Artificial Insemination (AI) and Oestrus Synchronisation of Beef Cattle

Information compiled by Endell Veterinary Group, Paragon Veterinary Group and RAFT Solutions/Bishopton Cattle Breeding Services.
Compiled by Dr Mary Vickers, AHDB Beef & Lamb.

Key messages

+ AI allows suckler producers to serve their cows or heifers with high genetic merit sires
+ Successful synchronisation requires attention to detail in managing the cattle, setting up handling facilities and planning labour
+ In controlled breeding programmes synthetic hormones are used to adjust the breeding cycle
+ Successful heat detection relies on carrying out regular observation
+ A cow or heifer standing to be mounted is the most accurate sign of oestrus
+ A simple rule of thumb is to inseminate a cow or heifer 12 hours after she is first seen standing to be mounted
+ A beef cow’s oestrus cycle averages 21 days and starts at day 0 when she shows signs of standing heat
+ Fixed-time AI removes the need for heat detection, as cattle are served at a predefined time during the programme
+ Once a programme has been agreed it is important to adhere to timings carefully

Keywords:
Artificial insemination (AI), Oestrus cycle, Oestrus synchronisation, Heat detection, Controlled breeding programmes, Fixed-time AI (FTAI)
Introduction

Traditionally, AI has not been used in beef cattle to the extent that it has in the dairy industry due to the need for accurate heat detection, additional handling requirements and poor results achieved with non-cycling animals.

The development of synchronisation programmes that allow cattle to be inseminated at a fixed time and that minimise the time needed to observe heats (oestrus) and handle cattle, has made it possible to incorporate AI successfully into beef breeding programmes.

However, neither AI nor synchronisation can substitute for, or overcome, sub-optimal management – only with attention to detail will the full benefit of these techniques be achieved.
Benefits of AI

There are many ways AI can benefit beef producers. The main advantage is it allows farmers with suckler herds to access high genetic merit sires with desired Estimated Breeding Values (EBVs), rather than relying solely on a few bulls on the farm to serve all the females.

It also means sires can be selected for different groups of females; for example, one bull for the heifers, a second to produce heifer replacements and a third for producing calves with superior carcase traits for the beef market.

It can also potentially reduce the requirement for keeping bull(s), although a sweeper bull is often still required. This can be an attractive incentive for smaller beef herds where the maintenance cost for a bull may be around £45/calf born, over and above the purchase cost, which for top bulls may be prohibitive. AI also avoids the potential health risks associated with using natural service.

Choice of the most appropriate bull for the females being served is vital. It is important to check the EBV for calving ease (direct), as this indicates how easily a calf sired by a particular bull will be born. Management of the herd should aim to reduce the risk of calving difficulties because they have a negative effect on subsequent cow fertility and calf performance.

There are many other EBVs available to help producers select bulls that will produce progeny to fit the farm’s requirements and complement the females out of which they will be born.

Synchronising heats

To obtain maximum benefit from using AI, synchronisation can be used to:

+ Facilitate block serving and a compact calving period
+ Reduce the time and labour required for constant heat observation
+ Improve the timing of AI

Synchronisation, however, does require repeated collection and handling of stock. It does not completely eliminate the need for heat detection, as females returning to heat have to be identified and served, unless a sweeper bull is used.

It is important to consider how AI and synchronisation will be integrated into the management of the herd. Farmers need to decide how non-pregnant cows will be detected, how many times a batch of cows will be synchronised and whether a sweeper bull will be used.

Critical success factors

Successful synchronisation requires attention to detail in managing the cattle, the handling facilities and planning the labour. It is vital to have planned how any programme is going to work on the farm before starting. AI and synchronisation will not be suitable for every beef enterprise.

Cattle

+ Feed cows a consistent ration so they are on a rising plane of nutrition which meets their requirements, including minerals, for a minimum of six weeks prior to service and six weeks after
+ Cows or heifers should be in the correct body condition, fit not fat. The ideal body condition score (BCS) at service is around 2.5–3. Exclude cows that are very thin or very fat, at BCS <2 or >4
+ Cattle should be kept in a stable social group for at least six weeks prior to and after service
+ Heifers should be at least 65% of their mature body weight at first service
+ All stock must be free from disease
+ All medication, e.g., vaccines and parasite treatments, should be given in advance of any synchronisation programme and/or service
+ Ideally, some females should be observed cycling before synchronisation or AI*
+ Ideally, cows should have calved at least 50 days before the synchronisation programme begins*
+ Stock should have a pre-service vet check to ensure they have a healthy and functional reproductive tract
+ Need to keep accurate calving, breeding and pregnancy records

* Some progesterone-based synchronisation protocols can help overcome non-cycling animals and can be beneficial when synchronising cows that have been calved <50 days. However, pregnancy rates from service at the first post-calving heat may be reduced compared to serves at later heats

**Facilities**

+ Need to be suitable for multipleplings, causing minimal stress to the cattle
+ Need to be adequate to handle several interventions easily during the synchronisation and AI process
+ The crush should be under cover to provide good working conditions for insemination
+ Most synchronised females will calve within a two-week period and a significant proportion may calve on one day. Sufficient calving pens should be available

**Labour**

+ There needs to be enough staff to cover the high workload at breeding and calving
+ Synchronisation and AI programmes can range from handling cattle only once, to handling over five times in three weeks
+ Employing experienced, skilled and disciplined labour will reduce stress and time for the farmer and the cattle
+ DIY AI may make some synchronisation programmes more workable. However, the inseminator may not be doing AI routinely, which could affect conception rates
+ Plan ahead so that handling events can be timed to avoid busy times or when help is limited

**Choosing the correct sire for AI**

+ Choose sires that are above average for calving ease direct EBV and that improve the genetic merit of the herd for important traits. Estimated breeding values are available for a range of maternal and terminal traits and can help identify the best sire for specific cows or heifers
Signs of heat/oestrus

Accurate detection of standing heat and the subsequent timing of insemination is critical to successful AI where a fixed-time AI programme is not used or for serving cows on heat after the programme has finished.

A cow or heifer standing to be mounted is the most accurate (primary) sign of oestrus.

Cows or heifers on heat will allow other cows to mount them or move forward slightly with the weight of the cow that is riding them. Cows that move away quickly when mounted are not on true heat.

Other secondary signs may be seen which indicate that a cow or heifer will be coming into heat soon or has recently been on heat. These include:

- Discharge of clear mucus from the vulva. Long clear elastic strings of mucus indicate an imminent heat. Cloudier, thicker mucus indicates a recent heat
- Mounting other cows. Cattle that mount other cows may be in heat or approaching heat. Females that are mid-cycle or are in-calf are less likely to perform mounting activity
- Swelling and reddening of the vulva
- Restless behaviour, such as increased walking, following other cows and bellowing are all indicators of cows that are either in or approaching oestrus
- Rubbed tail head and dirty flanks due to being frequently mounted. The hair around the tail head may be matted or rubbed off completely
- Blood stains on the tail or vulva. Some cows and most heifers have a bloody mucus discharge one to three days after oestrus. These cattle should be watched for heat 17–20 days later
- Decreased feed intake due to increased activity and less time spent feeding

Heat detection

In beef cows and heifers, standing heat tends to last for around 10–12 hours.

Successful heat detection relies on regular observation of the breeding groups. Ideally, these should be observed at least three times a day, including once early in the morning and once in the evening around dusk. Each observation should last at least 20 minutes.

Heat detection aids such as tail paint, mounting detectors, teaser bulls and activity meters can help identify females showing heat when no one is around but should be used alongside regular observation by a person.

The more females that are on heat simultaneously, the more heat activity will be exhibited.

High stocking rates and concrete or slippery flooring (as opposed to straw yards or pasture) are known to reduce oestrus behaviour. Beef cows with calves at foot often show very little bulling activity.

The best time to inseminate a heifer or cow is slightly before the time of ovulation, which occurs approximately 30–38 hours after the start of standing heat. This means that cows or heifers should be inseminated in the latter two-thirds of heat or within a few hours after heat has finished.
Increase walking, bellowing and general restlessness

Primary signs of oestrus

Secondary signs of oestrus

Ovulation approximately 30-38 hours after start of standing heat

Best time to inseminate – approximately 9 hours

Coming into heat 6–24 hours

Stands to be mounted (STBM) 10–12 hours average 3–30 hours range

Going out of heat up to 24 hours

Stands to be mounted

Mounts other cows

Chin pressing and licking

Sniffing

Increase walking, bellowing and general restlessness

Swelling of vulva and mucus discharge

Dirt and skin marks

Bloody discharge

A simple rule of thumb is to inseminate a cow or heifer 12 hours after she is first seen standing to be mounted.

When to inseminate – AM/PM rule

Table 1: Rule of thumb on timing of insemination after standing heat has been observed

<table>
<thead>
<tr>
<th>When seen standing to be mounted?</th>
<th>Time to serve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>Afternoon</td>
</tr>
<tr>
<td>Afternoon/evening</td>
<td>Next morning</td>
</tr>
</tbody>
</table>

If there is uncertainty about the timing of the start of oestrus then it is advisable to inseminate immediately and then observe, re-inseminating 12 hours later if the cow or heifer is still standing to be mounted.
The reproductive system

A beef cow’s oestrus cycle averages 21 days and starts at day 0 when she shows signs of standing heat.

Ovarian follicles, the basic unit of female reproduction, each contain a single egg. Under the influence of follicle stimulating hormone (FSH), a number of new follicles mature every seven to ten days. This is known as the ‘follicular wave’ and results in one follicle becoming dominant.

Oestrus occurs when there is a dominant follicle on the cow’s ovary that is almost ready to ovulate. The egg is released on day one (ovulation). This is ready to be fertilised if a cow has been served and semen is present inside her.

After ovulation a progesterone-secreting body called a corpus luteum (CL) develops at the ovulation site. The presence of high levels of progesterone stops more eggs being released.

From day 17, if the cow is not pregnant, the CL regresses due to other hormones called prostaglandins produced by the uterus and progesterone levels decline. This fall in progesterone, combined with the increase in another hormone called oestadiol produced by the dominant follicle, induces a peak in luteinizing hormone (LH). This stimulates the next dominant follicle to release an egg.

If pregnancy occurs, the CL does not regress and continues to function and release progesterone.

Figure 2: The normal oestrus cycle of a cow

Source: Penn Veterinary Medicine
Controlled breeding programmes

In controlled breeding programmes, synthetic hormones are used to control the breeding cycle of the cow.

Fixed time AI (FTAI) programmes are designed to:

+ Control follicular wave dynamics
+ Induce regression of the CL
+ Induce ovulation of a dominant follicle

The following hormones are often used during synchronisation programmes.

**Progestosterone releasing devices (P4 devices), eg CIDR®, PRID®**

This is a device placed in the vagina that imitates the function of the CL by releasing progesterone. As with natural progesterone this suppresses the release of GnRH (gonadotropin-releasing hormone) which in turn regulates the release of LH and FSH. Removal of the progesterone device produces a surge of GnRH, generating increased frequency and size of LH pulses which induce ovulation two to three days later.

Progestosterone-based programmes are often used in cows as they are more effective at synchronising non-cycling animals.

**Prostaglandin (PG)**

This hormone shortens the reproductive cycle by inducing regression of the CL, causing ovulation of the dominant follicle two to five days later. If there is no CL present when the prostaglandin is administered it will have no effect. This means heifers or cows must be cycling to make use of PG.

**Gonadotropin-releasing hormone (GnRH)**

This hormone stimulates the release of both FSH and LH, causing the following two main effects:

+ Ovulation of dominant follicles, leading to the formation of a CL
+ Stimulation of further follicular development

GnRH can be used to assist the timing of ovulation in relation to insemination.

Other hormones are available for inclusion in the various programmes. Discuss options in more detail with a vet.

Note: Many hormone injections require administration via a deep intramuscular injection. It is important the manufacturers’ instructions are followed carefully.

**Equine chorionic gonadotropin (eCG)/Pregnant mare’s serum gonadotropin (PMSG)**

Research has shown that administration of the hormone equine chorionic gonadotropin (eCG) at the same time as the removal of the progesterone device, improves synchronised conception rates in beef cows. Most benefit is likely to be seen in thin cows (BCS <2) calved <55 days at first AI. Caution is required as high doses may increase the risk of twins.
Oestrus synchronisation with fixed-time AI

Fixed time AI programmes remove the need for heat detection because the cattle are served at the predefined time during the programme. There are a number of fixed-time AI programmes and these should be discussed with a vet before choosing one.

The following examples of fixed-time AI programmes are popular in beef herds, as the cattle require minimal handling and relatively good results can be achieved.

Table 2: Examples of fixed-time AI programmes

<table>
<thead>
<tr>
<th>Day</th>
<th>1. PG only (x2)</th>
<th>2. PG + GnRH</th>
<th>3. P4 + PG (+/- eCG)</th>
<th>4. P4 + GnRH + PG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>PG</td>
<td>GnRH</td>
<td>Insert P4 devices</td>
<td>GnRH + insert P4 devices</td>
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<tr>
<td>1</td>
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<td>6</td>
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<td>PG</td>
<td>PG*</td>
<td>PG + remove P4 devices</td>
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<td></td>
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<tr>
<td>8</td>
<td></td>
<td></td>
<td>Remove P4 devices ** (eCG) ***</td>
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<tr>
<td>9</td>
<td></td>
<td>GnRH + FTAI 56 hours after PG</td>
<td>GnRH + FTAI 56 hours after P4 removal</td>
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<tr>
<td>10</td>
<td></td>
<td></td>
<td>FTAI at 48 and 72 hours after P4 removal or single FTAI at 56 hours after P4 removal</td>
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<tr>
<td>11</td>
<td>PG</td>
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Note: these are examples only and there are many variations on these programmes. With any synchronisation programme a compromise must be found between the number of cattle handlings and the potential conception rate achieved within the programme. Priorities between these two factors will vary according to farm and should be discussed with the herd vet.

* PG is usually injected 24–48 hours before P4 device removal
** P4 is usually removed between 7 and 9 days but can vary depending on device and veterinary advice
*** eCG = inject 300-400iu of eCG or PMSG for thin/late calved heifers/cows

KEY:
FTAI = Fixed-time AI
GnRH = Gonadotropin-releasing hormone
PG = Prostaglandin
P4 = Progesterone

Once a programme has been chosen it is important to adhere to the timings carefully.
1. Prostaglandin (PG) only

This programme is suitable for all cows or heifers that are cycling and consists of two PG injections administered on day 0 and secondly between days 10–12. Prostaglandin programmes are not suitable for:

- Cattle that are not cycling, eg immature heifers
- Females that are recently calved, <50days
- Females in poor body condition, BCS <2

Alternatively, there are less costly options using prostaglandin administration that involve additional observed heat detection. The options are flexible but generally involve initial insemination to observed heat for a period of six days, then for those not served, one or two injections of prostaglandin, with heifers and cows subsequently observed and inseminated to standing heat for periods of five days after injection. Consult a vet for more information on these options.

Note: inadvertent administration of prostaglandin to a pregnant cow or heifer will usually cause abortion.

2. PG + GnRH

This programme is suitable for herds with a high percentage of cycling heifers or cows (cows >50days post-partum and/or in good BCS 2.5-3). This programme tends to be less effective in heifers compared to mature cows.

3. 3 P4 + PG (+/- eCG)

This programme is suitable for herds with a high proportion of heifers or cows which are not likely to be cycling normally because they are too young (heifers), are in poor body condition or have only recently calved (less than 50 days post-partum).

For thin cows (less than BCS 2) or those less than 50 days calved, addition of eCG may increase conception rates, but care must be taken as higher does rates can increase twinning rates.

There is the option of a single insemination at 56 hours or double insemination at 48 and 72 hours. Pregnancy rates tend to increase by 5-10% when double insemination is used.

If fixed time AI is being carried out, it is important to inject PG 24-48 hours before the P4 devices are removed. This will reduce the risk of continued production of progesterone for a functional CL after device removal and ensure good oestrus synchronisation.

Addition of GnRH at the start of the programme is optional. It is used to ovulate any existing dominant follicles, ensures a new follicle wave is initiated and could therefore eliminate the need for double insemination.

The time between insertion and removal of the progesterone implant can be varied between seven and nine days, but this would not be advisable when GnRH is used at the start of the programme.

4. P4 + GnRH + PG

This programme is also suitable for herds with a high proportion of heifers or cows which are not likely to be cycling normally because they are too young (heifers), are in poor body condition or have only recently calved (less than 50 days post-partum).

There are advantages to including progesterone releasing devices in females not observed to be cycling (or examined by a vet). The addition of the progesterone devices prevents premature expression of heat (between day 6 and 8) and improves the chances of a fertile ovulation in non-cyclic cows.

Addition of GnRH at the start of the programme eliminates any existing dominant follicles and ensures a new wave, while at the end of the programme GnRH ensures timely ovulation.

This programme also has the advantage of only three handling sessions.
Sweeper bulls

Most fixed-time programmes rely on a ‘sweeper bull’ to detect and serve repeat breeders that fail to conceive to AI. However, repeat synchronisation programmes are available.

Repeat synchronisation

Repeat synchronisation programmes aim to synchronise cows or heifers that have failed to conceive following the first synchronisation, thus allowing second and third rounds of AI. These programmes also recruit any late calvers into subsequent rounds of insemination.

The advantage of this is that there can be up to three opportunities for cows to be served with fixed-time AI, so a stock bull may not be required.

Disadvantages include increased handling and higher cost. Anyone considering this option should contact their vet for further advice.

Conception rates

Conception rates for the different synchronisation programmes vary within and between herds due to a variety of factors.

Conception rates of 50% are readily achievable, although the range is between 30% and 75%. Attention to detail and good planning will help optimise results.

Generally, conception rates tend to be better with heifers compared to cows, as long as they are cycling before entering the programme.

Pregnancy detection

Pregnancy scanning can be done from around 30 days after breeding to confirm if cattle are in calf or not and if they are carrying twins. It can also predict calving date in cows and heifers that are up to three months pregnant.

Further advice

Various modifications of these programmes are available. The choice of the most suitable synchronisation programme for a group of cattle should be made in conjunction with the herd’s vet. They will be able to offer advice about achieving the best results from AI.