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Gibberellic acid: a technology for managing feed shortages on dairy farms?

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Summary

- Gibberellic acid can be used to boost pasture growth during periods when slow growth is likely
- Modest growth responses (200-500 kg DM/ha) can be expected when gibberellic acid is applied in autumn/early winter or late winter/spring
- Gibberellic acid should be applied within five days of grazing to a residual of about 1500 kg DM/ha
- Yield responses to gibberellic acid are greatest 3-4 weeks following application
- Gibberellic acid should not be applied to pastures less than one-year-old
- Pasture responses to low application rates of gibberellic acid are likely to be economical, provided the extra DM is harvested efficiently 3-4 weeks after application.

Introduction

Use of gibberellic acid (GA) on dairy farms to stimulate pasture growth in autumn/early winter or late winter/early spring, when feed shortages are anticipated, is increasing on dairy farms.

This trend has been facilitated by the advent of a cheap source of GA from China, the availability of competitively priced GA products (e.g. ProGibb® SG, Express®) and the generally positive improvements in pasture dry matter (DM) yield following its application.

Gibberellic acid is a plant hormone that, when applied to slow growing pasture, re-activates plant growth processes. Mobilisation of plant energy reserves and/or increased leaf and stem elongation can occur, both contributing to modest increases in DM production. All pasture species respond to GA application.

Considerable research[1] has been conducted on the use of GA on pastures since the 1950s, with yield responses commonly ranging from 200-500 kg DM/ha at about four weeks after application.

Using GA successfully in your farm system

The best pasture response to GA occurs when soil temperature is greater than 7°C and less than 16°C and the pasture has adequate water and nutrients to support plant growth.

GA is best applied within five days of grazing to a normal residual of around 1500 kg DM/ha. There is no withholding period for grazing but it is essential to graze the treated pasture within 3-4 weeks of the application of GA, when the yield response is greatest. This means that, unlike N fertiliser, GA cannot be applied to the whole farm at once, to rapidly boost pasture cover.

GA enhances elongation growth of leaf sheaths and stems, so part of the response comes from increased utilisation of more erect pasture. To correct for the height-enhancing effect of GA, rising plate meter calibration multiplier coefficients should be reduced downwards, around 10 kg DM per rising plate meter (RPM) unit. For example, the recommended April to August equation[2] is RPM reading x 140 + 500; this becomes RPM reading x 130 + 500.

Pastures should be at least one-year-old before application of GA. This is because of the possibility of reduced root growth and/or tillering following GA application[1],that could impede the development and establishment of new pasture plants.

Some yellowing after GA application is common but swards recover with no apparent ill effects.

Application rate

Low rates of application are recommended (~8 g of active ingredient/ha in 100-200 litres of water). Sticking to label recommendations minimises possible side-effects.

Higher rates only give a slightly greater response and are, therefore, uneconomic. A wetting agent is recommended to aid leaf coverage and GA uptake by plants. Application should not be made before grazing, or if rain is likely within two hours.

Season to apply and capturing the benefits

If a feed shortage is anticipated during autumn, GA can be applied, however, it is important that the sprayed pasture is grazed 3-4 weeks later, without compromising the build-up of pasture cover for winter. This requires careful planning.

In spring, GA can also be used in anticipation of a feed shortage or to boost feed supply. Late spring applications of GA can create a feed surplus and the need for more silage making to maintain pasture quality. Again, it is important GA is applied when the planned rotation length ensures the pasture will be grazed or harvested within 3-4 weeks.

Responses to GA in winter have been reported for kikuyu and ryegrass pastures in Northland[3], kikuyu pastures in Hawaii[4] and for tall fescue pastures in the USA[5], among others. Research is still needed to clarify winter responses to GA of ryegrass in New Zealand. It is possible GA-induced reserve utilisation, to drive winter responses, could compromise spring growth.

GA and nitrogen (N) applications

Limited research suggests GA can be applied at the same time as N applications, as their effects on plant growth and pasture yield are additive[1] and complementary, in that N applied with GA will counteract any tendency of GA to reduce tillering.

GA should not be used as a substitute for N. If pastures are N deficient, N fertiliser should also be applied to achieve maximum GA responses.

Yield response to GA applications

A summary of the field trials carried out by the supplier of ProGibb® SG gave an average response of 310 kg DM/ha over untreated control pastures, when measured four weeks after the application of GA[6]. One trial at Massey University[1] measured a response of 225 kg DM/ha under similar conditions to the commercial trials.

Possible side-effects to GA application

Early research[1] suggested yield depression following the initial 3-4 week response. This was mostly related to high rates of application. Application of a low rate of GA is essential to minimise side-effects and to obtain a more cost-effective response.

A plot trial conducted in Canada[7] found that ryegrass responses to GA above ground were linked to reductions in root mass below ground, with the root reduction greater than the shoot response. Similar results have been recorded for a *Poa* species[8].

In a French study, GA-induced reduction in cocksfoot root growth was avoided by simultaneous N application. However, recent work at AgResearch (Parsons & Rasmussen, pers. comm.) found that GA increased the root mass of potted ryegrass plants. Therefore, further research is needed to clarify the reasons why root responses to GA are inconsistent. Reductions in tiller population density are also possible following GA application, according to a recent literature review[1].

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Other points of interest

In some biennial plants (e.g. chicory) GA application has been reported to stimulate flowering but in grasses, the number of seed heads is usually unchanged or sometimes decreased after GA application.

Limited research suggests application of GA does not affect pasture quality or feeding value[1].

GA is not a substitute for fertiliser and should be used in anticipation of feed shortages to boost growth in the short-term (3-4 weeks after application). GA is best used as soil temperature begins to drop in autumn or as soil temperature begins to increase again in late winter/early spring.

Economics of GA application

As an example, using ProGibb® SG at a cost of $12/ha with application by contractor, the total cost (including product) was about $42/ha (assuming $30/ha to apply) or 14c /kg DM for a predicted response of 310 kg DM/ha[6]. Costs will be influenced by how much of this extra feed is eaten by the cows and the actual contractor costs.

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The science and art of detecting oestrus

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Summary

- Achieving a high level of reproductive performance during AB mating requires an equally high standard of oestrus detection performance
- Skill, commitment and attention to detail are the key ingredients for good performance in oestrus detection
- Oestrus and ovulation are rigidly coordinated by reproductive hormones and neural networks to ensure the cow has the best chance of being inseminated at the right time
- Stress is common to many of the factors known to reduce expression and detection of oestrus
- There are two possible errors with oestrus detection: missing heats and putting up cows for AB at the wrong time
- Although oestrus detection performance is difficult to measure precisely, there are some useful reports and approaches to assessing if performance is poor, average or good.

The science of behavioural oestrus in cattle is a fascinating subject, but successfully detecting oestrus is an art that requires skill, commitment and attention to detail.

This review article will describe the physiology of behavioural oestrus in cattle, the importance of successfully detecting oestrus on reproductive performance and farm profit, as well as what successful operators do when it comes to detecting oestrus.

The need and challenge of detecting oestrus

Breeding high genetic-merit replacements for the dairy herd requires the use of artificial breeding (AB) and, therefore, correct identification of cows in oestrus.

There is a clear link between oestrus detection performance and farm production, profit and sustainability through the impact that oestrus detection performance has on subsequent calving patterns. Calving pattern is essentially determined by pregnancy rates (PR) during the preceding mating, with some modification by culling-replacement and/or calving-induction policies.

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The PR is the product of conception rate (CR) and submission rate (SR) (*Eq.1*).

Eq. 1 *PR = CR x SR*

Pregnancy rate reflects '*herd-fertility*' as it describes the ability of the herd to get pregnant within a specified time period (e.g. proportion of the herd pregnant within six weeks) during the mating season. The PR is also known colloquially as the 'in-calf' rate.

Conception rate reflects *'cow-fertility'* as it describes the proportion of individual cows conceiving to an insemination e.g. proportion of cows pregnant to first insemination or following an oestrus synchronisation treatment (*Eq.2*). It is often confused with PR or "in-calf" rate.

Eq. 2 *CR = No. cows pregnant / No. cows inseminated*

The PR takes SR into account and, therefore, accounts for cows that were not inseminated (*Eq.3*), but does not penalise for cows having taken more than one insemination to get pregnant.

Eq. 3 *SR = No. cows inseminated / herd size (those to be mated)*

Since herd size is essentially fixed, SR is driven entirely by the number of cows inseminated. This will depend on (*Eq.4*):

i. number of cows having oestrus (*including anoestrous cows responding positively to anoestrous treatment); and,

ii. the efficiency with which cows in oestrus are being detected, which is oestrus detection efficiency (ODE).

Eq. 4 *No. cows inseminated = No. cows having oestrus* x ODE*

The preceding logic demonstrates that expression and detection of oestrus are important determinants of calving pattern and hence influence farm productivity, profitability and sustainability.

Behavioural signs of oestrus

Around a dozen behavioural characteristics of oestrus in cattle have been described, including inter-animal conflict activity, flehmen, vulva sniffing, chin resting, bellowing, attempted mounting activity and congregating into sexually active groups[8,9]. There are also various physiological signs that may be associated with oestrus including a reddening and swelling of the vulva, mucus discharge, increased temperature, reduced milk yield, and change in milking order. These signs are not consistently expressed[10] and should, therefore, be considered secondary.

The primary indication of oestrus is when a cow stands immobile while being mounted from the rear by other cattle (Fig.1). Those that are not in oestrus will rapidly terminate contact if another attempts to mount. Cows that mount, or attempt to mount another animal, are more likely themselves to be in oestrus or in the pro-oestrus phase of the oestrus cycle than in the anoestrous, luteal and pregnant states of reproduction[11,12].

Figure 1. Standing oestrus – the definitive sign of a cow in oestrus. The cow standing in this photo has braced her front legs to take the weight of the 'riding' cow. The cow riding is also likely to be in oestrus, but this will need to be confirmed. Other cows that are in oestrus will be attracted by this activity. A sexually active group (SAG) will form. Identifying and investigating SAGs is easy when doing paddock checks.

Studies indicate that early morning and late evening are when cows in oestrus are most active[1,2,3]. Despite visual confirmation of standing oestrus being the 'gold standard' (Fig.1), even skilled personnel making visual observations at 4-5 hour intervals from early morning to late evening miss 10% of animals. In practice, the use of aids, such as tail paint and heat mount detectors, are necessary for oestrus detection[2].

Hormonal control of behavioural oestrus

An increase in blood oestradiol, in the absence of progesterone, is obligatory for the onset of behavioural oestrus[4] (Fig.2a).

In the non-pregnant cow, this situation occurs after the ovarian *corpus luteum* is eradicated during a process called luteolysis. Progesterone plummets as the *corpus luteum* dies, and a positive feedback loop between luteinising hormone (LH) and oestradiol is established in the absence of progesterone (Fig. 2b & Fig. 3, pg 8).

The large and maturing preovulatory follicle (Fig. 2c) becomes increasingly sensitive to LH[5]. Circulating concentrations of LH and oestradiol increase progressively[6,7] until activation of the neural networks responsible for eliciting behavioural oestrus and the preovulatory LH surge are activated.

The signalling system is located in the hypothalamic region at the base of the cow's brain. Like all neural networks that control behaviour, it is a complex system that includes numerous interconnections allowing other biological systems (e.g. the stress response axis) to modulate the nature of the oestrus signal.

Oestrus and ovulation are rigidly coordinated

The oestrus signal is rigidly coordinated with ovulation. The onset of oestrus and the preovulatory LH surge occur at the same time, and it is the LH surge from the anterior pituitary that initiates the ovulatory process.

The LH surge is triggered by a coincident surge of gonadotrophin releasing hormone (GnRH; Fig. 3b, pg 8) after activation of the 'surge centre' in the hypothalamus[13,14]. Ovulation occurs about 32 hours after the onset of oestrus and LH surge, and is characterised with rupture of a large mature follicle on the ovary and release of an egg to be fertilised. The expelled egg passes down the oviduct where fertilisation takes place.

Successful fertilisation requires that sperm are ready and waiting for the egg, which illustrates the importance of timing the insemination to a detected oestrus. Cows are only fertile at this particular time.

Factors that influence behavioural oestrus

Intensity of behavioural oestrus is reduced by negative energy balance, which may be a consequence of excessive energy output (i.e. very high milk yield[15] or insufficient energy intake[16]).

The effect of bodyweight change on oestrous cycle characteristics in non-lactating dairy cows has been reported[17]. Feed allowance was progressively restricted such that these animals lost 20% body weight over a period of six months. They were then offered a generous feeding allowance to regain the lost weight during the subsequent six months.

Only one of these cows became anovulatory after the 20% bodyweight loss, but the oestrus detection rate at the nadir in bodyweight was reduced to 40%, compared to >80% preceding this nadir and 100% once the cows were back into positive energy balance. These results demonstrated that expression of behavioural oestrus is negatively affected by low bodyweight associated with restricted feeding, even though cows may continue to have ovulatory cycles.

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Figure 2. Schematic representation of follicular dynamics during the oestrous cycle (*c*) in a cow having two waves of ovarian follicular development. Corresponding profiles of ovarian steroid hormones (*a*) and gonadotrophins (*b*) in peripheral circulation are depicted in upper panels. Shaded vertical bars depict oestrus. LH = luteinising hormone; FSH = follicle stimulating hormone.

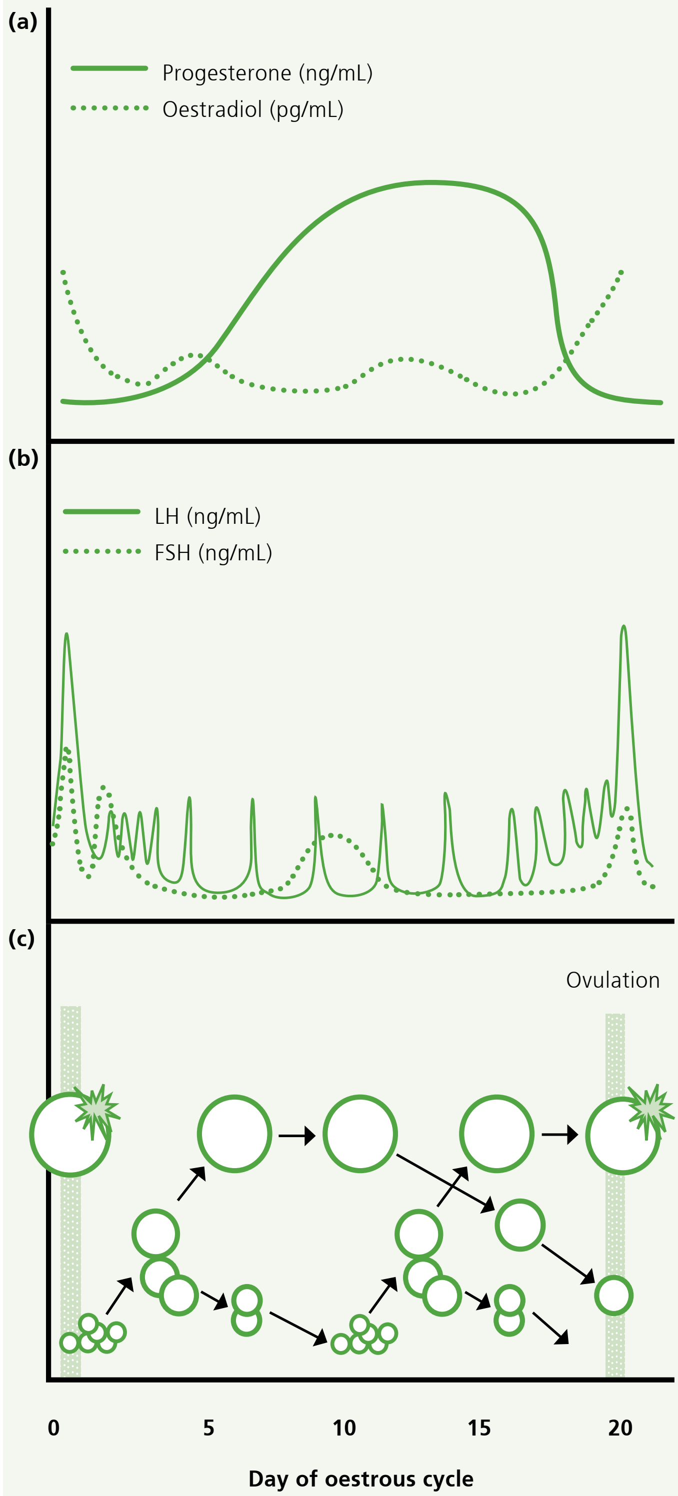

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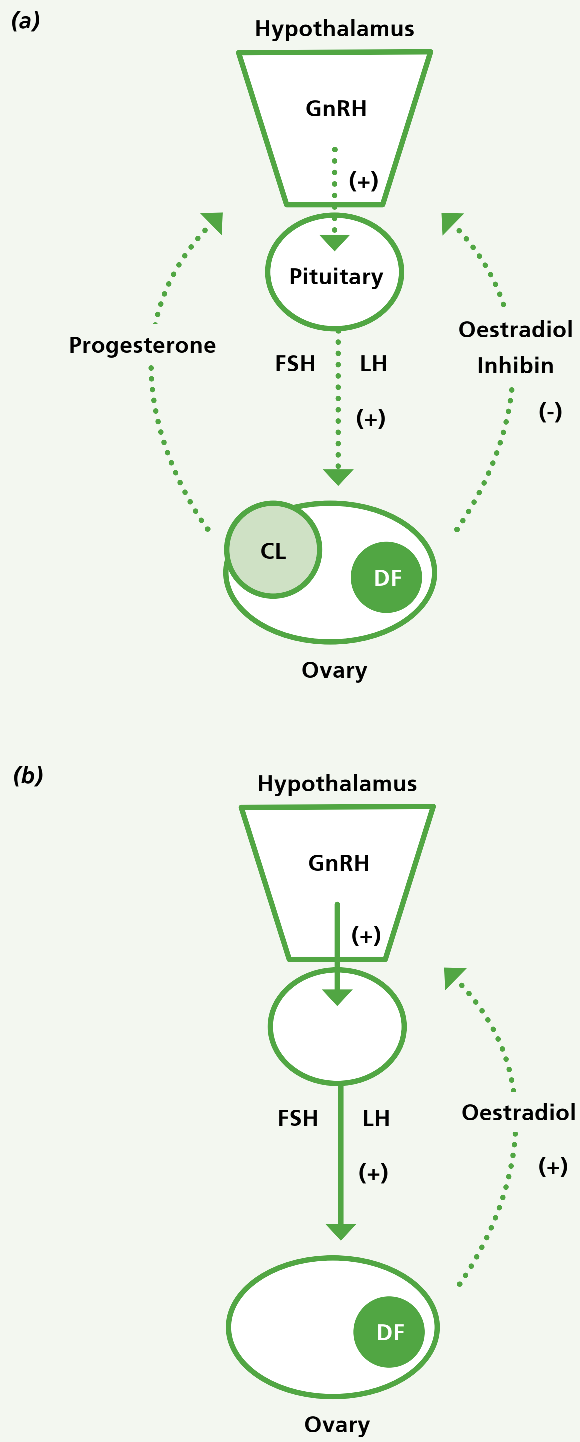
Figure 3. Endocrine feedback signals between the ovaries and the hypothalamic-pituitary axis when peripheral concentrations of (a) progesterone (P4) are elevated (e.g. during luteal phase) or when these concentrations are (b) basal (e.g. after luteolysis). GnRH - Gonadotrophin releasing hormone; FSH - Follicle stimulating hormone; LH - Luteinizing hormone; CL - Corpus luteum; DF - Dominant follicle.



This result may reflect the observational beliefs of farmers experiencing a situation where "cows were cycling well then stopped when hit with a feed pinch during mating".

A number of other factors besides nutritional balance influence the characteristics of behavioural oestrus. Breed, temperature-humidity index, type of oestrus (synchronised versus spontaneous) and social dominance status are included among the factors that influence expression and detection of behavioural oestrus[18]. Concrete flooring and lameness are detrimental to expression of oestrus[19].

A common theme is that stress reduces expression of oestrus, and this is supported by findings that administration of stress response hormones (i.e. adrenocorticotropin and cortisol) inhibits the behaviour of oestrus as well as the LH surge required for ovulation[20].

The animals' sense of 'well-being' is perhaps an underestimated quantity regarding factors that might regulate oestrus.

A review of the higher nervous activity of cattle[21] reported that cattle have acute sensory capabilities. They can distinguish the colours of the visible spectrum; have an accurate sense of light intensity; acute hearing; and a keen sense of smell and taste. Cattle are acutely aware of environmental stimuli and these might influence their behaviour during oestrus.

Skill, commitment and attention to detail

Survey data from Australia and New Zealand indicate that oestrus detection performance improves when it:

- is the highest priority job during AB
- is considered so important that it becomes a sole job (i.e. the person doing oestrus detection does not do other jobs while oestrus detection is being performed)
- is designated to one or two experienced people, otherwise the situation becomes one of 'all care and no responsibility'
- involves observation of cow behaviour, not just a visual assessment of the tail head of an immobilised cow while in the milking bail
- is supported with a mix of aids such as tail paint and heat mount detectors.

Oestrus detection fatigue, or burnout, is an issue that some farmers say they experience. This experience may lead them to forego doing premating heats and making the AB period as short as possible. In addition, fatigue is likely to increase the number of errors that are made with detecting cows in oestrus.

The cost of getting detection wrong

Poor oestrus detection is a result of two types of errors[22]. The first error relates to the issue of 'sensitivity', characterised by missing cows in oestrus during the AB period. The consequences within a seasonal herd manifest in the subsequent season with later calving, lost milk production and fewer AB replacement heifers.

A cow whose oestrus goes undetected during the AB mating period will calve at least 21 days later in the subsequent season. Lost revenue and mitigation expenses have been estimated to cost the New Zealand farmer $160 for each missed 'heat' during the AB period. On this basis, the cost to the New Zealand dairy industry is calculated to be around $65 million annually.

The second error relates to 'specificity' of oestrus detection, inseminating cows not in oestrus is problematic. Firstly, it's a waste of semen and expenses associated with AB. Secondly, submitting non-oestrus cows to AB provides misleading information that may confuse further mating management decisions for that particular cow. Finally, inseminating cows that are already pregnant substantially increases the risk of pregnancy failure[23,24,25].

"The science of behavioural oestrus is a fascinating subject, but successfully detecting oestrus is an art that requires skill, commitment and attention to detail."

How can I tell if oestrus detection is being performed at the highest standard?

Measuring oestrus detection efficiency is problematic because of the 'he said, she said' problem. How can a farmer be adjudged to have missed a heat or put a cow up for AB at the wrong time, when there was no 'expert' present to make those calls?

Oestrus detection efficiency cannot be measured with absolute certainty, but there are some useful indicators to assess if this task is being performed poorly, averagely or very well.

There are two reports available to most farmers to assess oestrus detection performance. The first is the *InCalf Fertility Focus* report. This report uses the 3-week submission rate of early-calved, mature cows as a proxy for measuring the sensitivity of oestrus detection (i.e. what percentage of cows having an oestrus are being submitted to AB?). The big assumption with this indicator is that the early-calved, mature cows are cycling and should be picked-up in heat during the first weeks of AB.

This assumption may breakdown when the herd has such a serious non-cycling problem that even this subset of cows has non-cyclers among them. A problem is indicated either way by a poor 3-week submission rate in early-calved, mature cows – missed heats or a serious non-cycling issue.

Another useful report is the 'return-to-service interval analysis' available through your herd improvement company. This report presents the distribution of return intervals, which allows the specificity component of oestrus detection efficiency to be explored. A good distribution will reflect the true cycling physiology of cattle. That is, the majority of return intervals should be in the 18 to 24-day range.

It is acceptable to have some 'short cycles' but these should be in the 8 to 12-day return interval range. These could be real returns of cows that have just started cycling. Intervals shorter than the normal 18 to 24-day, and outside the genuine short 8 to 12-day range, are virtually impossible from a physiological perspective. One of the inseminations (first or second) was performed at the wrong time to create 2 to 7-day and 13 to 17-day returns.

Studies indicate that it is usually the first insemination that was wrong. Intervals longer than 24 days could be a consequence of detection errors or a result of early embryonic loss. There is no easy way to distinguish between these possibilities.

Lastly, an assessment of the practices used on-farm to detect oestrus should be included in the assessment of oestrus detection performance. Evidence that good practices are being followed, such as those described above, indicates that oestrus detection is being performed diligently.

A situation where the person doing detection is also milking, jumping up from the pit every now and then to inspect poorly maintained tail paint, indicates a high level of risk that deficiencies with oestrus detection are contributing to reduced reproductive performance in the herd.

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Chicory and plantain – your questions answered

Julia Lee, DairyNZ Scientist; Elena Minneé, DairyNZ Technical Team Leader

Summary

Chicory and plantain are capable of growing a large amount of high quality feed during summer/autumn and increasing summer milk production when ryegrass pasture quality is low.

To get the greatest benefit from these forages, it is important to be aware of the risks and follow best practice guidelines for establishment and management.

Chicory and plantain are two increasingly popular forage herbs grown on dairy farms. Farmers who are growing, or considering growing, these species may find answers to some commonly asked questions useful.

What needs to be considered before integrating herbs into a farm system?

It is important to have a clear understanding of the purpose of herbs on-farm. Generally, farmers want to grow chicory or plantain to increase feed quality and/or supply during the summer and autumn, to provide a break in weed (e.g. yellow bristle grass) or pest cycles before pasture renewal or to utilise excessive nutrients (N and K) in effluent areas[1,2].

These are all valid reasons, however it is important to be aware of the risks and follow best management practices to ensure high herbage yield, quality and utilisation. Feed budgeting is also extremely important to ensure there is sufficient feed during crop establishment and during winter (particularly for chicory). Options for filling feed gaps during these times include supplementary feeds such as palm kernel expeller (PKE) or maize silage, using nitrogen fertiliser strategically, grazing off or sowing annual ryegrass into chicory crops.

When should the herbs be established?

Both species can be sown in either spring or autumn, however, it is advantageous to sow chicory during spring, as there will be no, or very little, reproductive stem development until the following year.

Herb seeds are more sensitive to temperature than ryegrass seeds and should be sown when soil temperatures are above 12°C. As a rough guide, sowing before the end of October achieves a good balance between not running short of feed in the spring and getting the most out of the herb crop.

It is important to plan the establishment process carefully because planting 'too early' in the spring runs the risk of a late frost damaging young plants, while planting 'too late' runs the risk of dry conditions reducing plant establishment and survival.

How should the herbs be established?

Chicory and plantain are best established by sowing into a cultivated seedbed or directly drilling seed into herbicide-treated pasture[3,4].

Applying herbicide before direct drilling improves seedling establishment and survival, as it removes competition from established pasture plants and weeds, allowing newly emerged plants to obtain adequate light, nutrients and water[5].

(cont'd p12)

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While broadcasting seed is the simplest and cheapest technique of sowing, it reduces the number of plants that establish, reduces the yield and increases the amount of weeds in the crop[3]. DairyNZ research indicates that the increased cost of direct drilling, compared with broadcasting seed (approximately $240/ha), is more than compensated for by the increased yield (2.2 t DM/ha)[3].

What else is required for good establishment?

Using treated seed (e.g. Superstrike®) is highly recommended to improve plant establishment and yield.

Herb seeds are sensitive to sowing depth and should be sown at less than 10 mm depth[6,7].

Slugs can cause quite a bit of damage to herb crops. If they are likely to be a problem on your farm, broadcasting slug bait at sowing will improve establishment.

Few registered post-emergent herbicides are available, so it is vital to ensure good control of broad-leaved weeds before sowing. If necessary, the crop should be sprayed with approved herbicides three weeks after planting (when the weeds are less than the size of a $2 coin).

Should herbs be sown as a pure species or in mixed pastures?

Both chicory and plantain can be sown as a pure species, mixed with red and/or white clover or sown as part of a diverse pasture mix. There are advantages and disadvantages to each (Table 1), and the choice depends on the desired purpose of the herbs on-farm.

What seed rates should be used?

The recommended seed rates for sowing chicory are 4-6 kg/ha for a pure sward or chicory/clover mix, or 1-2 kg/ha in a diverse pasture mix. The recommended rates for sowing plantain are 8-10 kg/ha for a pure sward or plantain/clover mix, or 1-4 kg/ha in a diverse pasture mix.

How early after sowing should the first grazing occur?

Research has demonstrated that plantain plants should have a minimum of six fully developed leaves before they are ready for their first grazing[8], while chicory plants need at least seven fully developed leaves[8]. This is to ensure plants have a well-developed root system and, therefore, high survival and potential for growth.

What is the optimum grazing frequency for herb crops?

Both chicory and plantain sown with clover, or as a pure species, are best grazed between 25-35 cm height[9].

- In the first year after sowing in the spring, the herbs can be grazed at 25-35 cm height to increase herbage production. This is because chicory will have little reproductive stem development and, although seedhead will develop in plantain swards, it should be less than 10% of the feed available
- In the second year after spring sowing (or the first year after autumn sowing), the herbs should be grazed at 25 cm height to limit chicory stem/plantain seedhead development and maintain feed quality.

Table 1. The advantages and disadvantages of herb sowing options

	Advantages	Disadvantages
Pure species	Dedicated grazing management (greater herb production and persistence) Maximum benefit from herbs (e.g. mineral content).	Shorter growing season (mainly for chicory, plantain does grow during winter but slower growth rates than ryegrass) Requires nitrogen fertiliser.
Herb with clover	Dedicated grazing management (greater herb production and persistence) High benefit from herbs (e.g. mineral content) Clover provides nitrogen Clover fills in gaps in sward rather than weeds.	Shorter growing season (mainly for chicory, plantain does grow during winter but slower growth rates than ryegrass) Potential bloat risk if swards become clover-dominant.
Herb in diverse pasture mix	Increased pasture production in summer/autumn High nutritive value in summer/autumn Longer growing season.	Grazing management cannot be optimised for all species in the mix Herb plants may not persist (particularly chicory if grazed during winter) Feeding value of herbs diluted Some herbicides affect chicory and/or plantain which may reduce options.

Depending on the growth conditions, the time taken for chicory to reach 25 cm height is about 2-3 weeks in summer/mid-autumn, 3-5 weeks in mid to late autumn and 2-3 weeks in spring. Plantain takes about 2-3 weeks in summer/mid-autumn, 3-6 weeks in mid to late-autumn, 6-9 weeks in winter and 4-5 weeks in spring[9].

It is also very important that chicory is not grazed during the winter[10]. It is dormant during this time and grazing reduces the size of the taproot and creates entry sites for fungi, which reduce plant survival. As a guide, swards can be grazed until about mid-May, as long as soils are not waterlogged and/or grazing is not during wet conditions.

What is the optimum post-grazing residual height for herb crops?

The optimum post-grazing residual height for chicory and plantain is between 5-10 cm[10,11]. Achieving strict control of post-grazing residuals in herb crops is more difficult than in ryegrass pastures, however this is not a big concern since grazing frequency has a greater impact than residual height on the chicory and plantain[9,10].

How much can these crops yield?

Table 2 presents total dry matter (DM) yields from experiments with chicory and plantain in the Waikato[3,9,12,13,14,15] and Manawatu[8,16,17]. As a rough comparison, total DM yields from rotationally grazed farmlet ryegrass pastures in the Waikato are also shown, both from 'normal years' and those experiencing significant drought (e.g. 2007/08).

How nutritious are chicory and plantain?

Both herbs are highly nutritious, however good grazing management is required to maintain high quality. Table 3 (pg 14) provides some general nutritive values of chicory and plantain that were cut or grazed by dairy cows at 20-25 cm height[3,9,18].

Herbs also have a higher mineral content than ryegrass pasture[10], with greater concentrations of phosphorous, sulphur, sodium, copper and zinc in both chicory and plantain[19]. Chicory also has greater concentrations of magnesium and boron than ryegrass, while plantain has greater concentrations of calcium and cobalt[19].

Table 2. Total DM yields from chicory and plantain compared with existing ryegrass pasture

	Yield (t DM/ha)			
	0 to 8 months (from October establishment to May)	**9 to 20 months** (from June to May)	**TOTAL over 20 months**	**Experiment** (reference numbers)
Chicory	8.5	9.4	17.9	16
	9.5-11.0	10.6-11.4	20.1-22.4	9
	9.8-13.4	N/A	N/A	3,12,17
Plantain	11.2	19.0	30.2	Irrigated[14]
	11.3	17.4	28.7	Unirrigated[14]
	11.3-14.4	N/A	N/A	3,9,17
Ryegrass pasture ('normal years')	11.7-17.4	14.9-22.6	29.4-35.6	
Ryegrass pasture (drought year)	9.9-11.2	14.1-15.9	29.2-31.0	

Note: N/A means the data is not available. Experiments were grazed by cattle[3,12,13,15,17] or sheep[8,16] or cut[9,14].

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Table 3. Nutritive value of chicory and plantain cut or grazed by cows at about 20-25 cm height

	Energy (MJ/kg DM)	Protein (% DM)	Fibre (% DM)	Sugars + starch (% DM)	Minerals (% DM)	% reproductive stem or seedhead in the sward
Chicory	12-13	18-27	21-28	9-18	10-15	0-18
Plantain	11-12	16-28	25-33	9-20	11-16	0-20

NOTE: Quality of forages may be outside this range depending on crop management.

Is there a milksolids response from feeding herbs?

There is little published research on the milksolids response of dairy cows to chicory and none on plantain. Milksolids responses from cows fed a base diet of ryegrass pasture plus 4 kg DM/cow/day of chicory in summer was 40 g MS/kg DM offered, similar to the response to turnips[20].

Recent DairyNZ research conducted in late summer/autumn indicated that when the quality of ryegrass was moderate (10.5 MJ ME/kg DM), milksolid yields were similar from cows fed 100% ryegrass pasture or ryegrass pasture supplemented with herbs.

However, when ryegrass quality dropped to 9.6 MJ ME/kg DM, cows fed first year chicory or plantain as 20-40% of the diet ate about 1 kg DM more and produced about 17% more milksolids[18]. Additional research is being carried out to understand the milksolids response to herbs better.

What factors affect plant survival?

Survival of chicory and plantain plants is reduced by:

- grazing for the first time, before plantain has six fully developed leaves or chicory has seven fully developed leaves[8]
- grazing too frequently. For example, consistently grazing crops when they reached 15 cm height reduced chicory plant density by 30% and plantain plant density by 10% by the second summer[9]
- grazing when soils are wet, as both species are susceptible to treading damage
- grazing chicory during the winter[10].

Should chicory be taken through a second year?

This decision depends on how many chicory plants have survived the first summer. The decision to take chicory through a second year should be made in early autumn.

As a guide, at least 25-30 chicory plants per m^2 are required to achieve a satisfactory yield in the second year (more than 10 t DM/ha).

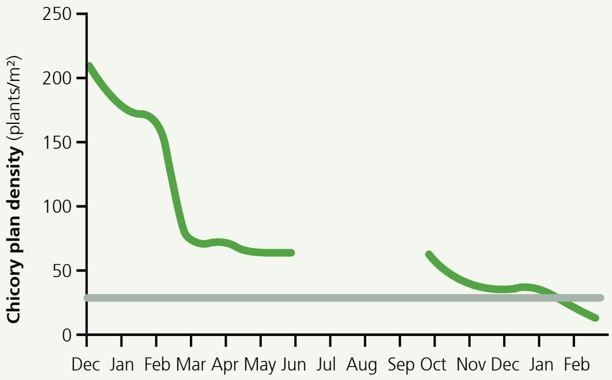
Figure 1 shows the decline in spring-sown chicory plant density over 18 months under dairy cow grazing in the Waikato. In March there were 76 plants/m^2 so the chicory was taken through a second year, in which it yielded 11.4 t DM/ha over seven grazings between June and March (note chicory was not grazed during the winter). As a comparison, ryegrass pasture grew 14.6 t DM/ha from June to March.

Should annual ryegrass be undersown in chicory after the first summer?

The decision to undersow depends on how dense the chicory is and what feed requirements are during winter on-farm. If the chicory sward is still relatively dense in early autumn (e.g. 30 or more plants/m^2) and there are alternative options for winter feed, such as PKE or maize silage, then undersowing annual ryegrass may not provide any advantage.

However, if the chicory plants are becoming a bit sparse and/or there is going to be insufficient winter feed, then undersowing with annual ryegrass (which essentially means the end of the chicory crop) or putting the pasture back into permanent pasture is a good option.

Figure 1. Decline in chicory plant density over 18 months under dairy cow grazing. The grey line indicates the minimum plant density required to achieve a satisfactory yield in the second year. The gap is winter, when chicory does not grow.



Are there palatability issues with plantain?

There are anecdotes that dairy cows have refused to eat plantain at certain times of the year and, unfortunately, it is not known what may cause this. In the three years of growing plantain at Scott Farm in the Waikato, the cows have never refused to eat it. There have been times when it takes them longer to graze to the desired residual, however, they have still achieved it in the allowed time.

To minimise the risk of unpalatability, plantain swards should be grazed relatively frequently (≤ 25 cm height) when the seedhead is relatively immature and before the leaves become too old and fibrous. In addition, planting plantain with clover rather than as a pure sward, may be beneficial.

What kind of caterpillars eat plantain and chicory and do they need to be sprayed?

In late February to mid-March, holes may begin to appear in herb leaves, particularly plantain (Figure 2). These are caused by caterpillars (e.g. common carpet moth, white butterfly, diamondback/cabbage moth).

As the caterpillars do not feed on roots or growing points, their impact is largely aesthetic. If damage is severe, however, the caterpillars can be controlled with an approved insecticide. Some farmers have suggested that grazing every 21-24 days in late February to mid-March may reduce the caterpillar population or damage from the population.

Figure 2. Caterpillar damage in a plantain/white clover crop.

A best practice guide for establishment and management of chicory and plantain is currently being developed, that will cover all of these questions and more. For more information email **julia.lee@dairynz.co.nz.**

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Focus on international research

The following is a brief summary of some key science papers recently published.

Mantysaari, P. and others. (2012). Energy efficiency and its relationship with milk, body, and intake traits and energy status among primiparous Nordic Red dairy cattle.
Journal of Dairy Science 95:3200–3211.

In this Finnish study, the relationship between "energy efficiency" and milk production was evaluated. They used two definitions of efficiency:

- energy conversion efficiency (**ECE**): milk production from energy eaten
- residual energy intake (**REI**): the difference between energy consumed and the predicted amount of energy required (i.e. accounts for BCS change).

Both definitions of efficiency were associated with increased milk production. However, milk production in high ECE cows came from increased body condition score mobilisation, the condition needs to be replaced in late lactation and the dry period. With REI, the increased efficiency was associated with a reduction in dry matter intake.

DairyNZ comment: DairyNZ data also indicate a big variation in how efficient cows are at utilising energy. The results highlight the importance of being able to measure dry matter intake and BCS change to be able to select cows for improved energy efficiency. The importance of accounting for the milk production from body condition score gain to measure true differences in efficiency is also highlighted.

Roberts, T. and others. (2012). Metabolic parameters in transition cows as indicators for early-lactation culling risk.
Journal of Dairy Science 95:3057-3063.

In this Canadian study, blood metabolites and minerals were measured pre and post-calving as potential indicators of whether cows would be culled in the first 60 days in milk (i.e. indicators of health problems after calving). Elevated blood fatty acids (indicator of negative energy balance) and ketone bodies (indicators of ketosis) and lower blood calcium concentrations (indicator of milk fever risk) within one week before calving through two weeks after calving were associated with an increased risk of culling in early lactation.

DairyNZ comment: these data are consistent with New Zealand and international research results. However, they are often mis-interpreted to suggest cows should be fed more pre-calving to ensure blood fatty acid and ketone body concentrations are lower at calving. There is evidence that the high blood fatty acids and ketone bodies occur because the cow is already sick AND that feeding her more increases the problem. Most importantly, cows should be at BCS 5.0 one month pre-calving. Such cows should be fed 80% of their energy requirements in the last two weeks before calving. This is generally what happens when farmers use the spring rotation planner.

Wall, E. and others. (2012). The effect of lactation length on greenhouse gas emissions from the national dairy herd.
Animal (first view articles): 1-11.

In this UK study, computer models were used to investigate the effect of three lactation lengths (305, 370, and 440 day lactations) on methane emissions. Longer lactations required fewer milking cows and replacements to maintain milk yield, but annual greenhouse gases rose from 1,214 t of CO_2 equivalent/farm for lactations of 305 days to 1,371 t CE/farm for 440-day lactation. This apparent anomaly can be explained by the less effcient milk production (kg milk produced per kg live weight) in later lactation, an effect that is more pronounced in longer lactations. Changes in lactation persistency or replacement rate did not greatly affect greenhouse gas output, but higher producing cows produced lower yields of greenhouse gases compared with low yielding cows.

DairyNZ comment: the effect of lactation length on yield of greenhouse gases is surprising and requires evaluation under a New Zealand pasture-based setting. DairyNZ data and Irish data are not in agreement with their conclusions regarding the effect of replacement rate and greenhouse gas emissions. In New Zealand data, lower replacement rates reduce the emissions of greenhouse gases.