Estrus during lactation: a new reproductive challenge for modern production

In numerous mammalian species, birth is followed by an anovulatory period lasting a variable amount of time. Lactation is one of the principal regulators of this period because it strongly inhibits the appearance of estrus or ovulation.

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Lactational anestrus

In pig production, the wean-to-estrus interval is very important for productivity and should be as short as possible to optimize the efficiency and profitability of the farm. For the same reason, we should allow fewer lactation weeks than would naturally occur, so that the number of farrowings per sow per year can be increased.

Even so, the days-to-weaning has been increased to more than 21 days in recent years both to satisfy animal welfare laws and because of the increase in sow prolificacy. This factor encourages the transition in sows from anestrus to starting an estrus cycle (most commonly, three weeks post-partum) as a result of more frequent luteinizing hormone (LH) pulses and reduced piglet suckling (Quesnel, 1993).

Gonadotropin-releasing hormone (GnRH) and LH pulses are low during lactation (Cox, 1982). Although LH pulses (low baseline levels in the first week post-partum) are inhibited during the course of lactation, they increase slightly starting on day 21. Nonetheless, they will always be lower than those observed at the time of weaning.

Follicle-stimulating hormone (FSH) is regulated during lactation by estradiol and ovary-derived inhibin. However, its levels double between days 14 and 28 of lactation. This increase could explain the follicle diameter size observed as lactation progresses (Stevenson and Britt, 1980).

In light of all the above, follicular development is inhibited during this time (preventing their growth to ovulatory sizes), meaning that neither estrus nor ovulation can occur.

The inhibition of these hormone (GnRH/LH) pulses is mediated by the release of prolactin, oxytocin and endogenous opioids (Prunier, 2003) and is related to two processes (*figure 1*):

- Stimulation from piglet suckling.
- The metabolic status of the sow: she remains in a catabolic state during lactation because milk production is very high and her feed consumption is insufficient to compensate for this production while also maintaining her body weight.

Prolactin targets ovarian tissue and its concentration in plasma increases to maximum peaks 8–12 hours post-partum. These levels increase 10–15 minutes after piglet suckling and return to baseline levels 30–40 minutes after this stimulation stops. This hormone inhibits ovarian function indirectly by influencing LH pulses and the ovarian synthesis of estradiol.

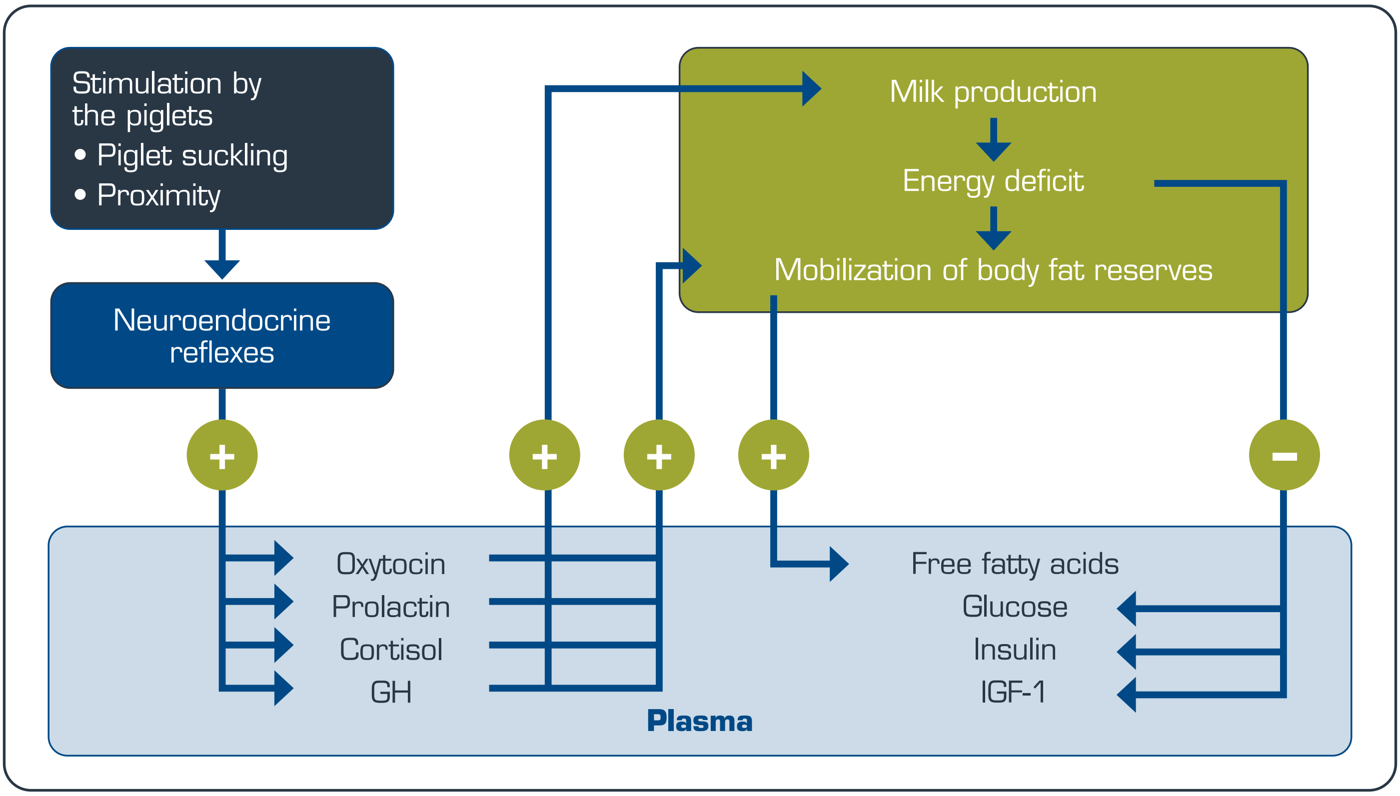

Figure 1. Schematic representation of the neuroendocrine and metabolic consequences of the piglet suckling stimulus and milk production. GH: growth hormone; IGF-1: insulin-like growth factor 1. Source: Quesnel, 1993.

The metabolic status of lactating sows

The piglet suckling stimulus triggers a neuroendocrine reaction involving prolactin and oxytocin, both of which contribute to metabolic changes during lactation that promote the use of protein and energy reserves for milk synthesis.

The sow must maintain her catabolic state to maintain this lactational anestrus, which is caused by the relationship between her daily requirements and metabolizable energy intake (*figure 2*). If this changes and she is no longer losing or maintaining her weight (a change in metabolism), the inhibition of LH pulses will stop, thereby favoring her coming back into estrus.

It has been observed that plasma glucose levels are low during lactation because it is used by mammary tissues. In turn, levels of free fatty acids are elevated because sows need to mobilize their body fat reserves to meet the nutritional requirements of milk production.

Low insulin concentrations can also contribute to the inhibition of LH pulses in lactating sows (Tokach, 1992).

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The stimulation caused by suckling induces the release of endogenous opioids in the brains of sows, which in turn inhibits the release of GnRH and LH.

Although it is unclear how metabolic changes are conveyed to the hypothalamic–pituitary–ovarian axis, glucose, insulin and leptin are the most likely signaling pathways (Quesnel, 2009).

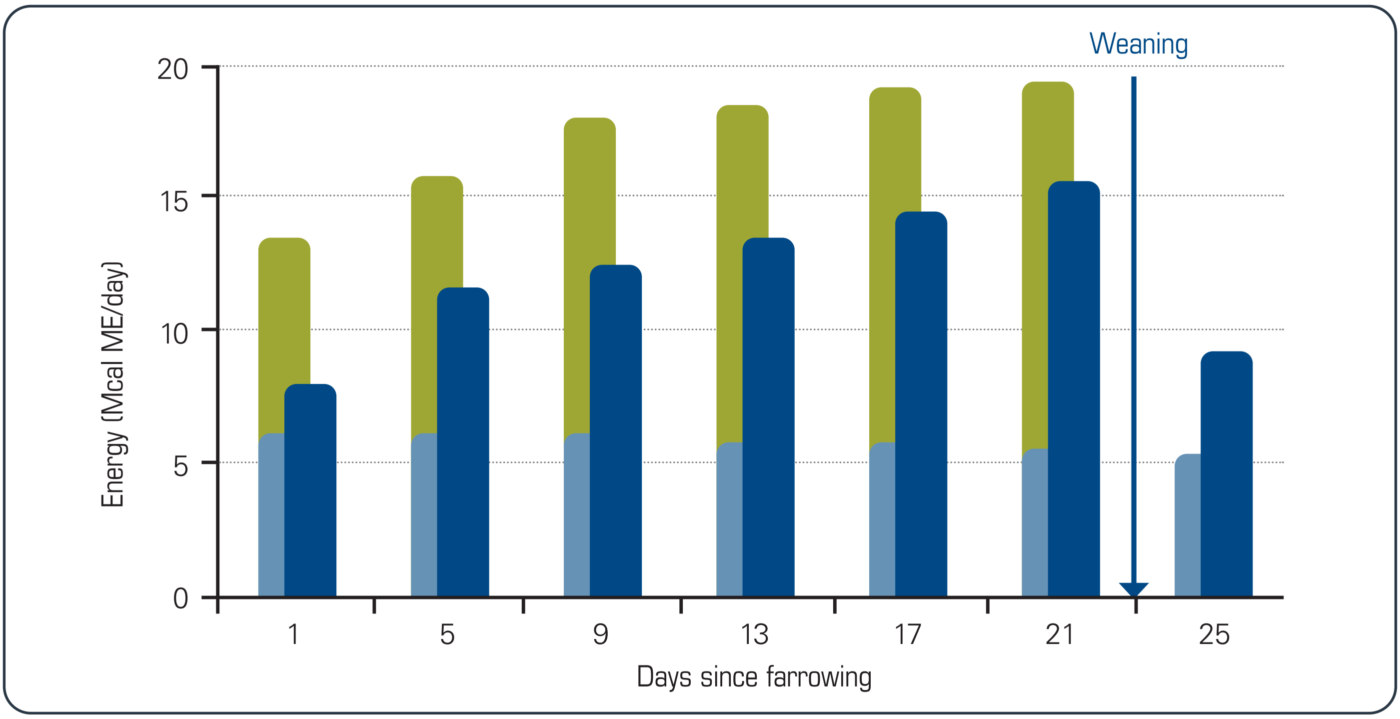

Figure 2. Daily requirements and metabolizable energy consumed (kcal/day) during lactation and after weaning for a primiparous sow with an average productivity level (data calculated based on Noblet and Etienne, 1986 and Dourmad, 1991). Maintenance (■); Lactation (■); Feed consumption (■); ME: metabolizable energy; Mcal: megacalorie. Source: Quesnel, 1993.

Lactational estrus

In recent years it has been noted that an increasing number of sows return to estrus during lactation, to the extent that a much higher percentage are affected than if this were purely anecdotal. On some farms, this is becoming a problem that must be treated, while on many others it remains undetected because diagnosing it and identifying its causes are not easy. At first it appeared that this problem was associated with certain kinds of sows, but it is now found in every genetic line used in industrial pig production.

It is highly likely that this increase is related to the wean-to-estrus interval as well as other factors such as changes in genetics, litter size, parity and frequency of nursing.

What is lactational estrus?

Lactational estrus is the spontaneous estrus and ovulation that occurs in a sow that is lactating, when she should naturally be in anestrus.

Milk production and the frequency of nursing falls after the third week of lactation (thus, lactation >3 weeks favors its occurrence). In addition, the piglets will start to become less dependent on their mother's milk at this time. As a result, the metabolic status of the sows may change, so that they enter an anabolic state. This will end the inhibition of the hypothalamic–pituitary axis and trigger a hormonal (GnRH/LH) cascade, thereby causing estrus to appear during lactation before the piglets are weaned.

Starting on day 21 of lactation, both the frequency and duration of piglet suckling decrease, leading to an increase in follicular growth and LH reserves in the pituitary gland, thus increasing the probability of ovulation in response to external stimuli.

Today, lactational estrus appears to be associated with every genetic line, with up to 25 % of modern sows now showing spontaneous ovulation during the lactation period on days 21–28.

What has been observed on farms?

Sows will go into estrus 11–14 days post-weaning; this does not behave like a standard anestrus (7–11 days post-weaning) and does not usually occur in periods of seasonal anestrus, which normally appears between October and March when the temperatures are lower and the photoperiod is decreasing.

In addition, the incidence in multiparous sows is higher than in primiparous sows, as older sows tend to lose little body weight during lactation and will be more likely to experience follicular growth and ovulation. In addition, gilts farrowing for the first time have a stronger bond with their litters and nurse their young more intensely. This factor, combined with the metabolic deficits characteristic of this first farrowing, means that they have little capacity to ovulate during their first lactation.

Of note, in some populations, there may be a percentage of sows that ovulate but that do not have detectable estrus (In one study, estrus was only detected in 50 % of the sows that had ovulated during lactation; Hulten, 2006), thereby leading to reproductive losses because sows were thought to be in post-weaning anestrus.

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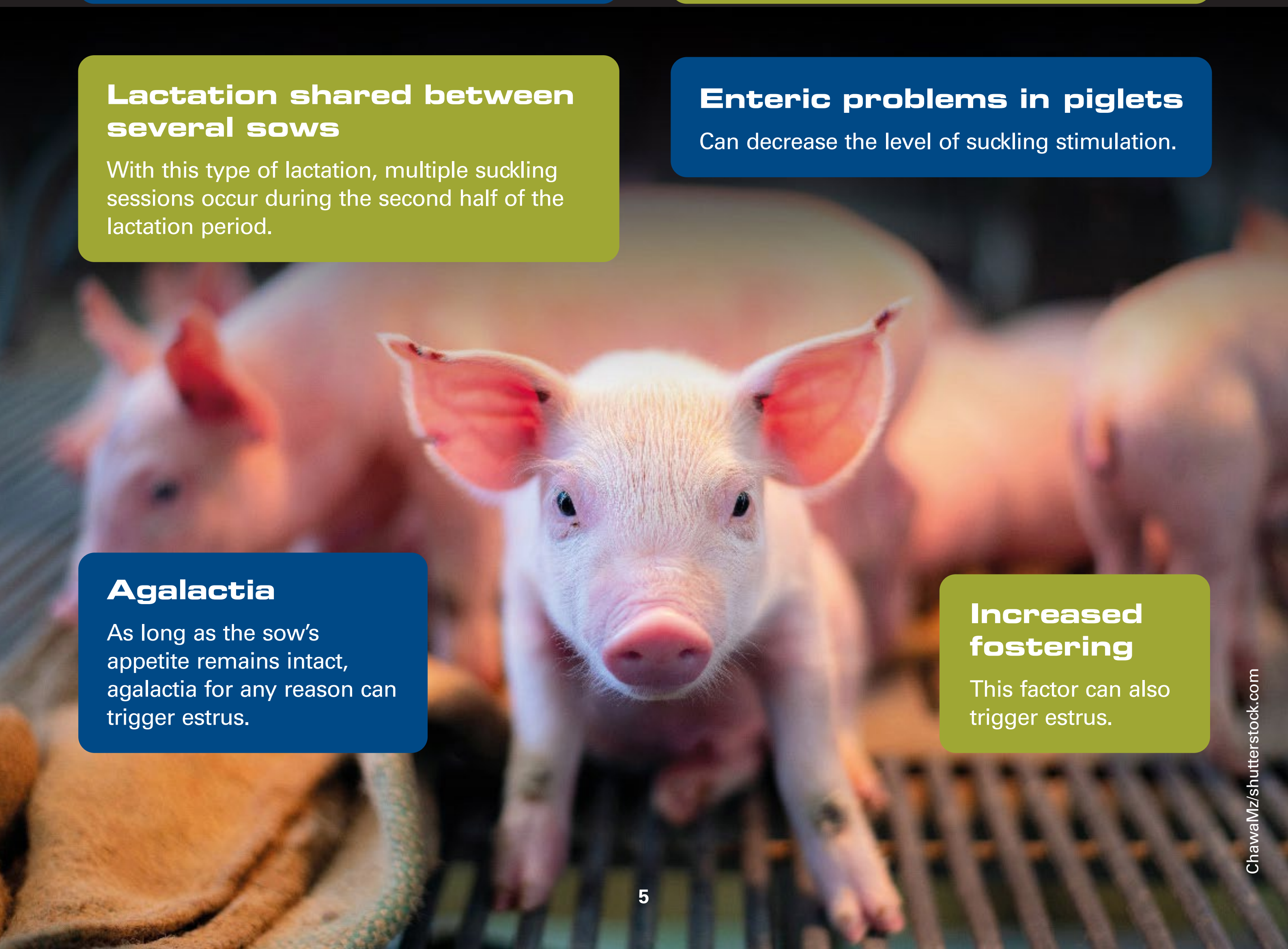
Why does this occur and when does it appear?

Recent Dutch and Australian studies concluded that modern sows have a high capacity to spontaneously ovulate on days 21 to 28 during lactation, usually towards the end of 28-day lactation periods.

The genetic selection of pigs in recent years with the aim of reducing the wean-to-estrus interval seems to have created sows that respond better to external stimuli such as exposure to the boar, partial weaning and stress in terms of the pulsatile release of LH during lactation. This allows them to recruit and select follicles and ovulate during lactation more easily (Kemp, 1998).

The main factors that can favor the appearance of lactational estrus (and its appearance in a higher percentage for which production would be feasible) are:



Litters with few piglets (< 7)

As this reduces the piglet suckling stimulus, sows go into an anabolic state as a result of decreased milk production. One study showed that the appearance of lactational estrus increased by 33 %, 78 %, or 89 % by reducing the litter size to < 10, < 7, or < 5 piglets, respectively, on days 18–24.

Partial weaning at the end of lactation

Removing the two biggest piglets from the litter results in a reduced demand for milk, which increases the energy available to sows and can also trigger estrus.

Lactation shared between several sows

With this type of lactation, multiple suckling sessions occur during the second half of the lactation period.

Enteric problems in piglets

Can decrease the level of suckling stimulation.

Agalactia

As long as the sow's appetite remains intact, agalactia for any reason can trigger estrus.

Increased fostering

This factor can also trigger estrus.

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Prolonged lactation

This especially occurs among foster sows raising litters of younger piglets.

Stress

General stress stimulations in the farrowing room such as mixing, transporting and relocating animals.

Vaccination of piglets during lactation

Vaccinating piglets can prevent suckling for several hours at a time because of the reactions vaccines can cause.

Feeding

The practice of *Ad-libitum* feeding, the administration of several meals a day or large amounts of feed (Knox, 2021) all favor lactational estrus. As previously mentioned, this phenomenon also appears in colder periods when sows' ingestion capacity is higher and they go into an anabolic state.

Direct effect of insulin

Insulin directly affects the hypothalamic–pituitary axis, which increases the ovulation ratio, and so an increase in this hormone will also favor a return to estrus. Moreover, overfeeding induces increased follicular aromatase activity and/or follicular development, which has been associated with a marked increase in insulin (along with the involvement of other currently unknown metabolites and growth factors).

Intermittent lactation

Estrus will appear 5–6 days after the start of intermittent lactation.

Group housing systems during lactation

Production systems that use group housing for sows during part of the lactation period can increase the appearance of lactational estrus. In these systems, sows are loose in a farrowing pen, meaning that the frequency of suckling at the end of lactation is lower than in conventional systems. In turn, this will counteract the suppressive effects of endogenous opioids on GnRH/LH. It has also been observed that sows usually lose less weight in these housing systems and, as we have already mentioned, this can also restore the release of GnRH/LH. In group systems, the presence of piglets from other sows creates competition and discourages sows from lactating, which can also contribute to the appearance of lactational estrus (Soede, 2012).

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The consequences of lactational estrus in terms of production parameters

After farrowing, three key processes occur:

1. Regression or involution of the uterus.
2. Regression of the corpora lutea and maturation of the set of ovarian follicles.
3. Development of the feedback mechanisms and endocrine support required to re-start ovulation and the estrus cycle.

Normal uterine physiology re-establishes itself 20–25 days post-partum. If the sow comes into estrus earlier (during lactation), this is detected and she is mated, the production data for the next cycle will compromised, her subsequent fertility could be jeopardized and embryonic death may increase due to an inadequate uterine environment. Although lactation may continue after insemination, prolonging it for more than 23 days post-mating will increase embryonic mortality rates.

The piglet suckling reflex is associated with control of uterine involution, with lactating sows showing much faster involution than those whose litters are removed early.

The release of LH creates a pattern of high-frequency, low-amplitude pulses that triggers recruitment of the follicles present in the ovary, allowing them to grow to an ovulatory size. Therefore, if this happens during lactation, the available follicles may be in a poorer condition than they would have been post-weaning (oocytes with a diminished size and developmental capacity), thereby producing worse reproductive results.

However, some studies have also demonstrated reproductive indices in sows inseminated during lactational ovulation that were comparable to those of weaned controls, meaning that in certain cases the quality of follicular development is restored during lactation (Soede, 2012). Nevertheless, other studies have shown poorer production data, such as an Australian study indicating that the farrowing rate is higher in sows mated at weaning than in those mated during lactation, after having induced lactational estrus (Terry, 2014). Hence, because it is very complicated or impossible to predict the outcome, the recommended course of action is not to inseminate these sows, but to detect the problem and try to resolve it.

Lactational estrus will go undetected in most cases because, generally speaking, the way sows are managed in farrowing areas is not conducive to estrus detection. This also leads to erroneous diagnoses during the delayed wean-to-estrus interval when lactational estrus is confused with false anestrus, potentially leading to failed treatment with gonadotropins. If the percentage of sows with lactational estrus is high, it will also complicate the mating objectives for the next batch, jeopardizing future productivity.

A recent study demonstrated how the problem of lactational estrus can affect reproductive parameters. It evaluated 1,563 sows between January and May 2016, with an average of 26 days of lactation. Of these, 4.2 % showed lactational estrus, with a between-batch variance of 0–12 %. The average start of estrus was on day 22 and fertility remained reasonable but was lower than in sows that weaned without having presented estrus (Sigmarsson and Kauffold, 2016).

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How to detect lactational estrus

As previously mentioned, the management practices in farrowing areas make it very complicated for operators to detect lactational estrus, so we must seek out other measures that could help us. In addition, many of these affected sows will ovulate without showing signs of estrus (up to 50 % of the total number of sows that cycle during lactation may not show estrus).

Estrus can be diagnosed during lactation by:

1. Performing an ultrasound on the ovaries

If ovulation has already occurred and the sow has started another cycle, we should find follicles of a pre-ovulatory size or even the presence of corpora lutea (*figure 3*).

Figure 3. Performing an ovarian ultrasound to diagnose lactational estrus.

2. Analyzing sow records

This is to verify the extended wean-to-estrus intervals, especially in multiparous sows with small or low-weight litters.

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3. Analyzing progesterone at the time of weaning

At the time of weaning, animals should show no or low levels of progesterone, because the ovary normally would have follicles starting to develop (about 4 mm), and no new or regressing corpora lutea generating high levels of progesterone.

It is important to calculate the percentage of these problem sows present in various consecutive batches because it is always possible for one of them to spontaneously ovulate during lactation.

To facilitate this kind of diagnosis, we can use a progesterone rapid test kit (PROGESTERONE-STRIP test by MSD Animal Health). This is a semi-quantitative, semi-competitive ELISA with color-based results: the intensity of the color (pink) is inversely proportional to the concentration of progesterone in the blood.

The example in *figure 4* shows the use of the kit on a farm experiencing clear problems with lactational estrus. Estrus was delayed by 10–15 days post-weaning in some 20–40 % in each batch of weaned sows. No signs of estrus had been observed in the farrowing area, but a review of the progesterone concentrations showed that the sows with a delayed wean-to-estrus interval corresponded to those whose progesterone was > 5 ng/mL, meaning they had ovulated during lactation.

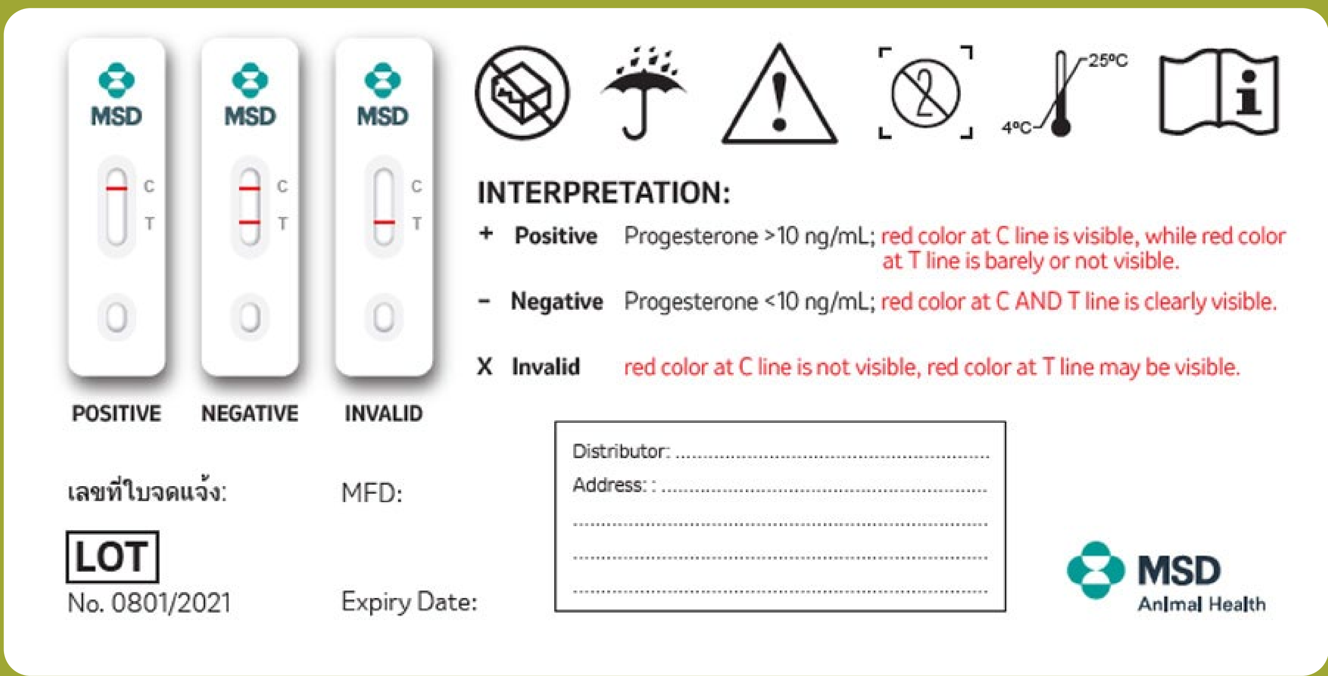

Figure 4. PROGESTERONE-STRIP test by MSD Animal Health used on a farm with lactational estrus problems.

How can we resolve lactational estrus?

There are several means we can use to help us resolve lactational estrus:

1. Try to treat the problem sows.
2. Use a direct measure to prevent it from appearing: altrenogest.
3. Directly determine the cause of the problem and implement measures to resolve it.

1. Try to treat the problem sows

There are studies that have used prostaglandins at weaning to decrease the delay in coming out of estrus on farms with this problem. One such study showed a decrease in the number of sows with late estrus, reducing the WEI from 6.3 to 5.5; 12 % of sows on this farm had lactational estrus (Gamabde, 2004) and they increased fertility by 19 % ($p = 0.08$).

2. Use a direct measure to prevent it from appearing: altrenogest

This measure consists of administering altrenogest (Regumate®, MSD AH) 1–2 days before lactational estrus usually appears and continuing its administration for all the multiparous sows in each batch until weaning. This will usually be around days 18–21 and in 24-day lactations, altrenogest would be administered during days 17–24 (a total of 8 days), thus maintaining inhibition of the GnRH/LH pulses until weaning. The administration of altrenogest (Regumate®, MSD AH) during lactation has been shown to increase the number of live piglets born in the next farrowing, probably because it fosters better, more homogeneous follicular development at the beginning of estrus (Lopes, 2017).

3. Directly determine the cause of the problem and implement measures to resolve it

For sows in an anabolic state, feed increases could be limited during the last few days of lactation to try to attain a metabolic state that will keep the hypothalamus-pituitary-ovary axis inhibited. In addition, all the management-related causes explained above should be considered, such as minimizing the movement of piglets between litters, avoiding partial weaning, etc.

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Or don't try to resolve it, induce it instead!

Some studies have recently appeared in which lactational estrus is used as a different strategy, to try to achieve production benefits. This entails inducing estrus during lactation, inseminating the sow and having her gestate while she is still lactating, thus reducing the time between cycles and obtaining larger, higher-quality piglets upon weaning. These are forward-thinking management techniques that mostly work with sows going through lactation in communal groups (which minimizes the frequency and time spent nursing), as stated by Wettere in his article, "Controlling lactational estrus: the final frontier in the management of breeding sows." However, the possibility of large-scale implementation remains unclear given that it would not be viable on current farms and further studies to confirm the reproductive results would be needed.

In different studies, lactational estrus was stimulated by changing the time sows spent nursing and by exposing them to the boar for 15 minutes each day; 93 % of them went into estrus and were mated during lactation, achieving pregnancy rates similar to those of the control sows.

Another example of such a strategy was the induction of estrus with gonadotropin treatments during lactation, as described by Kirkwood (1998). This aforementioned study used two groups of sows: one weaned at 28 days and the other treated with 1,000 IU of pregnant mare serum gonadotropin (PMSG) on day 28, with weaning at 42 days. The sows were mated at weaning or after treatment (during the induced estrus). The farrowing rate was lower in the induced group, but the litter sizes were the same for both.

Conclusions

Lactational estrus is now a problem that affects many farms and can appear regardless of genetics and production type. When it appears in a higher percentage than normal in the sows of each batch, it complicates management and leads to financial losses due to delays in the weaning-estrus interval, treatment costs and disorganization of the farm's production batches.

The causes of lactational estrus are closely linked to the management of piglets in the farrowing pens and how the sows are fed.

Although it is not easy to detect, simple tools are available, such as ovarian ultrasounds or measuring progesterone levels at weaning or in sows with increased weaning-estrus intervals. The use of these tools is key to implementing corrective measures, depending on the cause in each case. Altrenogest can be used during lactation as a treatment to prevent this problem from appearing, but we must delve deeper into the underlying causes of lactational estrus in order to truly eliminate the problem.

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