

Identifying the true value of effective replacement gilt

George Foxcroft¹, Jennifer Patterson¹, Eduardo Beltranena¹ and Murray Pettitt²
¹Swine Research and Technology Centre, Edmonton, Alberta; ²Prairie Swine
Centre Inc., Saskatoon, Saskatchewan.

Introduction

It has long been our view that improvements in gilt development programs can lead to major improvements in breeding herd efficiency. Whether gilts are reared in ‘in-house’ gilt multiplication systems, or supplied by a breeding company, available data suggest that the proper selection and management of replacement gilts has an impact on lifetime non-productive days (NPD). As discussed later, we have been accumulating data to support this view. However, the “true value” of improved management of replacement gilts goes well beyond a simple consideration of NPD. In a recent presentation at the Red Deer Swine Technical workshop, the audience was reminded that PigChamp 2002 data shows that on Canadian farms with an average herd female inventory is 1,046 (range 240-2,740), the an average replacement rate was 58.7% (range 33.4-74.4%). It is not unusual to see replacement rates of over 60% on larger production systems. An excessively large pool of replacement gilts is needed to meet these replacement requirements. Apart from the extra costs of maintaining a large gilt pool, the bias of production towards lower parity females places major constraints on breeding herd performance. The usual observation would be that the individual productivity of the gilts introduced into the breeding herd declines as the size of the gilt pool relative to gilt breeding targets increases. As a result, there is continual over-breeding to meet production targets of weaned pigs shipped to the nurseries, in turn leading to chronic over-crowding of pens in the gilt development area.

Therefore, it is essential that producers implement gilt management programs that will meet replacement targets from a smaller pool of gilts, and that these gilts have improved lifetime breeding potential. This will ultimately result reduced annual replacement rates (target in top 10% of breeding herds might be 45%), improving sow “fitness”, decreasing sow death losses, and increasing labor efficiency and space utilization. We believe that cost-benefit analysis will strongly favor these programs. We will try to review some of the background information on the type of gilt replacement systems that are likely to be most sustainable, and attempt to define the economic benefits associated with these programs. Even from an initial analysis of cost benefits, there are clearly important opportunities for improved efficiency, but we are increasingly aware of the need to justify a change in input costs to achieve some of these net gains. Perhaps those who allocate financial resources to the gilt development unit need to spend an obligatory period of time working in the existing systems to appreciate the need for investment – in the meantime we will do our best to present a convincing case for this investment!

However, we should also appreciate that some of the key advantages of improved breeding herd management cannot be defined in simple economic terms. These relate

more to improving the quality of the work situation and removing a level of futility that can only be counter-productive for both management and staff.

- A good example would be an issue that is probably the foundation of all gilt replacement programs – the ability to induce and record first estrus in gilts. The basic requirements of good estrus induction programs are well defined in research literature and relatively simple to understand; an effective interaction between mature boars with high libido and 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. As discussed later, 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. Assuming around 20 minutes per day of boar stimulation on a pen basis, this translates into around 3.5 minutes of labor per gilt eligible for breeding. 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 effective labor terms this also increases the labor budget to around 7 minutes per eligible gilt. Presented in these terms, we start to appreciate the inherent futility of poor gilt management programs; over 50% of the time spent in gilt stimulation being non-productive. Think of this in terms of a 50% v. 85% farrowing rate with the same amount of time spent breeding sows over a four-week period, and our inability to internalize the relative efficiency of gilt management programs is perhaps more obvious.

Therefore, by making gilt management more efficient, we improve both the utilization of both 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 the remainder of this review is 1) to define the goals of effective gilt management programs, 2) to back these goals with reliable data, and 3) to begin to provide the economic and social justification for making the necessary investment in such programs.

Key goals of effective gilt management programs.

Gilt development programs can be refined to match the individual needs of the producer (i.e. “in house” multiplication or out-sourced breeding stock), to identify the potential fertility of the gilt and provide opportunities to improve fertility and retention through gilt “conditioning” and pre-breeding management. *However, three key aspects of a good gilt management program are:*

1. **Implementing a strict selection program that identifies 75-80% of the most fertile animals, based on lifetime performance.** This is probably the real driver of increased replacement rates in recent years.
2. **Achieving appropriate weights at first breeding to improve retention in the breeding herd.** A minimum body weight after farrowing of 175 kg (135 kg at breeding) may be necessary to protect against excessive loss of protein mass in first lactation (Clowes et al., 2003) and to provide adequate fat cover to reduce culling of sows due to injury.
3. **Minimizing accumulated non-productive days (NPD) in the gilt pool, and thereby increasing the efficiency of space and labor utilization.** Low growth rate, unnecessary delays in stimulating pubertal estrus and breeding gilts, and inefficient allocation of gilts to breeding groups, are the largest contributors of NPD's in the herd.

Taking into consideration what we know about gilt development, and incorporating the above key points, we suggest the in-house gilt management system shown in Figure 1. Identifying “select” gilts at an early age is a critical part of a successful gilt development program. This selection process will involve of 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. Available data consistently show that at commercially acceptable growth rates (0.55 – 0.80 kg/d) (birth to 100 days of age), there is no relationship between growth rate and age at puberty (Figure 2). Experience in commercial practice suggests that modified, high energy, "conditioning" diets can be used to increase body fat stores in very lean gilts. In studies in which we attempted to slow growth in gilts with high fibre diets from 50 kg until puberty induction (Patterson et al., 2002a), we had very little impact on bodyweight at first estrus.

Pre-Select 2

“Pre-Select 2” will occur at 140 days of age, **at which time gilts will be assessed for weight, growth rate and backfat depth.** At this stage, gilts must achieve a lifetime growth rate of at least 0.6 kg/d. Figure 3 illustrates why 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 days 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 to us that exclusion of lower growth rate gilts is the preferred 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, gilt 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 inherent diseases, in which 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 40d.*** 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, as illustrated in Figure 4, a younger age at stimulation corresponds to a decreased age at puberty, but requires more days in stimulation; and vice versa, older gilts at stimulation are typically older at puberty, but require fewer days of stimulation. If a large proportion of gilts are required to reach a synchronous puberty, commencing boar exposure at an older age is desirable (Levis, 2000) (Figure 5). This is also probably most efficient in terms of labor and space utilization – ***increasing eligible gilts/pen space/day.***

However, stimulating gilts at an earlier age has several benefits (Figure 6).

- Stimulating gilts at a young age enables the producer to identify gilts that are most sexually mature (Foxcroft and Aherne, 2001).
- 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.

- A producer is able to manage gilts so that at breeding, gilts have achieved a target weight (135 – 150 kg) and body condition.
- Early stimulation also 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.

Historically, age at puberty has been shown to be normally distributed when growth rate is not limiting. The full extent of this variation in age at first estrus is most apparent if gilts are exposed to mature boars at an early age (say 140 days as in the study presented in Figure 6). 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, 75% of gilts were pubertal within 40 days of stimulation. When stimulation is delayed to at least 160 days (Figure 5), it is possible to identify 33, 16 and 7% of gilts that do not respond to boar stimuli within 20, 30 or 40 days, respectively.

It is becoming increasingly important to identify the 75 – 80% of gilts that respond best to boar stimuli, because there are sound biological reasons, and increasing amounts of production data, to support the suggestion that ***late maturing gilts will have reduced lifetime fertility***. An on-going study being conducted at 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 min direct exposure to an epididymectomized boar daily, starting at 140.0 ± 4.7 d 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. treatment with PG 600). 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 are being collected over three parities.

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 (Figure 7). 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 (Table 2). 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 1, 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.

However, be aware that puberty stimulation at a delayed age (> 160 days of age) will be reflected in the high body weight of “Non-Select” gilts (gilts that did not exhibit first estrus within 30 days). In our recent study, even when puberty induction began at 140 days of age, nearly 80% of “Non-Select” gilts at 180 d were over market weight (120 kg), creating financial penalties to the breeding unit if these gilts were then culled.

Further refinements to standardize breeding weight of gilts

The results of the ongoing study at Prairie Swine Centre 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, 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 heavyweight at breeding increase feed costs and may cause welfare problems because of potentially larger increased physical size of 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 (Quesnel and Prunier, 2003; Clowes et al., 2003). As suggested by Foxcroft (2002), 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*. As shown in Figure 3, if gilts from this study had been bred according to weight (135-150kg), they would have bred at their 1st through to their 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 (Table 1). It was predicted that 10, 32 and 58% of gilts would be bred at their 1st, 2nd and 3rd estrus, respectively (Figure 8). In our previous study, NPD's accumulated by each group when bred at third estrus are shown in Table 1; this table also shows the effect of implementing a breeding weight target of 135-150 kg on NPD. These estimated NPD are clearly closer to the real outcome of incorporating requirements for both a recorded natural estrus and a target breeding weight range into our gilt management strategy. Even in this situation we have already identified significant differences in lifetime NPD in the different categories of gilts. In particular, these data indicate that there are real advantages in at least identifying very late and non-responding gilts as “non-select” if this is possible. Our view is that “non-select” gilts should only be used as “opportunity” breeding if gilt mating targets have not been met.

Cost-benefit analysis of gilt management programs

The next real challenge is to extend the economic analysis of dynamic gilt replacement programs to achieve a clear view of the net benefits of particular systems. A brief summary of an initial attempt to develop such analyses forms the final part of this paper, and is based on the presentation of Beltranena et al. (2003) at the Red Deer Technical Workshop. In this analysis we compared breeding gilts at their first, second and third estrus in two systems: gilts housed and managed in pens and gilts housed and managed first in pens and subsequently in crates.

Case 1: Gilt Management in Pens

Figure 9 shows the layout of the gilt pool area for a sow herd where weekly groups of gilts are housed and managed in pens. We assumed that this gilt pool area receives 16 market-size (115 kg) gilts weekly (continuous flow) from the same farm. Gilts are taken as pen groups to the boar exposure areas. They alternate co-mingling with one of four epididymectomized boars (Eboars) for approximately 20 minutes daily. Gilts showing standing heat are temporarily moved into the small pens in this area to allow the boar to focus on the non-standing pen-mates. Eboars are allowed to breed standing gilts in the presence of pen-mates at the end of the Eboars' daily stimulation period a couple of times a week. Gilts showing first estrus (puberty) are recorded and returned to their pens.

Breeding at 2nd estrus

In this simulation, 7 gilts show estrus in the 1st week, 4 in the 2nd week and 2 in the 3rd week. Three non-responder gilts are shipped for slaughter by the end of the 4th week. Our data have shown that 75 – 85% of gilts show puberty within 30d of the start of boar stimulation (Figure 10). Non-responder gilts will be equivalent to those shown to the right of the rectangular box in Figure 10. In this simulation, gilts continue to be housed in pens and are bred mostly by AI at 2nd estrus. Bred gilts (cyclic minus 5% injured, other culls) are then relocated to the dry sow barn once a week. Thus, pens empty and re-filled by the end of the 7th week. Table 1 summarizes these estimates.

The barn area with 8 gilt pens, 4 Eboars and exposure areas, as depicted in Figure 1, was calculated at 378m² or 4071ft². Building cost was assumed at \$300 per 1m² or 10ft², amortized over 15 years. A labour budget was prepared based on routine daily activities conducted in this area. We estimated that one employee would invest about 3h/d including weekends. No time allowance was made for maintenance and repairs related to this area. Assuming that a market size gilt would consume on average 3.25kg/d during the stimulation period and between 1st and 2nd estrus, feed requirement estimates added up to ~111 tonnes per year.

What if gilts were bred lighter at 1st estrus?

If gilts were bred lighter at 1st estrus, barn area would be reduced by ~40% because only 5 gilt pens would be needed on a 4-week pen rotation. Eboars and exposure areas would be reduced to two. Labour requirements would also be reduced somewhat. We estimated savings of only about a ½h labour per day by breeding at 1st estrus compared to breeding at 2nd estrus. Feed requirements would be reduced by ~48 tonnes per year. This assumes that gilts during the puberty induction period would average 3.0kg/d intake.

What if gilts were bred heavier at 3rd estrus?

Delaying breeding until the 3rd estrus to allow gilts to become heavier and consequently fatter, would increase barn area only by ~15% because 10 gilt pens would be needed on a 9-week pen rotation. Six Eboars could be used but four boar exposure areas should suffice, as one operator could not handle checking more than four gilt groups simultaneously. Labour would not increase much (½h/d) above that required when breeding at 2nd estrus. Heavier gilts eat more; thus, we assumed 3.5kg average intake/day up to their 3rd estrus resulting in ~48 tonnes more of feed consumed per year. Table 2 summarizes these estimates.

Case 2: Gilt Management in Pens & Crates

To increase throughput and control feed intake, some barns house replacement gilts in a combination of pens and crates. Figure 11 depicts an example of the layout of such gilt pool area. Gilts are stimulated as previously described while they are housed in group

pens, but are relocated to individual crates within days of showing standing 1st estrus. Heat detection is thereafter carried out while a boar walks in front of the crate rows.

Comparing Pens-Only vs. Pens & Crates

The comparison of both systems is summarized in Table 2 for gilts bred at 2nd or 3rd estrus. Irrespective of breeding estrus, the pens and crates system can generate more bred gilts annually than the pens-only system described previously. Throughput is constrained by how long gilts are kept in crates in this area after breeding. Housing gilts in crates after breeding allows for a rigorous control of feed intake which impacts embryo survival in gilts.

Barn area is similar in size when comparing gilts bred at the same estrus, but we assumed that building costs were \$50 higher/1m² or 10ft² due to crates and extra slurry pits for the pens and crates example compared to pens-only system. We assumed similar labour (3 and 3½h/day for gilts bred at 2nd and 3rd estrus, respectively) for gilts housed in pens first and then in crates and those housed in pens-only. This is because we envisioned wet/dry feeders for pens and feed drops for crates. Thus, there would be no significant extra feeding labour. However, because of increased throughput, labour per bred gilt is lower for the pens and crates system compared to pens-only. We then assumed that voluntary feed intake for gilts housed in pens-only for up to their 2nd estrus would average 3.25kg/d. In contrast, gilts housed initially in pens and subsequently in crates may consume less (3.0kg/d) during the induction period but may not be offered free access to feed once moved to crates between 1st estrus and breeding at 2nd estrus. Therefore, savings in the order of 26 tonnes of feed or ~\$6.5 per bred gilt are possible by relocating gilts to crates after their 1st estrus and implementing a mild restriction (2kg/d). Nonetheless, gilts must be flush-fed (3kg/d) 7 to 10d prior to breeding at the 2nd estrus to prevent a reduction in ovulation rate.

Someone who relocates gilts to crates between the 1st and 3rd estrus and implements feed restriction followed by flushing should expect savings in the order of 39 tonnes of feed or ~\$11.50 savings per bred gilt, compared to housing gilts in pens-only having free access to feed for up to their 3rd estrus (3.5kg/d). Non-responder gilts may gain ~20kg during the 28d period between receiving them at the gilt pool area and the time they are culled. A 135kg gilt would only achieve an 85 index when culled and would not qualify for the health or lean incentive bonus under the new OlyWest contract. Thus, a non-responder is worth \$22.50 less compared to a market size gilt (Table 2; see footnote). This loss in carcass value of non-responders is then divided among the cost of their group-bred counterparts.

Costs vs. Benefit

So far we have only discussed costs for both systems, but what's the benefit? From the literature, we know that ovulation rate, and therefore, litter size increase with breeding estrus. At least the increase in ovulation rate seems greater in limit-fed gilts compared to gilts with free access to feed. Nonetheless, these values are old and the relevance to modern genotypes is questionable.

In these simulations, 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 would be ~\$20 and ~\$13 for the pens-only and the pens and crates systems, respectively. Similarly, we considered that the increase in litter size between the 2nd and 3rd estrus would be 0.2 pigs. The extra cost of this 0.2 pig benefit would be 26% higher for the pens-only system (\$17.97) compared to the pens and crates system (\$13.31). The benefit of merely an extra 0.2 pig gain by delaying breeding from 2nd to 3rd estrus is similar to the simulated cost of the first 0.7 pig gained by delaying breeding from 1st to 2nd estrus within system. However, no consideration was given to the potential benefit that increased weight and fatness resulting from delaying breeding estrus may have on sow lifetime productivity. These and other sow variables will eventually be integrated into the model.

As discussed earlier, the gilt study at Prairie Swine Centre Inc. used boar stimulation starting at 140d of age and gilts were bred at 3rd estrus. We found a huge range in body weight (90kg) and age (60d) at breeding! In order to reduce such impractical variation, we are conducting a subsequent study breeding between 135 to 150 kg irrespective of estrous cycle. We hope to reduce cost and address weight and age variation using this approach and cost-benefit analysis will need to incorporate such changes.

For the simple simulations presented here, we assumed a constant flow of ready-to-breed gilts. However, weekly variability constitutes feast or famine for many herds. This is a key factor to achieving herd breeding targets. Otherwise, fluctuations in the weekly number of hogs sold will impact revenues. Constant flow of gilts is a huge issue for herds managing all-in, all-out isolation barns. This is also one of the most overlooked cost centres for large production system! Gilts must be incorporated early into the destination herd to minimize the impact on flow. Otherwise, boars must be moved into the isolation barn(s) so that puberty induction can be carried out there. Cyclic gilts are then ready to be bred once they cycle at the destination barn. Again, adequate cost-benefit analysis of these different options is urgently needed to promote an active interest in the development of better systems.

Conclusions

The results of these conservative simulations indicate the importance of analyzing gilt pool costs and potential benefits. Costs may be reduced by housing pubertal gilts in crates or using other means (i.e., electronic sow feeders) to initially limit feed intake followed by flushing preceding the breeding estrus. The cost of achieving the very small increase in litter size by delaying breeding to 3rd compared to 2nd estrus was similar to the cost of achieving the larger increase in litter size obtained by breeding at 2nd compared to pubertal estrus. Such a decision should therefore be weighed towards the potential beneficial effects that accrued weight and fatness may have on lifetime sow productivity, rather than on first litter size born. We think now that breeding between 135 – 150kg irrespective of the number of recorded heats will not only reduce weight and age

variation at breeding, but will also optimize cost and provide gilts with sufficient body tissue reserves to ensure their longevity and retention in the herd. However, the loss in carcass value by the time non-responders reach 130kg and the cost of feed, barn space and labour spent by then may oblige producers to keep these gilts around for at least one parity and then cull them.

Our well-known colleague and and mentor, Frank Aherne, provided the Swine Research & Technology Centre with its unofficial *raison d'etre*..... **“In God we trust – everything else requires data”**. We hope that this review will be seen as an honest attempt to meet this challenge. We have some excellent data that reflects a commitment across the prairie provinces to improve our knowledge base through industry-relevant R & D programs. This R & D can now be extended to the creation of realistic economic models on which to base key management decisions. We hope this paper gives a useful insight into how we see this developing and the potential it offers for further improvements in breeding herd efficiency.

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Table 1. Breeding herd efficiency as determined by NPD accumulated by d30 of gestation of parity 2. (Prairie Swine Centre, and University of Alberta, Swine Research and Technology Centre, unpublished data 2003)

	EP	IP	LP	NP	SEM	P-Value
NPD actual ^{1,2}	50.5 ^a	58.5 ^{ac}	75.5 ^b	71.1 ^{bc}	4.6	0.0002
<i>NPD predicted</i> ³	41.2 ^a	41.4 ^a	49.2 ^a	69.2 ^b	4.7	0.0001
Born Alive	10.1	10.1	10.3	10.2	0.3	0.3583
Expected Savings ⁴	-	-	\$14	\$56		

¹NPD calculated from 170d (days to reach slaughter weight of 120 kg with an average growth rate of 0.71 kg/d)

²Actual # NPD accumulated to d30 of gestation of parity 2

³ *Predicted # NPD if gilts were bred at 135 kg body weight or 3rd estrus*

⁴ Expected savings of identifying “select” gilts compared to the additional NPD accumulated by late-responding and non-select gilts at the time of rebreeding after weaning their first litter. Accumulated NPD includes the NPD arising from gilts on inventory that were never bred, gilts bred but not farrowing, and the failure of parity 0 sows to re-breed after weaning.

Table 2. Cost estimates of breeding gilts at 1st, 2nd or 3rd estrus versus the corresponding potential benefit of increased litter size at 1st parity for gilts housed in pens-only or in pens first and subsequently relocated to crates

Breeding estrus	Gilts housed in pens-only			Gilts housed in pens & crates	
	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>2nd</u>	<u>3rd</u>
Gilts thru /y	1040	959	894	1040	1040
Cyclic	845	782	741	845	845
Bred gilts ^a /y	803	743	704	803	803
Non-responders	195	177	153	195	195
Area ^b \$	5.38	10.18	12.27	10.99	14.65
Labour ^c \$	15.91	20.64	25.41	19.10	22.28
Feed ^d \$	11.73	22.36	33.94	15.93	22.40
Non-responders ^e	5.46	5.36	4.89	5.46	5.46
Cost/bred gilt \$	<u>38.48</u>	<u>58.54</u>	<u>76.51</u>	<u>51.48</u>	<u>64.79</u>
Cost difference \$		20.06	17.97	13.00	13.31
Litter size increase		0.7	0.2	0.7	0.2

^aBred gilts = cyclic gilts – 5% injured, others culls

^b\$300 and \$350 per 1m² or 10ft² for pens-only and pens & crates, respectively

^c\$14/h wages + benefits

^d\$150/1000kg gilt diet

^eNon-responders 135kg live x 0.79 = 106.65kg dressed x 85 index x \$1.30 pork = \$117.85 vs. market gilt 115kg live x 0.80 = 92kg dressed x 114 index x \$1.30 pork + \$1 health bonus + \$3 loin size incentive (OlyWest Contract)= \$140.34

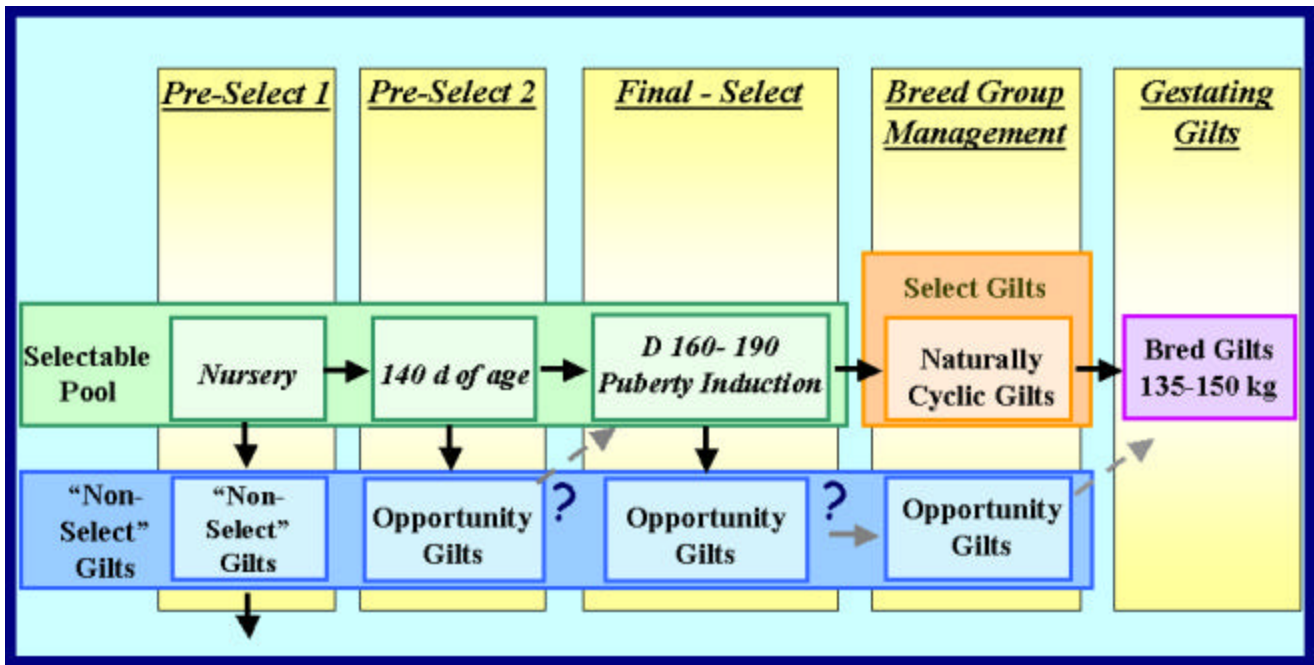


Figure 1. Schematic diagram of an efficient gilt management system.

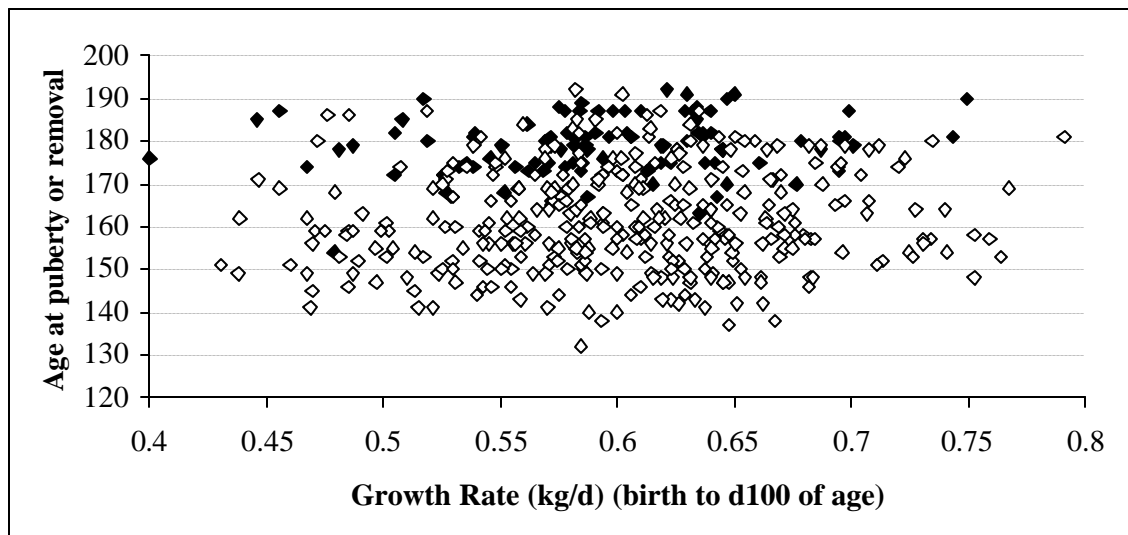


Figure 2. Relationship between growth rate from birth to 100 d of age and age at puberty or removal from experiment. Closed diamonds represent Non-Responsive gilts, open diamonds represent gilts that reached puberty (Prairie Swine Centre and University of Alberta, Swine Technology and Research Centre, unpublished data, 2003)

				<u>AGE AT PUBERTY</u>						
				160	165	170	175	180	185	190
GROWTH RATE (KG/D) AT 140 D OF AGE	0.50	WEIGHT (KG) AT 140 DAYS OF AGE	70	143	135	138	140	143	145	148
	0.55		77	146	137	140	142	145	136	139
	0.60		84	146	137	140	143	146	136	139
	0.65		91	145	135	138	141	144	148	137
	0.70		98	141	145	148	137	141	144	148
	0.75		105	136	140	143	147			
	0.80		112	145	149					
	0.85		119							
	0.90		126							

PREDICTED ESTRUS AT BREEDING

1st estrus ■ 2nd estrus ■ 3rd estrus □ 4th estrus ■ 5th estrus ■ 6th estrus ■ 7th estrus ■

Figure 3. Actual weight at growth rate at 140 d versus *predicted* weight and estrus at breeding (Prairie Swine Centre, and University of Alberta, Swine Research and Technology Centre, unpublished data 2003).

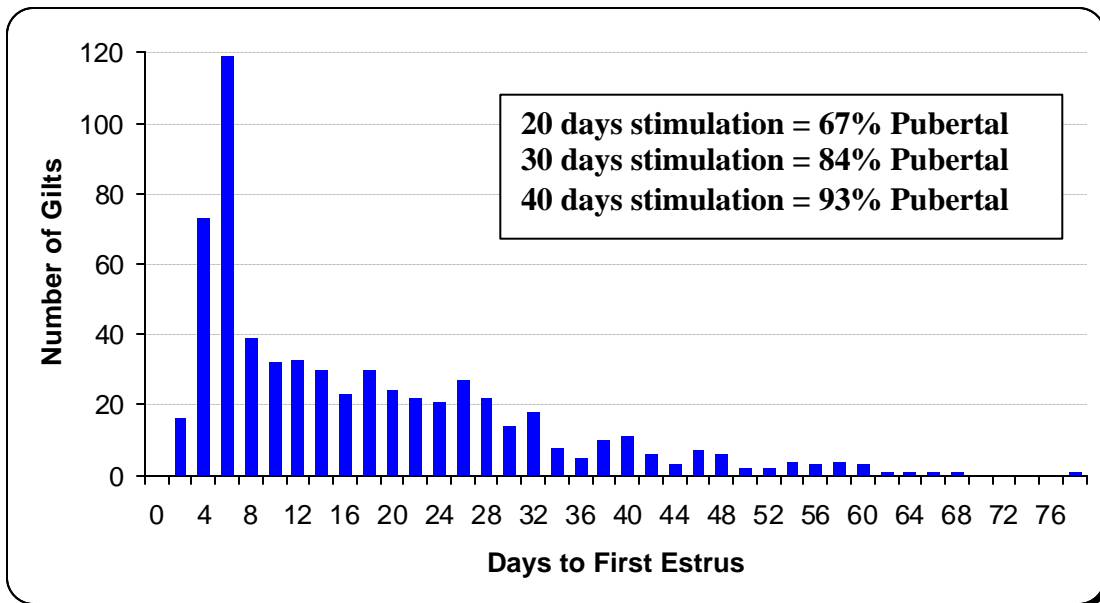


Figure 5. Number of gilts per day showing pubertal estrus after stimulation with direct boar contact from greater than 160 days of age (University of Alberta Swine Research & Technology Centre, unpublished data)

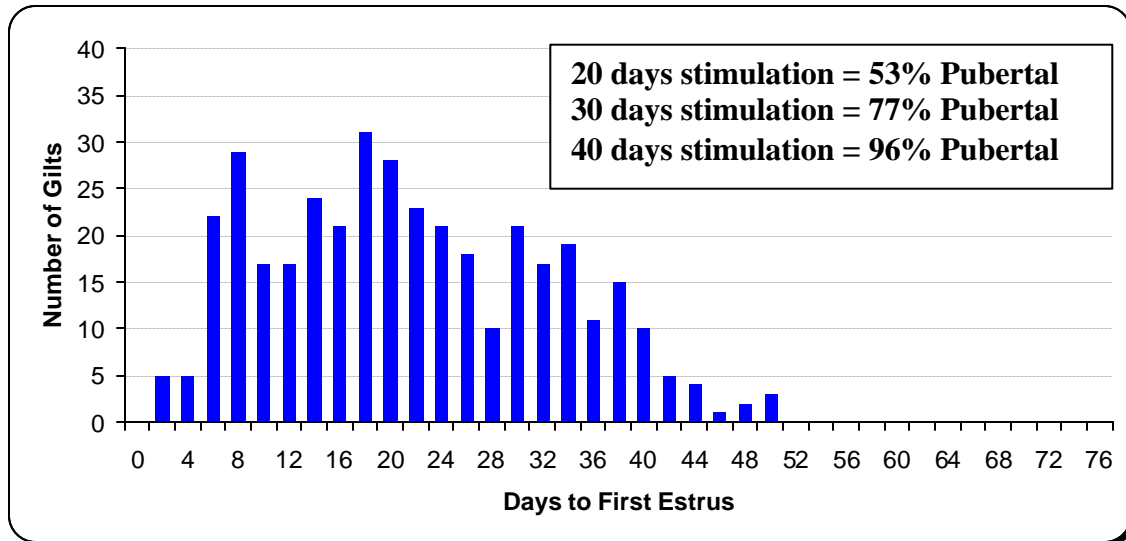


Figure 6. Number of gilts per day showing pubertal estrus after stimulation with direct boar contact from approximately 140 days of age. 112 gilts out of 509 (22%) did not exhibit first estrus. (Prairie Swine Centre, University of Alberta Swine Research & Technology Centre, 2003)

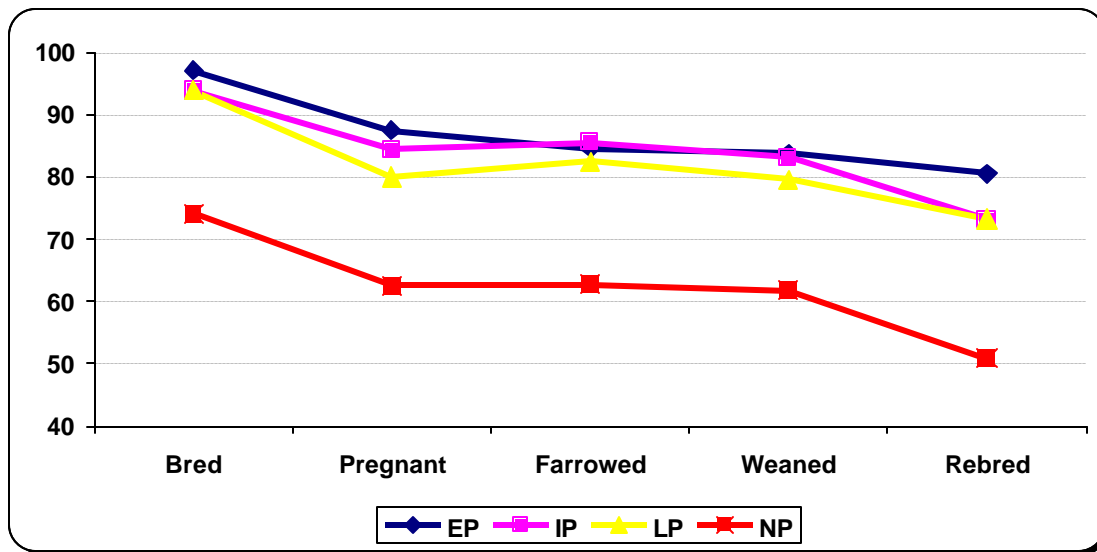


Figure 7. Breeding, pregnancy, farrowing, weaning, and rebreeding rate of parity 1 sows as a percentage of gilts originally on inventory (Prairie Swine Centre and University of Alberta, Swine Technology and Research Centre, unpublished data, 2003)

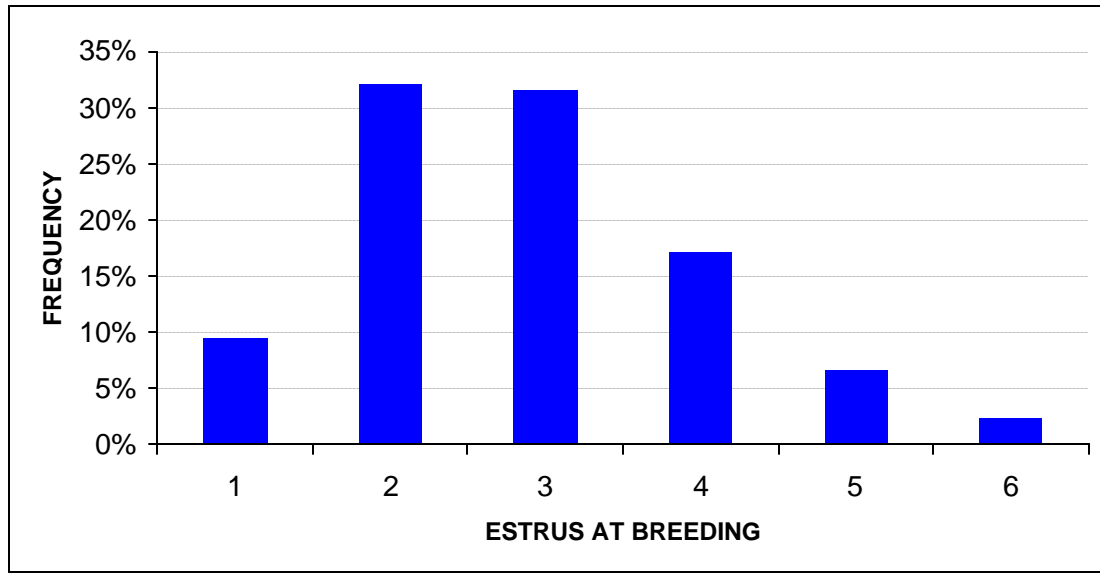


Figure 8. Distribution of *predicted* estrus that gilts are bred when body weight is targeted to be between 135-150kg. (Prairie Swine Centre, and University of Alberta, Swine Research and Technology Centre, unpublished data 2003)

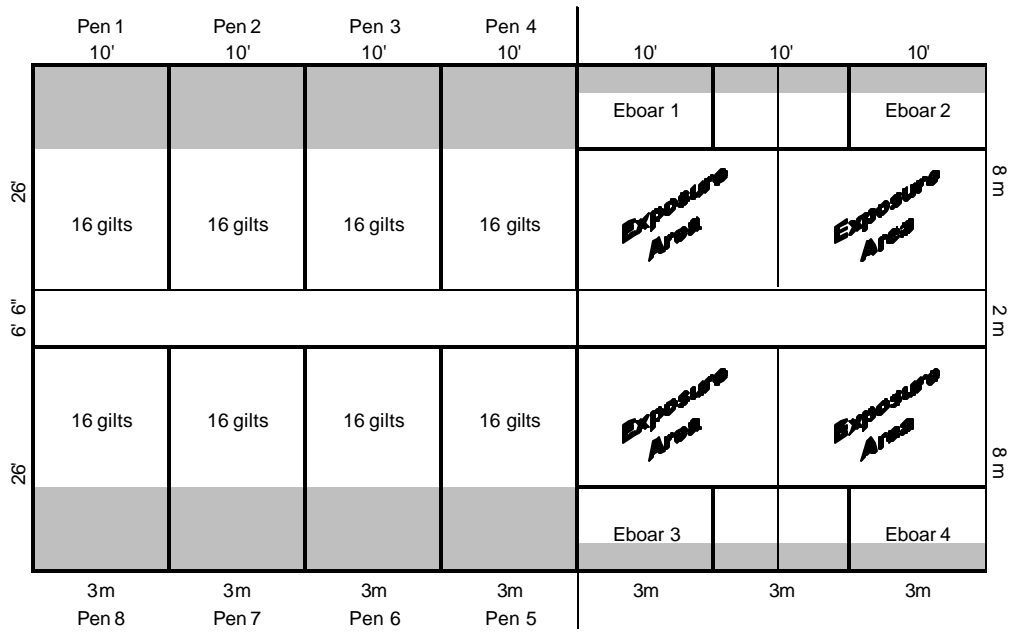


Figure 9. Layout of a gilt pool area where gilts are managed in pens and bred at 2nd estrus

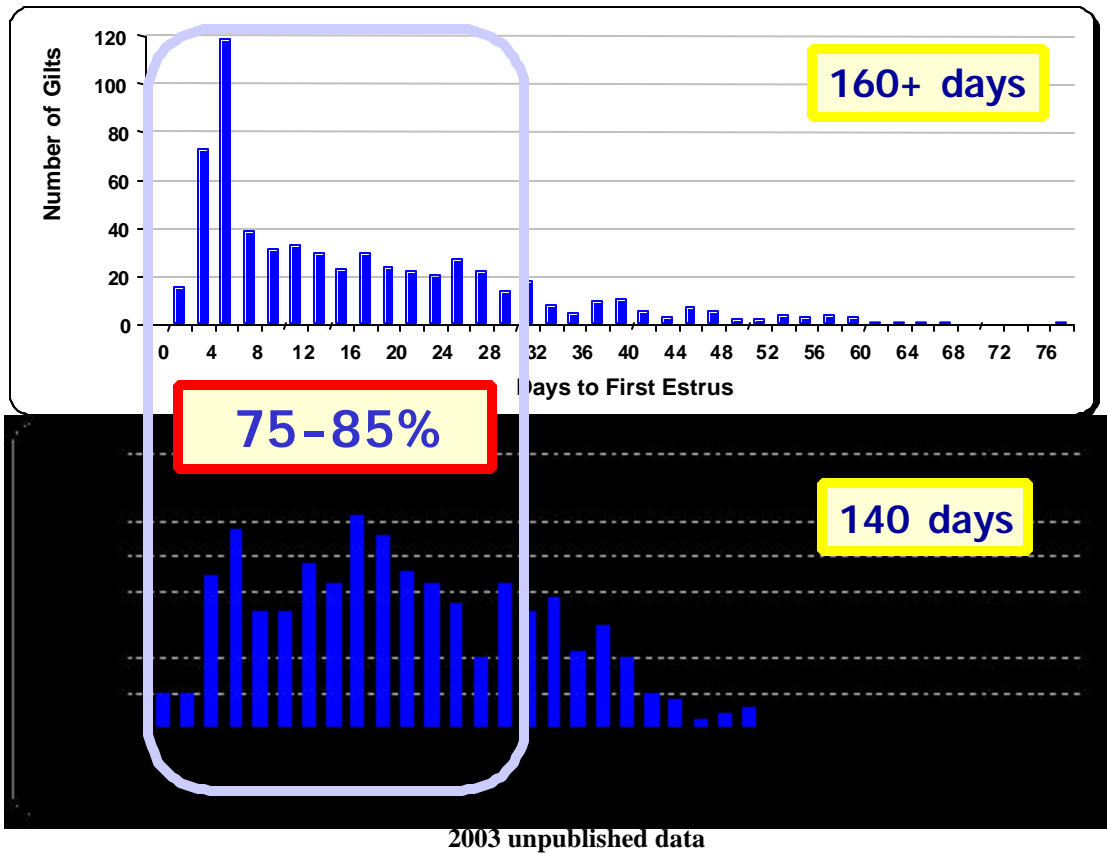


Figure 10. SRTC and PSCI data showing 75 - 85% of gilts show pubertal estrus within 30d of the start of boar stimulation at 140 or 160d

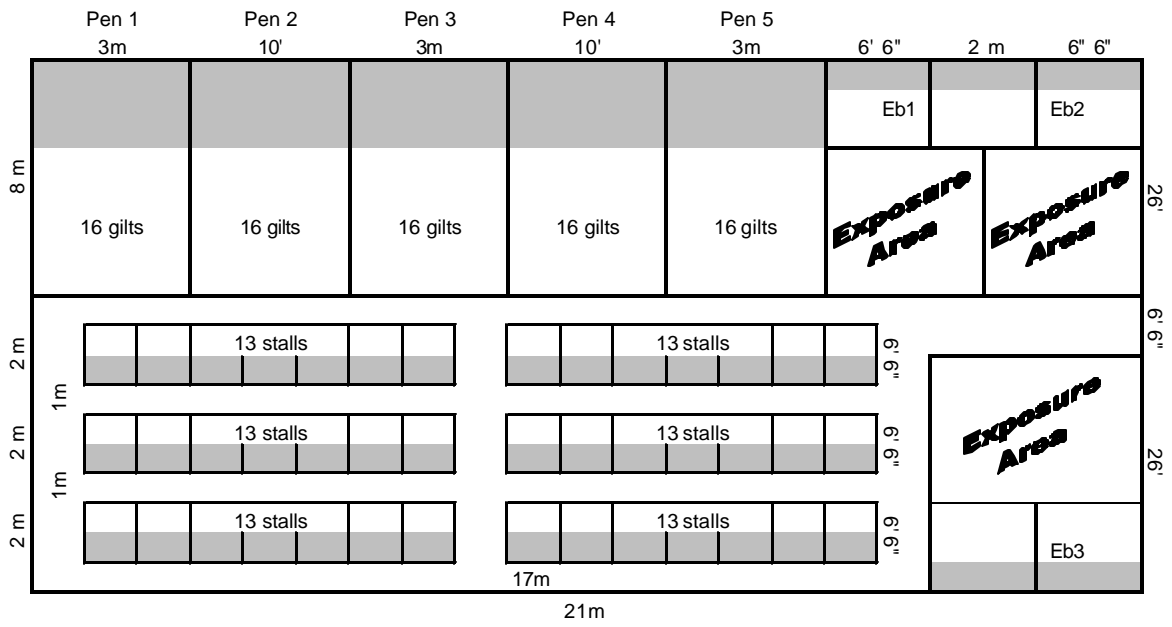


Figure 11. Layout of a gilt pool area where gilts are managed in pens until 1st estrus and then in crates