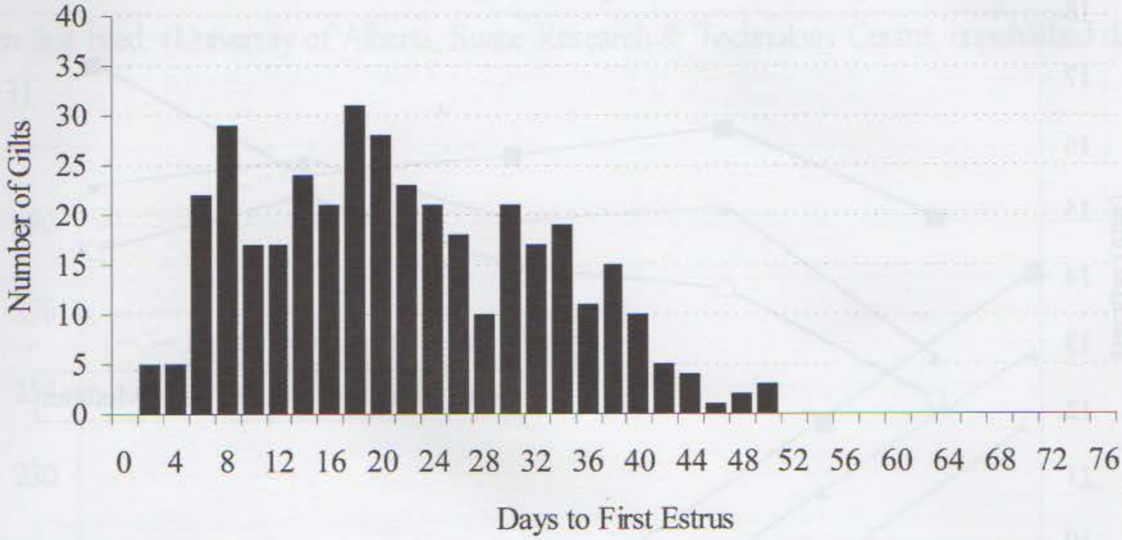


Figure 7: Number of gilts per day showing pubertal estrus after stimulation with direct boar contact from greater than 160 days of age. (University of Alberta, Swine Research & Technology Centre, unpublished data, 2003).

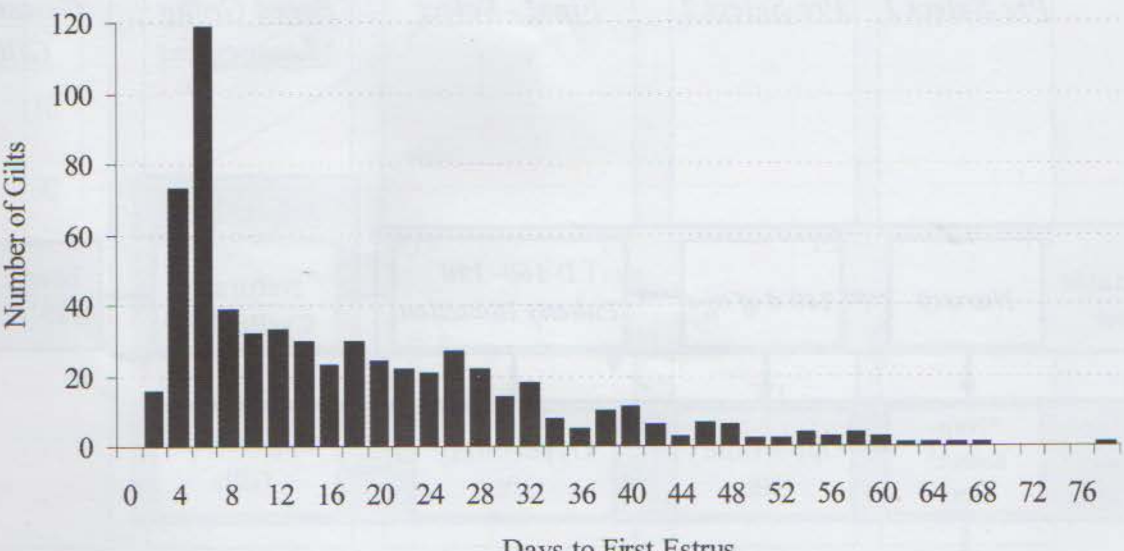


Figure 8. Breeding, pregnancy, farrowing, weaning, and rebreeding rate over three parities as a percentage of gilts originally on inventory (Prairie Swine Centre and University of Alberta, Swine Research & Technology Centre, unpublished data, 2004)

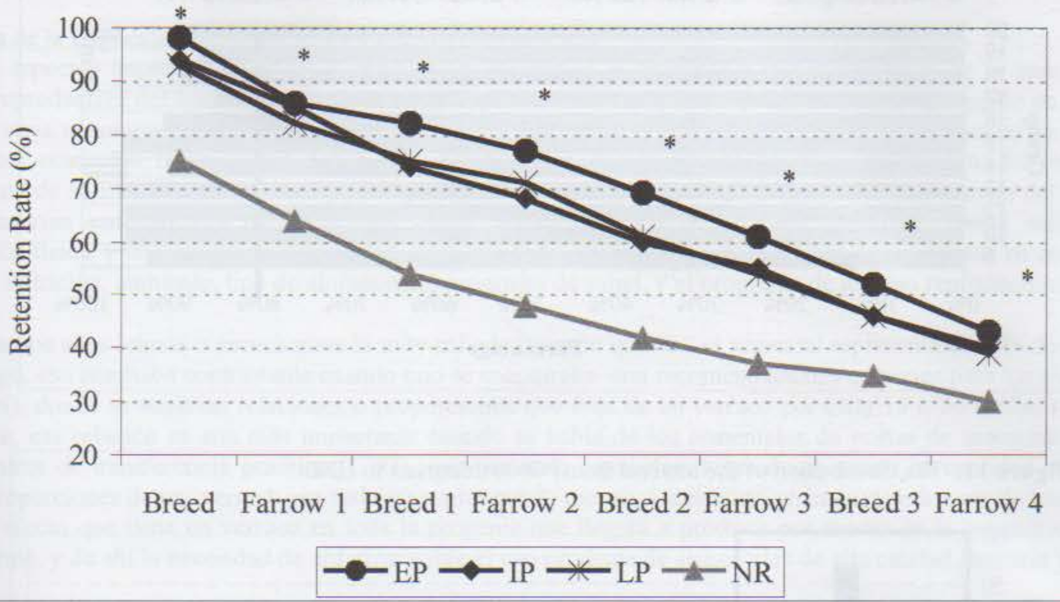


Figure 9: The distribution of weights at breeding for same gilts shown in Figure 6. The black rectangle illustrates the targeted 135-150 kg (+/- 5 kg) breeding weight range. The black bars represent gilts bred at 3rd estrus, irrespective of weight (43.2% fell into range). The checked bars represent gilts targeted to be bred within the weight range (72.4%)

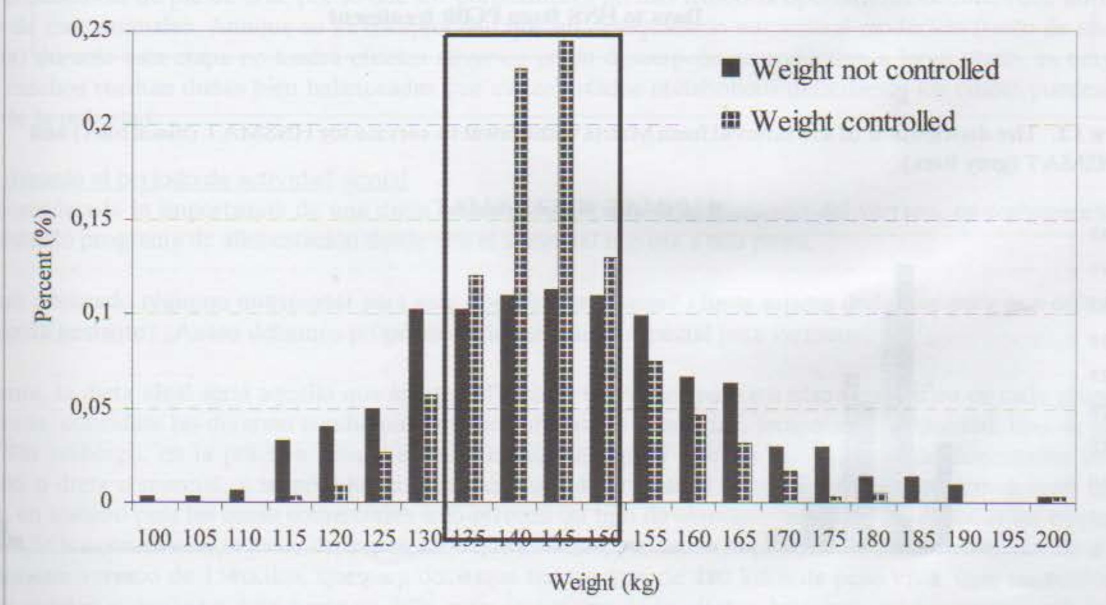


Figure 10. Percentage of gilts in heat less than and greater than 30 days (both natural and PG600 induced HNS) for monthly groups in the GDU.

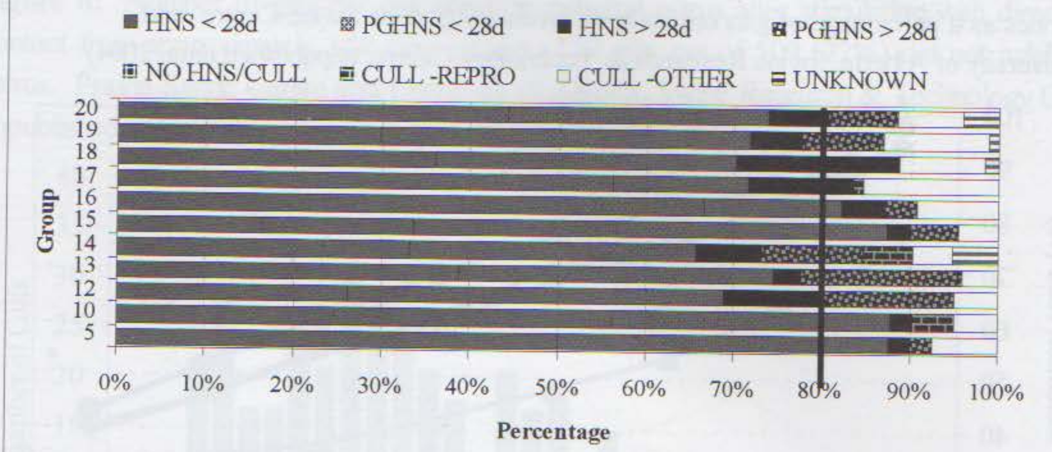


Figure 11. The distribution of the interval from PG600 treatment to HNS

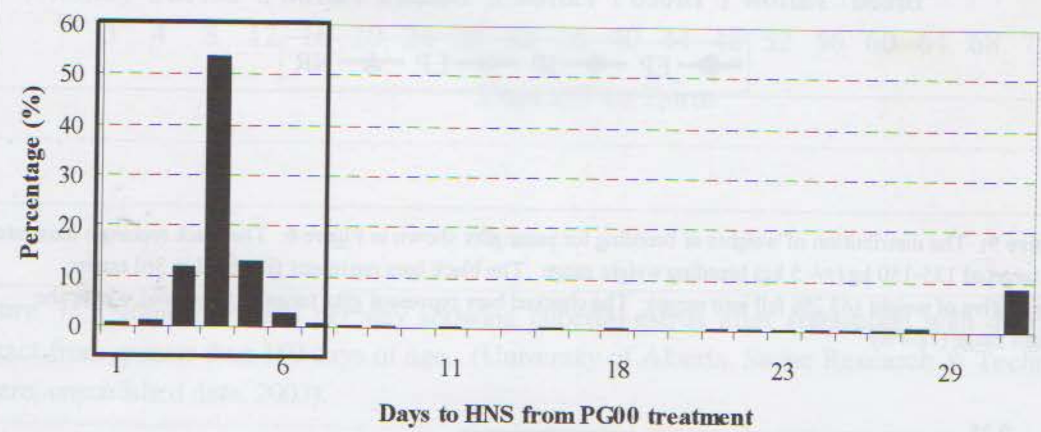


Figure 12. The distribution of the interval from Matrix withdrawal to service for HNSMAT (black bars) and PGHNSMAT (grey bars).