Review Article

Control of Estrus in Gilts and Primiparous Sows

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Abstract

The primary controller of weaned pig output is the successful breeding of enough females in the breeding week. The number of females available for breeding is dependent on the number of sows weaned sows and service-ready gilt availability. Primiparous (P1) sows often have longer wean-estrus intervals (WEI) and increased anestrus; ensuring sufficient gilts and sows are available may require control of estrus. Stimulating estrus requires appropriate boar contact or when this is not sufficient, administration of gonadotrophins. If gonadotrophins are used expect estrus 4 to 6 d later and it is usual to breed at the induced estrus. If there is a problem of non-response the most likely cause is the females had a missed estrus are in their luteal phase. This can be resolved by feeding altrenogest for 18 d; expect cyclic animals to return 5 to 8 d later. The estrus response can be improved by gonadotrophin treatment at the end of altrenogest feeding. Female fertility is optimized by ensuring sperm deposition in the period 0 to 24 h before ovulation. This degree of accuracy may require control of ovulation by treatment with human chorionic gonadotrophin (ovulation 40-44 h later) or gonadotrophin releasing hormone (ovulation 36-40 h later). Knowing time of ovulation will allow use of other breeding technologies such as use of lower sperm numbers per dose and single inseminations.

Keywords: altrenogest, estrus, fertility, gonadotrophins, ovulation

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Introduction

The output of the breeding herd is weaned pigs, and the factor most affecting the predictability of weaned pig output is the meeting of breeding targets (Dial et al., 1996). Ultimately, the objective is to not have empty farrowing crates. It is instructive to realize that when calculating the mean litter size in a farrowing batch the litter size in an empty farrowing place is zero. A secondary but significant factor is the farrowing rate. The ability to meet breeding targets is controlled by the availability of service-ready gilts and weaned sows. Gilt pool management drives the availability of sufficient cyclic gilts, and having sufficient cyclic gilts lends predictability to the breeding program. Interestingly, it has been suggested that gilts that achieve an early puberty may be relatively more fertile (Nelson et al., 1990; Holder et al., 1995), whereas late developing gilts may be less fertile. Indeed, it has been clearly documented in large population surveys that gilts that were older at initial breeding were culled sooner with life-time production of fewer pigs (Schukken et al., 1994; Le Cozler et al., 1998), while each study indicated no adverse effect of mating young gilts. Patterson et al. (2010) defined select gilts as those achieving puberty by 30 d after the start of boar exposure and documented reduced culling compared to non-select gilts. Although an effect of breeding age per se cannot be discounted, it seems more likely that gilts bred at an older age were later maturing but that delaying breeding of earlier maturing gilts will not result in poor performance. Therefore, the objective of gilt management should be to have them achieve puberty as young as possible and then subsequently be regularly prolific for as long as required. Sow availability is driven by predictable wean-to-estrus intervals, which is affected by lactation management and may require exogenous hormonal stimulation. This paper will discuss management strategies to control onset of estrus in gilts and sows.

The estrous cycle: The 21-day porcine estrous cycle consists of an approximately 15-day luteal phase, a 4-day follicular phase, and a 2-day estrous period. During the luteal phase, ovarian production of progesterone limits follicular development to the medium-sized (~4 mm) follicle stage. At about 12 to14 days of the luteal phase endometrial production of prostaglandin F2α causes regression of corpora lutea and termination of progesterone production. The removal of progesterone negative feedback allows resumption of appropriate secretory patterns of the pituitary gonadotropins, in particular luteinizing hormone (LH), which is the primary driver of follicular growth from the 4 mm stage to ovulation (Driancourt et al., 1995).

In sows, the wean-to-estrus interval (WEI) is equivalent to the follicular phase of the estrous cycle. During late lactation, ovarian follicles grow and regress in waves (Lucy et al., 2001). Depending on the stage of the follicular wave at the time of weaning, sows may have different sizes of follicles with different sensitivities to gonadotrophic stimulation which can influence the WEI (Lucy et al., 2001). It has been established that sows having a short WEI (e.g. 4-5 days) will tend to exhibit a longer duration of estrus and sows having a longer WEI (6-12 days) will tend to have a short duration of estrus. Ovulation occurs at about 70% through estrus independent of its duration so sows having short WEI will ovulate later after estrus detection (late ovulators) than will sows having longer WEI (early ovulators). The fertility of sows inseminated following a long WEI is less than that of sows inseminated following shorter WEI which likely involves a relatively poor synchrony between times of sperm deposition and ovulation. A management objective is thus to avoid long WEI, which are likely to be more evident with primiparous sows.

Stimulating pubertal estrus: To maximize the reproductive potential of gilts it is important to ensure full acclimatization before breeding. Breeding gilts at less than 190 days of age must not be done. The target is to breed gilts at their second estrus (or later) at 210 to 240 days of age and weighing 130 kg. Extremes should be avoided; gilts >130 kg at <175 days of age are at higher risk of early culling due to leg problems and those <130 kg at >240 days of age are unlikely to survive beyond first parity. Boar exposure is the most common practice for inducing earlier puberty. Adequate estrus stimulation requires direct physical contact while estrus detection may need only fenceline contact. To be effective, the rules of boar contact must be followed; appropriate gilt (180 days) and boar ages (>10 mo), direct contact for 15 min daily, adequate space allowance and housing gilts a minimum of 1 m away from the boars (Kirkwood and Thacker, 1992). It is also important to remember that if gilts are not bred at the detected estrus, then boar exposure should continue (e.g. at least 5 min every 2 to 4 days) in order to promote regular estrous cycles; irregular cycles make estrus detection problematic (Table 1). In practice, a problem often encountered is that a proportion of incoming gilts (5 to 15%) fail to show estrus in response to boar contact within a reasonable time period after herd entry (e.g. 28 days). Well-developed gilts failing to show natural estrus are unlikely to become fully productive sows and these late maturing gilts should be culled.

Table 1 Influence of boar exposure on cyclicity of gilts

	Boar	No boar
Study one		
Gilts having 3 cycles, %	97	66
Inter-estrus interval, d	20.5±0.4	20.0±2.3
Study two		
Cycles per 100 d	4.9	3.0
Incidence of long cycles, %	3.0	32.0

PE Hughes, unpublished data

Daily exposure of gilts to a boar is time-consuming. If this is an issue, an alternative is to house a sterile boar (i.e. epididymectomized [DiDi] or vasectomized) with gilts at a ratio of 1 boar per 12-15 gilts for 3 weeks from 175 days of age with the expectation that puberty will be achieved, sterile breeding may occur but no gilt will be pregnant. Then, the boar(s) is removed and daily contact for 24 days is initiated. If estrus is detected but the gilt is not required or she is <200 days of age, a sterile breeding should be allowed and a fertile breeding at the next estrus should be performed. Allowing a sterile breeding will enhance gilt fertility to the fertile breeding (Table 2).

If appropriate boar exposure is not effective, possibly as a component of seasonal infertility, or an early estrus is required, exogenous gonadotrophins can be administered. Common preparations include 1,000 IU eCG or a combination of 400 IU eCG and 200 IU hCG (Fertipig or PG600). These products are labelled for the induction of fertile estrus in prepubertal gilts. However, when eCG/hCG combinations are administered to prepubertal gilts, up to 30% may not exhibit behavioral estrus and about 30% of those that do exhibit behavioral estrus may fail to cycle regularly (Kirkwood, 1999). Since predictability beyond the induced estrus may not be good, gilts should be bred at the induced estrus. However, if historical data for a particular farm indicates >90% of gilts showing regular cyclicity following gonadotrophin injection, then breeding should be delayed until the next estrus as fertility will be improved.

A previous study showed that the farrowing rate of hormone-induced gilts was lower but that piglet production was increased because more gilts were bred (Kirkwood, 1999). Further, in that study where the gilts were well-developed, there was no adverse effect on long-term sow performance (Kirkwood et al., 2000; Table 3). However, more recently our study has shown a small increase in culling rates in all parities up to parity 6 in eCG/hCG-treated gilts, most particularly among treated gilts taking longer than 7 days to exhibit estrus after injection (Hidalgo, unpublished data).

Stimulating post-weaning estrus: Prolonged WEI (i.e. >5 days) is associated with reduced sow performance (e.g. Wilson and Dewey, 1993) and increased likelihood of early culling (Tantasuparuk et al., 2001). A delayed estrus is more likely in primiparous sows, especially as a component of seasonal infertility. A primary driver of prolonged wean-to-estrus intervals is inadequate lactation nutrient intake. Primiparous sows have a lower appetite than older sows, and will thus also have a disproportional reproductive response to environmental factors that reduce sow appetite.

Boar exposure of weaned sows is likely unnecessary until day 4 after weaning. However, where a record analysis indicates a problem of prolonged WEI an appropriate initial response is more strategic boar exposure (e.g. exposure during cooler times of the day starting the day after weaning). If this is not sufficient, hormonal stimulation of estrus may be needed (e.g. Fertipig/PG600). Several studies have examined the effects of eCG/hCG combinations and all agree that treatment results in a shorter and more synchronous onset of the post weaning estrus (e.g. Kirkwood et al., 1998; Table 4). A more cost-effective use of gonadotrophins will be to inject only problem sows with treatment limited to sows anestrus on day 7 after weaning. The response obtained will depend on the accuracy of non-estrus detection in weaned sows.

Table 2 Effect of sterile breeding at the prior estrus on gilt fertility

	Sterile bred	Control
No. gilts	80	80
Farrowing rate, %	87.5	77.5
Litter size, born alive	10.4	9.6

FX Aherne, unpublished data

Table 3 Long-term performance of gilts bred at a PG600-induced or natural first estrus

	Control	PG600-bred	PG600-skipped
Number of gilts bred	132	140	60
First farrowing rate	89.4	70.0	89.8
First litter size	9.9	9.6	10.7
P1 bred <7 days	68.3	65.4	67.3
Litters per sow	3.5	3.4	3.2
Pigs per sow	45.0	45.8	45.1

Kirkwood et al. (2000)

Table 4 Effect of PG600 at weaning on performance of primiparous sows

	Control	PG600
Number of sows	641	609
Bred by 7-d	326 (50.0%)	442 (72.6%)**
Wean-estrus, d	8.7 ± 0.3	6.7 ± 0.2**
Farrowing rate, %	86.9	86.0
Second litter size, Total born	10.5 ± 0.2	9.8 ± 0.2*
Pigs per weaned sow[a]	4.56	6.12

Kirkwood et al. (1998)

Estrus suppression : If gilts are known to be cyclic, the options for estrus control are limited to the feeding of altrenogest (Altresyn/Regumate). It should be noted that, unlike cattle, a single injection of PGF will not induce luteolysis before day 12 of the estrous cycle so is of little value in estrus control.

Altrenogest is an orally active progestogen that mimics the biological activity of progesterone by suppressing endogenous gonadotrophin secretion limiting ovarian follicle growth to the gonadotrophin-independent stage (medium follicles). In gilts, altrenogest does not prevent normal luteolysis but will continue to suppress final follicular growth and estrogen production after luteolysis by its negative feedback on LH release and so blocks estrus onset. Ideally, gilts should be individually fed so that they consume at 15 to 20 mg/d; underdosing altrenogest (<13 mg/d) is associated with cystic follicles (Davis et al., 1979). Estrus suppression is needed only from the time of luteolysis. Therefore, if cycle dates are known, altrenogest feeding can be minimized by only providing it from day 13 of the estrous cycle until 5 days before gilts are scheduled to be bred. Ninety to 95% of gilts are expected to achieve estrus on days 4 to 8 after last feeding.

Altrenogest can also be used to enhance fertility of primiparous sows after weaning by providing a longer period for metabolic recovery from lactation. This results in a longer but predictable WEI and a likely increased subsequent litter size (e.g. Kirkwood et al., 1986). It should be noted that the first altrenogest feeding must be on the day of weaning and most sows (>85%) will likely be estrous 5 to 7 days after the last feeding. With older parities of some genotypes, if records indicate a likelihood of lactation estrus or very short WEI, feeding can be initiated during late lactation.

Controlling time of ovulation: The development of fixed-time insemination of gilts and sows allows decreased timing mistakes and a reduction in labour requirements for estrus detection and inseminations. Both eCG and eCG/hCG combinations are effective for induction of estrus and the duration of this induced estrus is longer. This develops a population of late ovulating sows making timing of insemination relative to ovulation more difficult (Knox et al., 2001). However, this effect can be used to advantage since recent research has indicated 10 to 20% improvements in farrowing rate when sows were bred to a hormone-controlled ovulation (De Rensis et al., 2003; Cassar et al., 2005). Ovulation will occur in 85 to 90% of sows 42 hours after injection of hCG (38 hours after GnRH or LH). Therefore, if natural ovulation is expected to occur >38 hours after detection of estrus, such as with short WEI or gonadotrophin administration, the injection of these products will provide a high degree of predictability to time of ovulation. If time of ovulation is known, then timing of insemination is simple and allows single fixed-time inseminations (Table 5). An alternative strategy, assuming a high proportion of spontaneous estrus by day 4 after weaning, is to inject hCG or GnRH 80 hours after weaning and breed any sows in estrus 24 to 36 hours after injection. This protocol has resulted in a very high farrowing rate for estrous sows that were bred (Cassar et al., 2004), but the fate of non-estrous sows has not been determined.

Table 5 Effect of hormone-induced ovulation on farrowing rates and litter sizes

	Induced	Control
De Rensis et al. (2003)		
Number of sows	88	140
Farrowing rate, %	94.8	78.5
Litter size born alive	10.0	9.8
Cassar et al. (2004)		
Number of sows	198	370
Farrowing rate, %	90.0	75.7
Cassar et al. (2005)		
Number of sows	110 (102) [a]	131
Farrowing rate, %	84.2 (86.1)	68.7
Litter size, total born	10.3 (10.6)	11.1

[a] Data in brackets refer to a sow group inseminated only once.

Although GnRH (or analogue), hCG and LH are effective for inducing ovulation, they are fully effective only in the presence of follicles that are ready to ovulate (Driancourt et al., 2013). It is likely that a gilt or sow not exhibiting standing estrus at the time of insemination will not possess follicles appropriate for ovulation. Indeed, very high farrowing rates were observed in sows receiving only hCG at 80 hours after weaning and inseminated 40 hours later but only standing sows were bred. Success is likely to improve if follicle growth is stimulated prior to an ovulatory injection. Work conducted with prepubertal gilts has shown injection of 1,000 IU eCG followed by injection of GnRH at estrus detection resulting in very high gilt farrowing rates (S. Calamanti, cited in Kirkwood et al., 2012). Controlled ovulation may have particular relevance under conditions requiring precise timing of sperm deposition, such as with frozen-thawed semen. One study employing insemination of frozen-thawed sperm into peripubertal gilts found that 14 days of altrenogest feeding followed by eCG/hCG 24 hours later and a single insemination 32 hours after estrus onset resulted in a 70% conception rate (Spencer et al., 2010). Better results were obtained with cycling gilts; the sequential administration of altrenogest, eCG and GnRH in cyclic gilts could synchronize ovulation (Martinat-Botté et al., 2010) and when inseminated with fresh semen at 144 and 168 hours after the final altrenogest dose pregnancy rates of 92 to 96% were achieved.

Fixed-time insemination protocols for sows involve gonadotrophin treatment at weaning followed

by timed injection of GnRH or hCG, with or without a prior period of altrenogest feeding. The administration of the GnRH analogue buserelin at 86 hours after weaning and single insemination at 33 hours later resulted in reproductive performance that was similar to that of sows bred twice during estrus (Driancourt et al., 2013). More recently, vaginal deposition of the GnRH analogue triptorelin (Ovugel) at 96 hours after weaning followed by single insemination 24 hours later has shown promise (Knox et al., 2011, 2014).

An interesting application of controlled ovulation has been the resynchronizing of sows failing to conceive at their first post-weaning estrus. These sows are of lower fertility than those conceiving at their first service. The administration of altrenogest for 16 days followed by eCG 24 hours after last feed, then hCG 78 to 80 hours later with insemination 24 and 40 h after hCG resulted in conception rates of 86% which compares favorably with controls (83%) (Kauffold et al., 2007).

In conclusion, the application of estrus and ovulation control will allow fixed-time insemination of gilts and sows. However, it is important to take into account the comment of Brussow et al. (2009) in their review on timed insemination in swine: "the aforementioned technology requires healthy animals and a solid management and cannot be used to compensate for poor management".

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บทคัดย่อ

การควบคุมการเป็นสัดของหมูสาวและหมูนาง

Roy N. Kirkwood[1] Fabio De Rensis[2]

การควบคุมการหย่านมของลูกสุกรเป็นปัจจัยที่สำคัญในความสำเร็จของการผสมพันธุ์ของแม่สุกรในช่วงระยะเวลาที่ต้องการ โดยจำนวนของแม่สุกรที่จะใช้ผสมพันธุ์จะขึ้นกับจำนวนแม่สุกร แม่สุกรหย่านม และจำนวนแม่สุกรสาวพร้อมผสมพันธุ์ที่มีในฟาร์ม แม่หมูนางโดยมากจะมีระยะหย่านมถึงระยะเป็นสัดและระยะแอนเอสตรัสนาน จึงมีความจำเป็นต้องทำการควบคุมการเป็นสัดเพื่อให้ได้จำนวนแม่สุกรพร้อมผสมที่เพียงพอ การกระตุ้นการเป็นสัดปกติจะอาศัยการสัมผัสใกล้ชิดกับพ่อสุกรหรือการกระตุ้นด้วยการใช้ฮอร์โมนโกนาโดโทรปิน ในกรณีที่ใช้ฮอร์โมนโกนาโดโทรปิน แม่สุกรจะแสดงอาการเป็นสัด 4 ถึง 6 วันหลังได้รับฮอร์โมน และสามารถทำการผสมพันธุ์ในระยะเป็นสัดนี้ได้ แต่กรณีที่แม่สุกรไม่แสดงอาการเป็นสัดอาจเป็นเพราะตรวจการเป็นสัดพลาดหรือแม่สุกรอยู่ในระยะไดเอสตรัส ภาวะนี้สามารถแก้ไขได้โดยให้แม่สุกรกินโปรเจสตินสังเคราะห์ชนิดอัลทรีโนเจสนาน 18 วัน แม่สุกรมักจะกลับสัด 5 ถึง 8 วัน หลังจากการหยุดฮอร์โมน การเสริมโกนาโดโทรปินในช่วงที่หยุดให้อัลทรีโนเจสจะช่วยเพิ่มประสิทธิภาพการกระตุ้นการเป็นสัด การผสมพันธุ์ให้มีประสิทธิภาพควรทำการผสมเทียมในช่วง 0 ถึง 24 ชั่วโมง ก่อนการตกไข่ ซึ่งการเพิ่มความแม่นยำในการผสมพันธุ์นี้อาจใช้ฮอร์โมนฮิวแมนโครริโอนิก โกนาโดโทรปิน หรือ โกนาโดโทรปิน รีรีสซิ่ง ฮอร์โมน ซึ่งไข่จะตกที่ 44 ถึง 44 ชั่วโมง และ 36 ถึง 40 ชั่วโมง ตามลำดับ การทราบเวลาที่แน่นอนในการตกไข่จะช่วยให้สามารถผสมเทียมสุกรด้วยเทคโนโลยีอื่นๆ เช่น การผสมเทียมโดยใช้อสุจิน้อย และการผสมเทียมแบบครั้งเดียว

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