GETTING TO 30 PIGS WEANED/SOW/YEAR

Robert Knox
Department of Animal Sciences
University of Illinois, Champaign
1207 West Gregory Drive, Urbana, Illinois 61801
E-mail: rknox@uiuc.edu

THE GOAL

Pork production operations around the world are beginning to set new production targets for achieving 30 weaned pigs/sow/year (PSY). This lofty goal is not easy to attain but should not be considered out of reach. High pig production is a result of a complex series of interrelated factors. Because of substantial advancements made in swine genetics, facilities, and management, some large and small operations have already attained this goal, while others are nearing this target. The foundation required to achieve 30 PSY must begin with the herd genetic potential for total born and pigs born alive. Management of these genetics must focus on born alive and herd management to ensure proper longevity and parity structure. Although herd health must be considered a permissive and limiting factor for PSY, it will not be discussed in this article. Another key requirement for reaching high PSY involves maximizing the output of large numbers of pigs born alive with ensuing low pre-weaning mortality. This is achieved through intensive management during both early and late lactation. High standards for PSY must also focus management on achieving low numbers of non-productive days (NPD) through short wean to service and short entry to first service intervals, low repeat services, few open days before diagnosis and rebreeding or culling, and high farrowing rates to first services. Raising PSY to higher levels will be possible only as a result of proper feeding and nutritional programs for gilts and sows, and through intensive breeding management. Last but not least, as most will agree, the properly trained, dedicated and knowledgeable staff lay the foundation to moving along the pathway to high pig production. This article will discuss these factors and more to explore how it may be possible for "Getting to 30 PSY".

RECORDS FOR TOP DANISH, U.S., AND SPANISH BREEDING HERDS

The actual production figures for an 1180 sow herd farm in Denmark for a 12 month period of time are shown in Table 1 (Jensen, 2004).

Production records from commercial genetic suppliers indicate that certain clients are fast approaching (26) or actually have already achieved or exceeded 30 PSY for periods of up to one year of time (Peet, 2004; Vansickle, 2004). Data from the U.S. and Spain (Caldier, 2002) also indicate that both large and small breeding herds can approach 30 PSY and production figures available and obtained for 2002 to 2004 indicate that production was recorded in the 26 to 28 PSY range.

Table 1. Danish farm production measures for a 1 year period of time (2003).

Item	Measure
Born Alive/litter	14
Stillborn/litter	1.6
Pre-wean mortality	8-10%
Returns to service	4%
Lactation Length	24.5 d
NPD	8-10
Farrow rate	91%
Litters/Sow/Year	2.43
P/S/Y	30-32

However, for perspective, the data available for farms achieving or exceeding 26 PSY are the exception. These data show that the potential for operations within many countries is much higher than current production records, but that these averages are not indicative of current production for any country. The production figures for Denmark are excellent, but are just beginning to approach the targets needed to get to 30 PSY. For example, Danish data for 2003 (NCPD, 2003) indicates that the average production in number of pigs born alive has increased from 11.8 born alive in 2000 to 12.3 in 2003. The number weaned has also increased from 10.4 in 2000 to 10.6 in 2003. These production figures are recorded with lactation lengths averaging 30 days and with litters/sow/year averaging 2.25. The production averages for the 1.1 million sows in Denmark were recorded as 24 PSY. In contrast, for the 6.4 million sows in the U.S., the total numbers of pigs born averaged 11.4 with 10.3 born alive and 9.0 pigs weaned to produce an average of 20.2 PSY (PigCHAMP, 2004). In the U.S. these records result from an average lactation length of 19 days. These data indicate that for both Danish and U.S. pork producers the potential for improvement exists for average and even most top producers.

MODELS FOR 30 PSY

Simulation models for production of pigs produced/sow/year are determined from total sows mated, farrowing rate, farrowing interval (NPD), pigs born alive, and number of pigs weaned. Simulation results for the impact of making a 5% change in factors listed in the current measures are shown on PSY in Table 2.

From these values, it would appear that efforts which concentrate on total pigs born and pigs born alive will have the greatest impact on PSY. Realistically, changing the total pigs born and born alive can be multi-factorial and complex. Influencing litter size or total born starts with ovulation rate, or the number of eggs ovulated. Ovulation rate is a moderately heritable trait and has been selected for, in most existing maternal lines of pigs. In contrast, embryonic survival, uterine capacity, and total pigs born are lowly heritable, but selection even for these traits has been shown to increase the total pigs born and pigs born alive in maternal lines over extended periods of time. Pigs born alive is a trait that some genetic companies are now reporting they are adding into the selection criteria, and although likely to be lowly heritable, it does have the potential to improve performance in certain genetic lines of pigs. However, one clear way to impact born alive can result from attended farrowings, which can increase pigs born alive by 5% or 0.5 pigs at each farrowing. In most cases, farrowing rate can be changed more easily than total born and pigs born alive. Even a modest change of 2.5% in farrowing rate can increase PSY more than 0.5, while a 5% farrowing rate increase can increase PSY by 1.2. Collectively, improving born alive and farrowing rate each by 5% could increase PSY by nearly 2. Other factors evaluated in the simulation model involved changes in lactation length. Increasing or decreasing the length by one day would be expected to impact PSY by 0.2. It was also evident that when a nine day increase in lactation length occurred from a 21 day average to reach a 30 day lactation length, more typical for a European herd, PSY increased by nearly 1.8. For other factors, small changes of 5% in the average pre-weaning mortality would have little impact on advancing PSY (0.11), while changing the pre-weaning mortality average by 10 to 20% to have an average pre-weaning pig mortality of 6 to 8% could increase PSY by 0.3. Changes in the wean to service interval were not highly related to PSY, however, there is evidence to suggest that both pigs born alive and farrowing rate are related to sows that return to service soon after weaning (days 4 to 7). The increased reproductive production from shorter wean to service intervals was not simulated in the present model, but if this was performed under the assumptions of improved production from early returns, as reported by Steverink et al. (1997), a one day change from a 6-day wean to service interval, to a 7-day wean to service interval could be expected to reduce PSY by 0.8, and an 8-day wean to service interval by as much as 1.6 PSY. This decline in production would result from lower pigs born alive and reduced farrowing rates. Therefore, efforts that focus on advancing wean to service intervals toward 4 to 6 days could have significant advantages for improving PSY.

Table 2. Simulation modeling for the impact of a 5% change in the average production parameter on the change in PSY.

Parameter	Average	5% of average	Change in PSY
Liveborn (pigs)	10.5	0.53	1.22
Farrow rate (%)	80	2.5	0.67
Lactation length (d)	21	1.05	0.19*
Mortality (%)	8	0.4	0.11
Wean to service (d)	7	0.35	0.07

*assumes farrowing rate and born alive improves.

Using simulation models to test for the impact of multi-factorial changes is also important to determine how and where efforts could and should be expended, and which combinations of efforts are most realistic and effective. In simulation modeling, it becomes clear that the major influence on attaining 30 PSY will be through reaching a target of 13 to 14 pigs born alive, a farrowing rate between 85 to 90%, and a pre-weaning piglet mortality between 5 and 10%. Individual improvements in any of these production measures, alters the impact of the other on the target for 30 PSY, to a more or lesser effect depending upon its importance. For example, at a 90% farrowing rate, changing born alive from 11 to 14 pigs had the greatest impact on PSY, while reducing mortality from 10 to 5% had only minimal effect. When mortality was fixed at 8%, changes in born alive and farrowing rate each had a significant impact on PSY (Table 3).

Table 3. Changes in pigs produced/sow/year after simulation for impact of changes in farrowing rate and born alive with pre-weaning mortality fixed at 8%.

	Born Alive				
Farrowing Rate (%)	10	11	12	13	14
90	21.9	24.1	26.3	28.5	30.7
85	20.7	22.8	24.8	26.9	29.0
80	19.5	21.4	23.4	25.3	27.3

GENETIC IMPACT

A review of the progress made by Danbred for litter size (Peet, 2004b) suggests that in the last 10 years, regardless of the foundation breed, improvements have been made by two total pigs born in the Large White breed and more than three total pigs born/litter in the Landrace breed. The improvement is likely due to genetic improvement, as the improvement is progressive over time. Yet the improvement is also likely a result of improved management, nutrition, housing, and health. Evidence of improvement in PSY as a result of genetic selection is evident in France with reports for increases over time in total pigs born, pigs born alive and numbers of pigs weaned in the French Large White and French Landrace breeds. Yet interestingly, in contrast to the Danish company report, the improvements in the French breeds were greater in the Large White breed compared to the Landrace (Caldier, 2004). Reports from the U.S also indicate similar genetic effects and the National Pork Board's maternal line study showed that significant differences were observed in total born, born alive, and pigs weaned in response to different genetic lines even for animals that were managed under similar conditions (Moeller et al., 2004).

PARITY

Sow parity is related to reproductive performance and for PSY as a result of differences in total pigs born, pigs born alive, farrowing rate, and wean to estrus interval. The reasons for these differences as a result of parity are complex and may be mostly related to body condition and metabolic status. Lower performance is observed in parities 1 and 2 and in later parities (8 to 10) compared to sows in parities 3 to 7 (Koketsu et al., 2003). The production level with respect to parity may become problematic when considering current replacement rates. Early culling of sows prevents the sow and the herd from reaching optimal parity and herd parity structure. This problem can be exacerbated by poor replacement gilt management. High sow failure rates can lead to gilts entering the herd before their optimal period of time. In other cases, lack of fertile gilts at the correct stage may force herds to maintain an older and less productive parity structure. In either case, the potential for PSY is likely to be significantly reduced.

With annual herd culling rates exceeding 50%, prevention of early culling can be an effective management tool to boost herd performance. Most culling occurs due to reproductive failure, and 10% of sows fail to rebreed following weaning, while 20% fail to farrow to the first service. Of these failures, over 40% will return to estrus, while 35% are diagnosed as open without estrus. In both cases, this suggests problems with breeding sows, or failure of sows to conceive or remain pregnant. Other reasons for culling sows involve sows in poor body condition, poor feet and leg structure, and problems at farrowing. Methods that can help alleviate any of the causes for failure can help to stabilize the optimal herd parity structure.

REPLACEMENT GILTS

High culling rates force producers to have gilts available on demand to allow for culling of older or poor performing sows. However, in cases where gilts are not at the correct age or maturation, they may enter the herd at inopportune periods in their development and may be too young and immature or too old and over-conditioned. In either of the cases, sow longevity and reproduction may become compromised. The dilemma has been how should producers develop and manage gilts in order to obtain the correct number needed and also to meet maturation goals for mating, in order to improve herd longevity and reproductive performance.

Although there is no clear cut answer to the gilt management issue, producers who strive for 30 PSY, may need to adopt some new recommendations from those who have neared this target. One such suggestion involves the age at first mating. Controversial data exists and Goss (2003) reports that total pigs born and pigs born alive increases with age at first service peaking at 220 to 240 days before slowly declining. There is evidence to suggest that early puberty and earlier mating may be beneficial. Not surprisingly, gilt retention rates also match increases in backfat at the time of mating. Maximal longevity occurs when first service is achieved when backfat is >23 mm and weight at mating nears 165 kg. Moeller et al. (2004) reported that a line of pigs that expressed early puberty also coincidently had the greatest farrowing rate, total born, born alive, and lifetime productivity. Shukken et al. (1994) also showed that herd life peaked when mating occurred at 200 to 220 days of age. However, slight declines in pigs produced/litter were observed when mating occurred at younger ages, but the total lifetime production was greatest when mating occurred in the younger aged groups. What is interesting, is that several reports indicate no great effect of age at mating or numbers of previous estrus periods (one to four) (Young et al., 1990) or body composition (Rozeboom et al., 1995) at the time of mating. Similarly, a French report (Cozler et al., 1998) suggests that there is no apparent detrimental effect of early mating and early farrowing, although production is slightly reduced in these situations compared to mating and farrowing at more advanced ages. Yet longevity is improved when compared to gilts mated and farrowing at later ages. Jensen (2004) describes a gilt management procedure that is an integral part of their success for attaining 30 PSY. Their report suggests that herd sourcing, combined with 8 weeks allowed for isolation and acclimation, ensures health stability in their system. In this operation, they define the system as one that checks for heat in stalls, and mates gilts at 280 days and 160 kg+ at the time of breeding. Collectively, these reports suggest that inducing early puberty, but waiting until gilts have adequate size and backfat at slightly delayed ages very near 240 days of age, will allow the largest litter sizes with the greatest farrowing rates. Consider longevity though when setting age at service, and remember that in the long term model, parity structure is important for sustained production toward 30 PSY.

BREEDING MANAGEMENT

Recommendations from Danbred (Peet, 2004b) regarding the 30 PSY target also include breeding suggestions for gilts and sows. Jensen (2004) reports that for their farms, they provide gilts continuous boar exposure from entry until one day before expected estrus and then they remove the boar for 1 to 2 hours prior to heat checking. A boar is reported to be added for a "surprise effect" at the time of mating. This is thought to give a better estrus response and reduced insemination time. For weaned sows, continuous boar exposure is also provided for four consecutive days following weaning. Artificial inseminations are performed at 24 hour intervals either in the a.m. or the p.m. Problem sows showing poor standing responses, or sows with excessive backflow are inseminated again 8 to 12 hours later and again 12 hours after that. They also report that they leave the catheter in after AI and a new boar is brought in front of the sows. These procedures are thought to help movement of sperm to the site of fertilization. Interestingly, many U.S. production operations are also closing in on 30 PSY but are accomplishing this with the use of different genetics, and production practices slightly different to those used by the Danish producers. The U.S. producers do not utilize continuous boar contact, but instead supply either once or twice daily boar exposure for estrus detection, and may inseminate based on 12 to 24 h intervals. Since farms can apparently approach the objective of 30 PSY by different routes, the essential elements may involve what they share in common rather than what they do differently.

In either type of production system where production for PSY is above 26, there is little clear evidence to suggest that any or all of the production techniques are critical for high reproductive rates. However, in the same light, there is little information to suggest certain procedures are not beneficial or necessary. It may be surmised that failure to follow the described procedures could prevent attaining production targets or cause production to decline. Unfortunately, there are many uncertainties in understanding the biological limits to 30 PSY. Yet, what we know is that farrowing rate and litter size are most related to the numbers of fertile sperm inseminated and the number and timing of inseminations. Flowers and Esbenshade (1993) reported that the number of inseminations should equal two or more to reach maximal reproductive rates. For timing inseminations, at least one AI must occur within the 24 hour interval before the time of ovulation to maximize litter size and farrowing rates with semen less than 36 h old (Nissen et al., 1997). Rates of reproduction were reduced when AI occurred at an interval >28 hours before ovulation. With multiple inseminations, Watson and Behan (2002) reported that an AI dose must have at least 2 billion sperm cells when inseminating sows at 0 and 24 hours after onset of estrus and using semen <48 hours old. This was compared to the same procedure using 1 billion sperm cells, which resulted in reduced farrowing rates and litter sizes. Most studies indicate that 2 billion cells will not limit reproduction, but fewer cells reduce performance and higher cell numbers provide little or no advantage (Steverink et al., 1997). This may be related to sperm transport and reservoir establishment since these are similar when number of sperm in the AI dose were between 1 to 10 billion inseminated (Baker et al., 1968). Regardless of number of cells, low fertility sperm can cause problems, and in these cases, inseminations must occur even closer to time of ovulation (within 4 hours before ovulation; Waberski et al., 1994) to prevent reduction in reproductive performance.

So, what is known about the benefits or problems involving procedures for providing boar exposure? Interestingly, too much boar contact can reduce the detection of estrus in gilts (Hemsworth and Barnett, 1990) and sows (Knox et al., 2004) and too little can delay onset of estrus (Walton, 1986). But exposure of females to boars at breeding for gilts (Willenburg et al., 2003a) or sows (Knox, 2004) has not been shown to have any clear effect for improving fertility although there have been reports on reproductive hormones and uterine activity (Langendijk et al., 2000; 2003). So what are the most critical components of the boar for maximizing fertility? The method which ensures the most accurate detection for onset of estrus is the first key. Make sure accurate estrus detection is not hampered by over exposure to the boar or too short an interval between last boar exposure. For example, there is a noticeable decline in estrus detection rate but not incidence of ovulation in sows that were detected every 8 hours compared to those detected at 14 hour intervals or more. Yet at the same time, higher detection frequency at 8 to 12 hour intervals allowed slightly improved timings of inseminations and trends for increased farrowing rates and litter sizes when compared to 24 hour detection intervals (Knox et al., 2002). It would appear that increased frequency of estrus detection may have subtle benefits for AI timing, but that this comes with a risk for reduced estrus detection due to refractory behavior to the boar. In this light, boars must be housed away from gilts or sows to allow necessary sensitivity. In many cases this can and should be 2 to 4 hours. It is also clear though that increasing boar stimulation for gilts (Pearce and Paterson, 1992) or weaned sows (Walton, 1986) can advance onset of estrus. At mating, the boar can influence hormone release, but the response is inconsistent. The boar can impact follicle growth (Langendijk et al., 2000), and increases the incidence of ovulation and oxytocin release. Yet the presence of a boar at mating has little effect on fertility. Despite this lack of effect, it is clear the boar will improve standing in gilts and eases the procedure of insemination, and reduces leakage at the time of insemination (Willenburg et al., 2003a). However, if the boar does induce hormone release, is this in fact beneficial to fertility? The answer may lie in studies where exogenous hormones have been added to semen, and in these cases, the additional hormones have been shown to improve sperm retention, and increase movement to the reservoir. Therefore, boar exposure could in fact improve fertility when a risk of low fertility exists (Willenburg et al., 2003b).

NON PRODUCTIVE DAYS (NPD)

Much has been written on the essential measures for reproductive performance, but Peet (2004c) reported that differences in litters/sow/year was the factor most related to NPD. It is nearly impossible to achieve 30 PSY with farrowing rates that are not in excess of 85%, and actually approaching 90%. One of the keys to low numbers of NPD is the number of days a gilt or sow is not lactating or pregnant. This measure is used to determine the farrowing rate and litters/sow/year, for all sows mated in the herd. Open days accumulate from the time interval from gilt entry to first service, from the interval from weaning to service, from the number of days from mating until pregnancy failure occurs and can be diagnosed, and from the time when an open sow is identified and culled. Jensen (2004) reported that in their system, culling occurs for sows that fail to show estrus by 21 days post-weaning, show discharge at first return to estrus post-mating, that return twice following re-breeding, or for those sows that abort.

Entry to service interval for the replacement gilts are determined by the age at selection, and is a function of when the gilts are targeted for breeding. This measured interval is a function of the age at selection, age at puberty, and the number of previous estrus periods prior to targeted breeding. The goals for most U.S. and European operations should be to breed gilts at their second or third estrus, when they are a minimum of 210 days of age and a maximum of 240 days of age. The weight targets at breeding range between 260 and 300 lbs. Despite these goals, few operations meet these expectations for all replacement gilts. U.S. herds average between 25 to 40 entry to first service days (PigCHAMP, 2004), while some herds maintain an entry to first service interval less than 10 days. For sows, an important measure in the calculation for NPD is the variation in wean to service intervals. This interval is frequently delayed in primiparous sows, for sows weaned in the summer, and for sows with short lactations. Other predisposing factors involve poor body condition at weaning, excessive loss of body muscle and fat during lactation, and lack of adequate boar exposure. Techniques used to improve return to estrus can include maximizing boar exposure from time of weaning, minimizing thermal stressors, improving feed intake in lactation, and ensuring lactation lengths occur for more than 17 days.

Another key area for controlling NPD is the frequent determination for reproductive failure at the earliest stages, and employing corrective measures to minimize its impact on litters/sow/year. For example, in average herds, 20% of mated sows will ultimately fail to produce a litter to a service (Koketsu et al., 1997). Approximately 40% of the failures will be classified as conception failures since they will return at regular intervals at 18 to 25 days, or 38 to 46 days following service. Of these reproductive failures, 30% will return at the early interval and 15% at the later period. If all of these animals can be identified in estrus at the first period and rebred, NPD can be minimized, since catching them at the later period adds nearly 20 NPD. Sows that fail to remain pregnant to a re-service should be culled immediately, as this is a clear indicator of inherent infertility. Within the 20% of the females that will not farrow, the next greatest percentage of reproductive failure is composed of those that fail to return to estrus but are diagnosed as non-pregnant by ultrasound. Real-time ultrasound can be used to diagnose sows as early as 24 days following breeding (Miller et al., 2003). However, without detection, these animals may go on to accumulate excessive NPD, and in many cases, sows that are not pregnant, will amass 60 to 80 NPD days each (PigCHAMP, 2004). The reduction of NPD can be controlled using real-time ultrasound and estrus detection, combined with a more aggressive culling policy.

MANAGING SOWS IN GESTATION

Managing the gestating sow herd is an essential component to ensuring maximal farrowing rates and litter sizes. Poor farrowing rates and low litter sizes cause attention to be focused on the management of females in gestation. Some measures that have been reported to impact reproductive performance during gestation involve delayed wean to service interval, short lactation lengths, summer and fall seasons, low and older parities, excessive early gestation feed intake, elevated temperature during early gestation, and incidence of disease. Of the limited evidence available, there are suggestions that a variety of stressors that may occur during gestation could have some impact on pregnancy loss and litter size. Because there is a lack of information involving these stressors on reproductive performance, some general recommendations have been made and adopted. These include ensuring limited feed intake during the first three weeks of gestation, and not moving or grouping sows until 3-4 weeks after mating. Following the critical early gestation period, feeding for optimal body condition can occur during the early to mid gestation period. Feeding the sow can best be accomplished by frequent control of intake amounts and observation for backfat measures (Hughes, 2004). In the Danish system reported by Jensen (2004) sows were fed a fishmeal based top dressing supplement from the time of weaning until breeding. The sows were checked for heat each day for four weeks following breeding, and then real-time ultrasound performed for pregnancy detection before moving sows into group housing where they were fed individually in free access stalls. The fat and thin sows were moved back into individual stalls to control their feed intake to adjust body condition.

MANAGING SOWS AT FARROWING

The goal of 30 PSY is not attainable without ensuring high numbers of pigs born alive. In all production model simulations with farrowing rates at 90%, getting more than 28 PSY was not possible unless 13 to 14 pigs were born alive. This high number of total pigs born will result from a sequential series of events starting with high ovulation rate, followed by high fertilization rate, high embryonic and fetal survival, and then low numbers of stillborn pigs. The greatest opportunity to meet the goal for 30 PSY is through pigs born alive. The reason for this involves the realistic opportunity for most producers to increase their pigs born alive by one for each sow during the year. PigCHAMP (2004) figures indicate that for the top 10% of U.S. herds, the number of total born pigs averages 12.3 with 11.1 born alive and stillborns averaging 0.5. The Danish numbers reported by Jensen (2004) indicate 15.5 total pigs born, 14.0 born alive, and 1.5 pigs born dead. This high number of live born pigs is achieved without farrowing induction, but with assistance at farrowing when necessary. The discrepancy in total pigs born between the top U.S herds and the top Danish farms appears to account for much of the total pig production differences. However, it should not escape notice that the U.S. production figures suggest significantly fewer losses of pigs as stillborns. The exceptional U.S. herds that have achieved 27 to 28 PSY also report 13 to 14 total born pigs and an average of 12 to 13 pigs born alive. Yet even in these herds, there are indications of lower stillborn rates at farrowing. Interestingly, many U.S. producers are not averse to controlled management at farrowing and the use of hormonal induction technology.

CONTROLLING PRE-WEANING MORTALITY AND SOW MANAGEMENT DURING LACTATION

The top 10% of U.S. producers report an average 9.0% pre-weaning mortality, while exceptional producers report 6 to 7% mortality. Comparable numbers are reported by Danish production systems which average 8 to 10% pre-weaning losses (Jensen, 2004). One explanation for the differences in the numbers, not surprisingly, may involve the report that both stillborns and pre-weaning mortality increase with increases in the number of total born pigs. The incidence and causes for piglet losses have been reported (Waddel, 1996). The keys to minimizing these losses must begin with an understanding of why and when these losses occur. In fact, nearly 75% of all piglet losses occur during days 1 to 3 post-farrowing and only 13% of the losses occur during days 4 to 7 with very few occurring over the next two to three weeks. Almost 60% of the pig losses are attributed to injury with 18% of losses due to low viability. With this pig loss information in mind, almost all production operations have made adjustments to remedy these losses. The goal has been to prevent the pigs from becoming weakened, and prevent them from seeking the sow due to lack of milk, until they are hungry and ready to nurse. Jensen (2004) reported that they give all sows oxytocin to stimulate milk let down, and additional doses may be given later if deemed necessary. All pigs are confined to the creep area for one hour post-farrowing and later the 10 smallest pigs are allowed to nurse before the larger remaining pigs are added. In this system, all piglets are provided a milk supplement between days 3 to 10. Many recommendations for U.S. producers have concentrated on methods that improve attended farrowing. This is to ensure technicians are present to assist piglets find the teats, control the placement of heat lamps, allow pigs to find heat mats, and make sure sows are comfortable to prevent excessive up and down movement and repositioning. There are few listed recommendations for U.S. producers to give oxytocin to stimulate milk let down in all sows during the post-farrowing period.

During the mid to late lactation period, Jensen (2004) reports that pigs are provided creep feed starting on day 10. The use of this management tool is also common in U.S. herds, although no general consensus on the practice is reported. In the Danish system, they note that they feed sows three times each day, with feed intake gradually increased from 3 kg provided on the day after farrowing, to 6 kg fed by day 7, and then feed allowance increased 0.3 kg each day as lactation progresses. Daily feed adjustments are made to meet sow appetite. They also report a specific nursing sow management program that involves gilts being weaned at 20 days and then these females are used as foster mothers for the 13 larger five to seven day-old pigs from another mature sow. The gilt will then nurse these pigs for 15 more days before finally being weaned at 32-35 days. This extended nursing period is focused on allowing additional time for the uterus of the gilt to be repaired. The author reports that the extra time improves second parity litter size. In this nursing sow system, the sow that is weaned at 5 to 7 days will nurse the excess newborn pigs from other litters and will typically have an extended lactation length of 3 to 5 days.

PEOPLE

It is beyond the scope and intent of this article to cover the impact of people on production efficiency in the goal of 30 PSY. However, several authors (Jensen, 2004; Peet, 2004b; English, 2003) all agree that training, education, employee attitude and motivation, as well as inclination toward accurate record keeping and review, are essential components toward higher production goals. Management and employees must expend quality efforts toward each of the listed areas discussed in this article. In a report by Messenger (2003) involving a study of two herds, a 5 to 6% increase in PSY was recorded in the year following the implementation of training programs.

Taken as a whole, the targeted goal of 30 PSY only seems possible when all the components of this complex biological system are appreciated, given the appropriate level of attention, and given their correct level of importance in the puzzle.

LITERATURE CITED

Baker, R.D., Dziuk, P.J., and W, N.H. 1968. Effect of volume of semen, number of sperm and drugs on transport of sperm in artificially inseminated gilts. J. Anim. Sci. 27:88-93.

Caldier, P. 2002. Spanish database development. Pig Progress 18:8-12.

Caldier, P. 2004. Management and hyperprolificacy hot topics at the pig day. Pig Progress 20:14-16.

Cozler, Y., Dagorn, J., and Dourmand, J.Y. 1998. Is there an optimal age for first farrowing? Pig Progress 8-11.

English, P. 2003. Step By Step Improvement. Pork Jan.:20-21.

Flowers, W.L. and Esbenshade, K.L. 1993. Optimizing management of natural and artificial matings in swine. In: G. R. Foxcroft, M. G. Hunter and C. Doberska (eds) Control of Pig Reproduction IV. J. Reprod. Fertil. (Suppl. 48):217-228.

Goss, J. 2003. Prepare your gilts! Pig International 33:21-24.

Hemsworth, P.H. and Barnett, J.L. 1990. Behavioural responses affecting gilt and sow reproduction. J. Reprod. Fertil. Suppl. 40:343-354.

Hughes, P. 2004. Gilt management to maximise lifetime productivity. 2. Feeding from selection to culling. Dept. of Primary Industries and Fisheries, Queensland Govt. www.dpi.qld.gov.au/pigs/7848.html:1-4 (accessed Dec. 22, 2004).

Jensen, H. 2004. How I wean more than 30 pigs/sow on my farm. Danbred North America. Proceedings of Nov-Dec Producer Meetings.

Knox, R.V. 2004. The real impact of boars in breeding programs. Advances in Pork Production, Banff Pork Seminar, University of Alberta, Edmonton, Canada. 15:307-314.

Knox, R.V., Miller, G., Willenburg, K.L., and Rodriguez-Zas, S.L. 2002. Effect of frequency of boar exposure and adjusted mating times on measures of reproductive performance in weaned sows. J. Anim. Sci. 80:892-899.

Knox, R.V., Breen, S.M., Willenburg, K.L., Roth, S., Miller, G.M., Ruggiero, K.M., and Rodriguez-Zas, S. 2004. Effect of housing system and boar exposure on estrus expression in weaned sows. J. Anim. Sci. 82:3088-3093.

Koketsu, Y., Dial, G.D., and King, V.L. 1997. Returns to service after mating and removal of sows for reproductive reasons from commercial swine farms. Theriogenology 47:1347-1363.

Langendijk, P., van den Brand, H., Soede, N.M., and Kemp, B. 2000. Effect of boar contact on follicular development and on estrus expression after weaning in primiparous sows. Theriogenology 54:1295-1303.

Langendijk, P., Bouwman, E.G., Schams, D., Soede, N.M., and Kemp, B. 2003. Effects of different sexual stimuli on oxytocin release, uterine activity and receptive behavior in estrous sows. Theriogenology 59:849-861.

Messenger, J. 2003. It starts with stockmanship. Pork Jan.:20-21.

Miller, G., Breen, S., Roth, S., Willenburg, K., and Knox, R. 2003. Pregnancy diagnosis in swine: a comparison of two methods of real-time ultrasound, and characterization of image and labor requirements for positive pregnancy diagnosis. J. Swine Health Prod. 11:233-239.

Moeller, S.J., Goodwin, R.N., Johnson, R.K., Mabry, J.W., Bass, T.J., and Robison, O.W. 2004. The National Pork Producers Council maternal line national genetic evaluation program: a comparison of six maternal genetic lines for female productivity measures over four parities. J. Anim. Sci. 82:41-53.

NCPD. 2003. The National Committee for Pig Production. Annual Report. Denmark 1-57.

Nissen, A.K., Soede, N.M., Hyttel, P., Schmidt, M., and D'Hoore, L. 1997. The influence of time of insemination relative to time of ovulation on farrowing frequency and litter size in sows, as investigated by ultrasonography. Theriogenology 47:1571-1582.

Pearce, G.P. and Paterson, A.M. 1992. Physical contact with the boar is required for maximal stimulation of puberty in the gilt because it allows transfer of boar pheromones and not because it induces cortisol release. Anim. Reprod. Sci. 27:209-224.

Peet, B. 2004a. Step up to 30 pigs/sow in Canada. Danbred North America. Proceedings of Nov-Dec Producer Meetings.

Peet, B. 2004b. Laying the foundation. Danbred North America. Proceedings of Nov-Dec Producer Meetings.

Peet, B. 2004c. Lost days - the key to breeding herd efficiency. Western Hog Journal. Winter: www.albertapork.com/producers/whjournal/WHJ-2004-01(Winter)/whj.lost_days.htm.

PigCHAMP. 2004. PigCHAMP DATASHARE. www.pigchamp.com/benchmarking.asp. Accessed Jan. 28, 2004.

Rozeboom, D., Pettigrew, J., Moser, R., Cornelius, S.G., and El Kandelgy, S.M. 1995. Body composition of gilts at puberty. J. Anim. Sci. 73:2524-2531.

Schukken, Y.H., Buurman, J., Huirne, R.B.M., Willemse, A.H., Vernooy, J.C.M., van den Broek, J., and Verheijden, J.H.M. 1994. Evaluation of optimal age at first conception in gilts from data collected in commercial swine herds. J. Anim. Sci. 72:1387-1392.

Steverink, D.W., Soede, N.M., Bouwman, E.G., and Kemp, B. 1997. Influence of insemination-ovulation interval and sperm cell dose on fertilization in sows. . J. Reprod. Fertil. Suppl. 111:165-171.

Vansickle, J. 2004. Danes outshine U.S. National Hog Farmer Feb.:22.

Waberski, D., Weitze, K.F., Gleumes, T., Schwartz, M., Willmen, T., and Petzoldt, R. 1994. Effect of time of insemination relative to ovulation on fertility with liquid and frozen boar semen. Theriogenology 42:831-840.

Waddel, J. 1996. Management accounts for most deaths. National Hog Farmer Spring:12-17.

Walton, J.S. 1986. Effect of boar presence before and after weaning on estrus and ovulation in sows. J. Anim. Sci. 62:9-15.

Watson, P.F. and Behan, J.R. 2002. Intrauterine insemination of sows with reduced sperm numbers: results of a commercially based field trial. Theriogenology 57:1683-1693.

Willenburg, K.L., Miller, G.M., Rodriguez-Zas, S.L., and Knox, R.V. 2003a. Effect of boar exposure at time of insemination on factors influencing fertility in gilts. J. Anim. Sci. 81:9-15.

Willenburg, K.L., Miller, G.M., Rodriguez-Zas, S.L., and Knox, R.V. 2003b. Influence of hormone supplementation to extended semen on AI, uterine contractions, establishment of a sperm reservoir, and fertility in swine. J. Anim. Sci. 81:821-829.

Young, L.G., King, G.J., Walton, J.S., McMillan, I., and Klevorick. M. 1990. Reproductive performance over four parities of gilts stimulated to early estrus and mated at first, second or third observed estrus. Can. J. Anim. Sci. 70:483-492.