

8

Reproductive management

This chapter explains the impact of both nutritional and non-nutritional factors on the reproductive performance of the dairy herd.

The main points in this chapter

- Understanding the fertility timetable for the milking cow assists with managing reproductive procedures.
- 100 day-in-calf rate and 200 day-not-in-calf rate are two good measures of reproductive performance. Submission rate and conception rate are the other two important measures.
- Nutrition is just one of many factors affecting reproduction. These factors can be categorised into their degree of difficulty for the farmer to influence.
- The key nutrition factors are feed intake, body condition and heifer live weight.
- Heat detection, length of the voluntary waiting period and artificial insemination practices are three other factors.
- Farmers must set priorities to tackle fertility issues, dealing with the most important first. It is possible for a healthy, high-yielding cow to require up to eight inseminations to conceive.
- The simplistic answer for any problem cow is 'not enough insemination', but when is enough enough?

Improved reproductive performance provides many benefits to farmers such as:

- higher average milk yields each day – cows with poor reproductive performance will spend more of their time in late lactation, when daily milk yields are lower
- fewer cows that have become excessively fat because they have failed to conceive
- less compulsory culling of cows failing to become pregnant
- fewer cows with long dry periods
- reduced insemination and semen costs
- heifers calving at a younger age
- increased number of calves produced each year, thus providing more animals for sale or as replacements for the milking herd
- more efficient feed utilisation as a result of the above benefits
- more profits, less work and less worry.

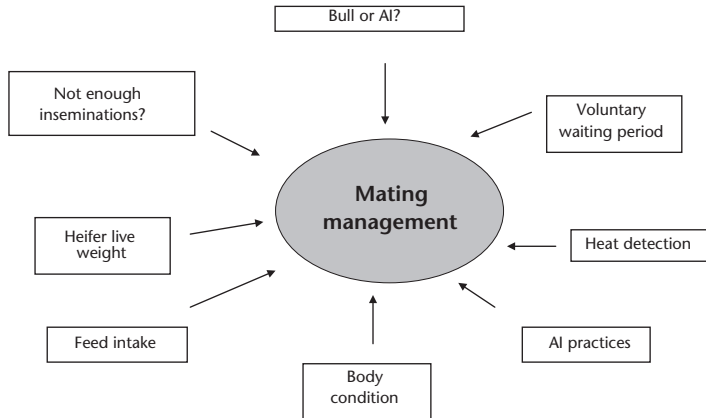


Figure 8.1. The key factors influencing the milking herd's reproductive management

The Australian dairy industry has a structured program to maximise the rate at which cows get in calf, called InCalf (Morton *et al.* 2003). It is a framework for a fertility management plan to make sure all the day-to-day actions work towards a goal of better reproductive performance. The 'fertility for life' cycle involves calf and heifer rearing, first mating, pregnancy and calving. Then for subsequent lactations, it involves matings and pregnancies, calvings and, eventually, culling. Success will require attention throughout the cycle. Basically, any management plan should answer an important question: today has everything been done to ensure high reproductive performance? From the day a calf is born, farmers control the factors influencing her future fertility, hence whether she gets in calf on time, every time.

There is no simple recipe because every farm is different and will require its own plan. InCalf focuses on the key drivers of:

- calf and heifer rearing
- body condition and nutrition
- voluntary waiting periods of no more than 50 days
- heat detection
- artificial insemination (AI) technique and sire selection
- bull management
- cow health
- heat stress management.

8.1 Measures of reproductive performance

8.1.1 Collecting permanent records on each cow

It is important to develop a system for collecting permanent records of each adult cow in the herd. This facilitates extracting data to calculate the above measures. Permanent records should include the following information:

- cow identification number, which should also be on an ear tag (preferably two tags, in case one falls off)
- birth date
- ancestry, such as dam and sire number and breed type, maybe grand dam and grand sires number and breed type, and cow's breed type
- vaccination dates
- important disease problems during rearing
- for each lactation:
 - lactation number
 - dry off date of previous lactation
 - calving date
 - each insemination date – this is generally the important data that is not routinely recorded
 - the date when confirmed pregnant by rectal palpation
 - the estimated age of the foetus
 - any estimates of live weight or body condition
 - peak milk yield or estimated full lactation yield
 - any diagnosed health problem.

8.1.2 The fertility timetable for the milking cow

The fertility cycle can be best understood by following the recommended reproductive timetable:

- calving, with minimum difficulty
- involution of uterus takes 21 days
- follicular development commences 14–21 days after calving, in a well-managed cow
- voluntary waiting period, or days after calving with no insemination, should not exceed 50 days
- cycling occurs every 18–24 days
- first insemination should be 50–80 days post-calving
- pregnancy takes 282 days
- dry off cow 50–60 days pre-calving
- transition period to calving for 14–21 days.

The annual fertility cycle incorporates replacing 20–30% of the herd with heifers each year and culling up to 10% of the cows for poor reproductive performance, and this includes 5% of the herd that will never get pregnant, even though they are healthy.

Before discussing the effects of herd and feeding management on reproductive performance, it is important to quantify reproductive performance.

8.1.3 Introducing 100 day-in-calf and 200 day-not-in-calf rates

There is an old saying 'If you can't measure it you can't manage it'. Benchmarks make it possible to respond when measures indicate reproductive performance can be improved and to assess whether it has improved as a result of management changes. The best



Routine pregnancy diagnosis is an integral part of good reproductive management (Vietnam).

measures describe the rate at which cows get pregnant when mated and the number that remain non-pregnant following mating.

For year-round calving herds, the two useful measures of reproductive performance are:

- **100 day-in-calf rate.** This calculates the percentage of the cows in the herd that become pregnant by 100 days after calving. It also describes how many cows will calve within about 13 months of their previous calving.
- **200 day-not-in-calf rate.** This calculates the percentage of cows not pregnant by 200 days after calving. Farmers want as many cows as possible to calve no more than 15–16 months after their previous calving.

To calculate these two measures of reproductive performance, one must know accurately when cows become pregnant. It is best to base this on pregnancy testing when cows are between 5 and 15 weeks pregnant. To achieve this, a herd pregnancy testing routine is necessary. Cows not returning to service should be examined on the next pregnancy testing day until they are confirmed pregnant. Pregnancy testing cows every 1–2 months allows most accurate monitoring.

Two other measures are frequently used to describe reproductive performance. These are average calving to conception interval (or days open) and inter-calving interval. These measures are not ideal because there are three major problems with their use, namely:

- They are only averages and don't indicate how many cows actually had long calving to conception intervals. Such problem cows require attention.
- They do not take into account cows that do not become pregnant at all. Obviously these non-pregnant cows are also problem cows.
- These measures can include cows that are routinely inseminated many months after calving, such as high-producing cows, which are normally culled as non-fertile.

8.1.4 Submission rates

The submission rate (SR) is the percentage of the herd which received at least one insemination within a specified number of days after calving.

To achieve a high 100 day-in-calf rate, a high percentage of cows in the herd must be submitted to insemination without undue delay after calving. The 80-day submission rate is the percentage of cows that receive at least one insemination by 80 days after calving.

8.1.5 Conception rates

The conception rate (CR) is the percentage of inseminations that are successful and result in pregnancy. To determine this value, dates of every insemination or natural matings to a bull must be collected and documented. The date of conception for each pregnant cow must also be recorded, based on pregnancy diagnoses, and this will be the date of the last insemination. The conception rate is then the number of conceptions or natural matings that resulted in a successful pregnancy (more than 40 days previously) expressed as a percentage of the total number of inseminations or natural matings for those cows. Conception rate to first inseminations is the number of cows conceiving at the first insemination expressed as percentage of the total number of cows included in the calculations. Herds can have high conception rates but poor 100 day-in-calf and high 200 day-not-in-calf rates.

The conception rate is only one aspect of reproduction because herd performance is also dramatically affected by:

- the time from calving to first insemination
- the percentage of returns to service that are detected.



A cow breeding wheel to monitor when cows are successfully bred (Vietnam).

Table 8.1. Achievable measures of reproductive performance in year-round calving herds

Measures of reproductive performance	Seek help	Top farmers achieve
100 day-in-calf rate	<45%	58%
200 day-not in-calf rate	>19%	13%
80-day submission rate	<61%	73%
Conception rate	<43%	51%

(Source: Morton *et al.* 2003)

High levels of reproductive performance can be achieved with only moderate conception rates when submission rates are high and a high percentage of returns to service is detected. High submission rates are essential for high 100 day-in-calf rates.

Data from Australian dairy farm surveys can provide a guide for actual and achievable reproductive performance in year-round calving herds. These are presented in Table 8.1.

These large-scale surveys identified six factors that have large influences on herd reproductive performance. Three are non-nutritional and three are nutritional. They are:

- **The length of the voluntary waiting period.** This is the number of days delay after calving before farmers begin inseminations. This is 50–55 days in the herds with the best fertility.
- **Mistakes in heat detection.** Farmers can make two types of mistakes: they can diagnose heat in cows not on heat (called a false positive) or miss a heat identification (undetected heat). Missed heats are more common. The higher the heat detection rate, the higher the submission rate. Farmers with over 80% heat detection rates had 73% 80-day submission rates.
- **AI practices.** There are many skills in AI, but discussion of these is outside the scope of this manual. Good first insemination rates were 45–48%.
- **Body condition.** Cows calving at condition scores of 4.5–5.5 (where 1 = emaciated and 8 = extremely fat) had higher 100 day-in-calf rates (54%) than those calving at less than 4.5 (41%). Cows calving in very high score (6.0 or more) may lose condition more rapidly after calving and can suffer reduced fertility.
- **Feed intake.** Better fed cows have higher fertility. Better feeding can improve 100 day-in-calf rate from 41% to 57% and reduce 200 day-not in-calf rate from 15% to 9%.
- **Heifer live weight.** The occurrence of the first oestrus in yearlings depends on live weight. So better feeding practices in early life will lead to younger age at first calving in virgin heifers. These heavier animals will also cycle earlier after calving.

8.2 Non-nutritional factors affecting reproduction

Reproductive performance is affected by many factors. Nutrition is only one possible cause of poor reproductive performance. In some herds, nutrition is not the most

Table 8.2. Factors affecting submission and conception rates with AI (or natural mating) in tropical small holder herds. Italics refer to natural mating.

Ease of influencing	Submission rate (Cows being submitted for insemination or mating)	Conception rate (Services per conception)
Difficult Outside farmer control	Mineral deficiencies (defining what minerals)	Semen quality Infectious diseases (requiring government support) Mineral deficiencies (defining what minerals)
Possible Requires some management skills and/or capital	Heat stress Genotype × environment interactions: Feeding to cows potential Genetic tendencies for lactation anoestrus Support of infrastructure, e.g. facilities	Semen handling AI technique Heat stress
Easy Requires little management skill and/or capital	Deferral of insemination or voluntary waiting period Heat detection Age Heifer size (and age) at first calving <i>Bull performance</i> <i>Bull:cow ratio</i> Body condition at calving Body condition loss after calving Induced calvings Post-calving nutrition (energy, protein, fibre) Health problems: Uterine infections Lameness Retained foetal membranes Milk fever Cystic ovaries	Timing of insemination <i>Bull fertility</i> Body condition at calving Body condition loss after calving Post-calving nutrition (energy, protein, fibre) Diseases affecting fertility: Uterine infections Other diseases

(Source: Moran 2005)

important cause of poor performance. Some of the other causes can be divided into those that affect submission rate and those that affect conception rate.

The many factors affecting submission and conception rates in tropical SHD herds are listed in Table 8.2 and categorised into:

- difficult to influence (generally outside farmer's control)
- possible to influence (require some management skills and/or capital)
- easy to influence (require little management skill and/or capital).

It is easier to improve submission rates than conception rates. For example, submission rate may be increased from 40% to 80% with careful management, whereas conception rates may only improve from 30% to 45%. Many of those factors influencing submission, but not conception, rates are behavioural, such as decreasing the length of voluntary waiting period and making more effort to improve heat detection.

8.2.1 Heat detection in tropical herds only using AI

Observations of oestrus are more difficult in the tropics due to anoestrus resulting from poor nutrition and/or intensive suckling. Furthermore, the oestrus period is shorter (10–12 hr), signs are less pronounced or mainly shown at night (in buffaloes or local cattle) when farmers are less keen on, or active in, heat detection.

For practical purposes, most small holders use AI rather than natural mating. This introduces another set of factors limiting herd fertility. Cows tied up in a stall can hardly express the most easily recognisable signs of oestrus, such as mounting and being mounted.

Cows show signs of heat when:

- they are 18–24 days after their last heat (if they are still non-pregnant)
- they stand to be mounted
- they attempt to mount other cows
- they are restless and bellow
- their feed intake is reduced
- they have poor milk let-down
- stringy mucus is seen exuding from their vulva
- their vulva is red and swollen.

The average duration of heat is about 14 hr in normal weather conditions. Heats can be as short as 2 hr and as long as 28 hr. Twice daily observations are then essential to catch short heats. Observations in the cool of early morning are more likely to detect heat than those in the middle of the day.

The best conception rates occur following insemination 4–12 hr after the first signs of heat are observed. However, the problem is knowing at what stage of oestrus the particular heat was first detected.

Heat detection can be improved with:

- routine night observations
- interpreting cow behaviour
- checking records for days since previous heat (for closer observation)
- using heat detection aids in larger herds, although tail paint is a cheap effective aid for most farmers
- using oestrus synchronisation as a management aid.

SHD farmers who continually tether their cows are disadvantaged because the cows cannot move around to show the most easy to interpret behavioural signs of heat. Having a small yard in which to let the cows out, say before milking, will aid detection. Using heat aids, such as tail paint or heat mount detectors, can improve detection rates.

Vasectomised bulls or hormone-treated steers running with the mating herd are also useful in larger herds. Heat synchronisation can offer efficient use of labour as the work of heat detection and AI is shortened into planned, intensive periods.

Each month farmers need to identify cows that have calved more than 80 days before, but have not been detected on heat, and examine them. This is important if more than 60% of the herd are in this category. Some of these cows may have had an undetected heat, whereas others may not have been on heat and can be treated as non-cycling cows.

If most of these cows are in low body condition, their feeding management should be improved. Others may be suffering disorders such as cystic ovaries, infected uterus and lameness, thus requiring veterinary attention.

Other important factors should be taken into account, such as:

- body condition: too fat or too thin
- rapid loss in body condition
- small heifer size
- diagnosed health problems, such as cystic ovaries, uterine infections or lameness
- heat stress, as apparent from observed high respiration rates and/or high Temperature Humidity Index (see Chapter 12).

Assuming heat can be detected early, the message must be passed on and acted on by the AI technician. Most dairy cooperatives have a simple and effective system of communication between farmers and AI technicians. Assuming the technician can reach the cow to be inseminated, many of the factors listed above are relevant.

8.3 Nutritional influences on reproduction

8.3.1 Energy intakes and balance

Energy intake affects milk production, body condition and live weight. Numerous studies have investigated the effects of milk production, body condition score and live weight on fertility. Results have varied widely. To date, the effects of energy intake on fertility have not been fully clarified. Nevertheless, some effects are clear. The effects of energy intake can be separated into effects on submission rates and effects on conception rates.

Effects of energy intake on submission rates

Cows in poor body condition have delayed heat, hence poorer submission rates. At the other extreme, cows can be too fat at calving. Cows calving in too high condition scores are at greater risk of fatty liver syndrome, with associated reduction in appetite, excessive weight loss and increased likelihood of retained foetal membranes and/or non-cycling.

Extensive work is now focusing on the effects of nutrition in high-producing cows. Probably the best current explanation of the causes of delayed cycling among high-producing cows comes from North America. Under the systems of management there, it appears that condition loss after calving is more likely to cause delayed cycling than is the level of milk production in early lactation.

The problem is that milk production peaks before maximum feed intake, even where cows are fed *ad lib*. Therefore in early lactation, cows' energy requirements exceed their intakes. They are in 'negative energy balance' and so they lose body condition and weight. There is also a lot of variation between cows within herds. Higher producing cows will generally have deeper and more prolonged troughs than lower producing cows.

This negative energy balance is worst in the first few weeks after calving. Intake capacity steadily increases and cows eventually move into positive energy balance. When in positive energy balance, cows began to gain condition.

How does this impact on reproductive performance? Some research suggests that cows have their first ovulation about 10 days after the greatest negative energy balance. So if the negative energy balance is prolonged, first ovulation will be delayed and submission rates reduced. Greater negative energy balance may also cause longer delays to first ovulation.

Effects of energy intake on conception rates

Energy intake and condition score affect onset of cycling after calving. Early onset of cycling clearly increases submission rates. Furthermore, early onset of cycling increases conception rates.

New Zealand research suggests that conception rates are improved in cows that have had at least one heat before mating. This is regardless of the length of time between calving and the start of mating.

The ovary produces progesterone after a cow has ovulated. Cows inseminated on their second ovulation will usually have had much higher progesterone levels for the previous 12 days.

There may also be other explanations for the improvement in conception rates among cows having a heat before mating. Hormonal changes may explain the positive effect of a heat before mating on conception. It appears that high levels of the hormone progesterone in the 12 days before insemination improve conception rates.

Energy balance may also affect conception rates in other ways. Negative energy balance long before insemination reduces conception rates. In the ovary, egg development begins around 60–100 days before the heat where the egg is released. It may be that adverse conditions around that time can result in a defective egg being produced and released. If true, this means that severe weight loss in early lactation leads to poor-quality eggs when cows are inseminated. For late-calving cows, which are mated soon after calving, weight loss in the dry period could have similar effects.

8.4 Implications for herd and feeding management

8.4.1 A simplified system for feeding management

Cows in early lactation have high nutrient demands to produce milk as well as return to normal heat cycles. Because they have yet to reach full intake capacity until 2–3 months post-calving, many show high rates of loss in live weight and body condition, thus delaying their first heat.

In many Asian large herds (say with more than 20–30 milking cows), all milking cows are managed together as a single herd except for feeding their concentrate allocation, which is generally based on individual milk yield. In such herds, reproductive management would be easier if the milkers were split into two herds: the non-pregnant and pregnant. This would be essentially the same as grouping the cows into early-mid and mid-late lactation.

Pregnancy diagnosis, rather than non-return to heat, would be the most suitable method to decide on moving cows to the pregnant group. Early pregnancy diagnosis by skilled operators can identify cows that are 6 weeks pregnant, while it can also provide a

good estimate of when cows conceived if tested at 15 weeks of pregnancy or less. Cows to be tested each month include those mated more than 6 weeks previously or those running with a bull for more than 80 days and not confirmed pregnant and cows previously diagnosed as pregnant but thought to have aborted since.

The non-pregnant cows should be offered the best quality forages and be more closely observed for signs of heat. Feeding management would be simplified if all cows in each group were offered the same amount of concentrates as well as forages. From our experiences with seasonal calving herds in southern Australia, there is little difference in the utilisation of concentrates for milk production whether all cows in early (or in late) lactation are fed the same amount of concentrates or fed depending on individual milk yields.

8.4.2 Management in late lactation

Good herd managers aim to dry off cows in the condition in which they want them to calve. How cows are fed in late lactation, and when they are dried off, will have huge effects on the condition score at drying off and at calving.

8.4.3 Dry cow management

Dry cows must not lose weight. Even if live weight does not seem to be declining, cows may still be losing condition. The increasing weight of the foetus and udder during pregnancy may mask losses of the cow's own body weight.

8.4.4 Management during the transition period

Decreases in appetite around calving have to be minimised. The cow's rumen needs time to adjust to the new diet. Digestion and intake can be reduced while the rumen is adjusting. This adjustment can start before calving.

In herds where milkers are fed moderate to large quantities of grains, lead feeding (gradual introduction of grain in the diet before calving) helps reduce the impact of dramatic change in diet. Lead feeding may also help retain condition in the last few weeks before calving. Anionic ('acid') salts may enable some forages to be fed to cows due to calve without increasing the risk of milk fever (see Chapter 6). Feeding some pasture may help reduce the impact of the dietary changes after calving.

8.4.5 Protein intakes

Excess protein

Some diets may lead to the protein content of total diet exceeding cows' requirements. The excess can reduce reproductive performance.

Most of the protein in forages is rumen degradable protein (RDP). Research work suggests that diets high in RDP depress conception rates. Imbalance between the amounts of fermentable carbohydrate and protein in the diet may be the key concern.

Diets with excess protein have effects other than on conception rates. It costs the cow energy to break down the excess protein: energy that could otherwise have been used for milk production and body condition. So, adverse effects of high protein diets on fertility may be due to an energy deficit.

Protein deficiency

The cow's highest requirement for protein is in early lactation. Requirements for both RDP and undegradable protein (UDP) increase after calving, especially among high-producing cows.

Many of the diets fed throughout Asia do not provide sufficient protein. This can also reduce reproductive performance.

8.4.6 Intakes of minerals**Calcium**

There are suggestions that sub-clinical calcium deficiency in cows around calving can result in calving troubles, retained foetal membranes and inappetence. If correct, these effects could result in reduced reproductive performance.

If either milk fever or sub-clinical calcium deficiency is considered to be a problem, anionic salts could be used in conjunction with other dry cow management strategies. Cows due to calve should not be fed supplements containing sodium bicarbonate.

Magnesium

Supplementary magnesium fed to calving cows reduces the risk of grass tetany. It also appears to reduce the incidence of milk fever. Some advisers recommend this to avoid sub-clinical calcium and magnesium deficiencies in cows at calving.

Phosphorus

Phosphorus deficiency has been shown to cause delayed onset of heat in some studies but not others. Phosphorous-deficient cattle can also be energy-deficient in some circumstances (e.g. during prolonged periods of underfeeding). In these situations, effects of phosphorus deficiency cannot be readily determined.

In early lactation, phosphorus supplied in the many forages is insufficient to meet cows' requirements. Affected cows then use their bone reserves of phosphorus. This may be sufficient to prevent reproductive performance being affected.

Selenium

There are numerous reports of retained foetal membranes due to selenium deficiency.

8.4.7 Herd management**Achieving 100% success with AI**

It is just not possible to achieve 100% of all cows getting back in calf no matter how many AI cycles a farmer undertakes. It is possible that a healthy, high-yielding cow may require up to eight inseminations to conceive. The difficulty for the farmer is deciding when enough is enough and when that cow should be culled.

Heat detection and insemination

Voluntary waiting periods should be no more than 50 days, after which cows should be inseminated when observed to be on heat. Although CR can be low (33% when 40 days post-calving, 45% when 60 days post-calving) cows can only conceive when inseminated. A voluntary waiting period of 80–90 days appears to be more the norm in most Asian countries.

There are two types of error in heat detection: missing a cow when on heat or inseminating a cow when not on heat. With the first error, SRs are low, while with the second error CRs are low. Small holder farmers (who depend on AI technicians to do the insemination) have an additional problem in that the technician must first agree that they also consider the cow to be on heat, before she gets inseminated.

8.5 Putting it all together – a plan for success

Reproduction is a complex issue and solutions to problems don't come in a single package, as many actions may be required to achieve targets. To ensure success, these actions need to be part of the overall farm management. It is easy to lose track of the length of time between when cows calve and when they should be first mated and how many times they have been mated this lactation.

8.5.1 Setting priorities to address fertility issues

- Put first things first, or what are the most important management practices required to achieve good reproductive performance?
- Small steps make can big gains.
- Attention to detail can make the difference.
- Solutions are often not expensive or time consuming.
- Keep accurate records, particularly of all inseminations.
- Have a plan for each stage of the cow's life cycle, because success requires a fertility life plan.
- Deal with the most important things first because some things are more important than others.
- Work on the things you can control before worrying about those you cannot control.
- Consider culling cows that have had many inseminations and are now producing little milk.
- Monitor performance carefully and set realistic targets (Table 8.1).

8.5.2 Some important decisions to make

- Select a suitable voluntary waiting period, ensuring it is short if milk yields decline rapidly in the herd or heat detection is poor.
- Assess the need to cull more severely by calculating the percentage of cows that have more than 16 months between calvings. If this is more than 15% of the herd, then some of the low-fertile cows need to be culled. Make a conscious decision on how long to continue mating any cow that is difficult to get in calf. This will depend on:
 - her current milk production
 - her age
 - her previous milking record
 - if she has clinical mastitis
 - if she has previously had difficulty getting back in calf
 - of most importance, the cost of keeping her compared with selling her and buying a replacement.

Heat detection must be optimised to limit missed heats, using both improved observation and greater use of heat records. In addition, feeding management must be addressed to ensure that:

- body condition scores are adequate at calving
- losses in body condition are minimised during early lactation
- target live weights are achieved for growing heifers.

The biggest factors affecting reproductive performance of individual cows are:

- problems at calving, such as abnormal calvings (assisted or twin calving) or heath problems (retained foetal membranes, vaginal discharges or lameness)
- cows having poor fertility in their previous lactation
- age extremes, in that very young (2 and 3 yr old) or old (7 yr or older) have poorer reproductive performance relative to middle-aged cows.
- generally speaking, a cow with a reproductive problem in one year is more likely to have a problem the following year.

One simplistic answer for a solution to any problem cow could easily be 'Not enough inseminations' but when is enough enough?