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Transporting stock

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Being transported is widely regarded as one of the most stressful events to which farm animals are exposed during their lifetimes. In addition, it greatly increases their risk of injury[1].

The welfare of animals during transportation is a shared responsibility between the animals' owners and managers, livestock agents, transport companies and drivers, those that manage the facilities where the animals arrive, and the government departments that regulate and monitor performance.

Regulations on animal transport are set out by MAF in the Code of Welfare (Transport within New Zealand)[2] and the Code of Welfare (Dairy Cattle)[3]. These codes set minimum standards requiring that animals selected for transport meet fitness requirements and that proper care must be taken when deciding if it is appropriate to transport young, old, pregnant or otherwise physiologically or behaviourally compromised animals. They also require that animals must not be transported if they are likely to give birth during the journey or be affected by metabolic complications of late pregnancy as a result of the journey.

Veterinarians at meat processing plants inspect incoming animals and have reported concerns to industry meetings about the fitness of animals arriving for slaughter, especially cull dairy cows. Multiple farm ownership also increases the frequency with which dairy cows are transported between farms while lactating, with an associated increase in transport-related problems.

Transport may also expose cows to biosecurity risks if they come into direct or indirect contact with animals, or their excreta, carrying diseases or strains of pathogens to which they have not been exposed on their farm of origin.

Practices which can be implemented to reduce the risks associated with transport include inspecting animals to ensure they are 'fit to transport', journey planning, preparation of animals, especially where the journey will exceed more than two to three hours, and ensuring that yards and loading ramps are well constructed and maintained.

Fitness to transport

The general principle when checking animals before transporting them is that they must "be fit enough to withstand the journey without suffering unreasonable or unnecessary pain or distress" (Dairy Code of Welfare, 2010)[3]. This means that the suitability of the animals for transport needs to be considered in the context of the nature of the journey itself, especially its duration.

Animals must be healthy and able to stand and bear weight evenly on all four limbs. Any animal likely to give birth during transport must not be transported.

Animals that are in very poor body condition are not suitable for transport. The agreed industry standard is that the minimum body condition for transport is 2.5. This agreement allows animals that need remedial management because of poor condition (under the Dairy Code of Welfare, when a cow's body condition score falls below 3, the person in charge must take urgent remedial action) to be acceptable for transport either to an abattoir or a place where they will be fed adequately. These standards were established because when a cow's body condition score falls below 3, it is a signal that she is utilising her final fat reserves from around her kidneys[4]. As these final reserves are depleted, the cow loses her physiological resilience and her ability to withstand the stress of transport, so any journey is deemed to impose unreasonable distress.

Transport checklist

- Pre-transport inspection and selection – are the animals "fit for transport" – see the latest *DairyNZ Body Condition Scoring Made Easy* guide for further information
- If a veterinary certificate is required it will most likely:
  - Require that the animal is sent to the 'closest available plant'
  - Have an expiry date before which the travel must take place
- Journey planning – rest stops (feed and water arrangements – depends on stock class but should water at least every 12 hours and feed every 24 hours). General recommendations are that cows rest for periods of 12 hours after each 10 hours of travel, including the time taken to load and unload
- Pre-conditioning the animals for long trips (more than two hours) – dry feed for five to seven days before travel is recommended, and magnesium supplementation
- Irrespective of pre-conditioning, ensure cattle are stood-off green feed for a minimum of four hours before loading
- Loading facilities checked and required maintenance carried out. Heavily pregnant cows must have a ramp slope less than 20° (1:3 gradient). This may preclude loading on the 'top deck'
- Check that the truck is suitable:
  - Sufficient space allowance (too much and too little both predispose to injury; need more space on hot days)
  - Head room (must be able to stand in a natural position with enough room overhead such that the head or back does not make contact with the compartment's ceiling).

Biosecurity risks of transporting animals

Animals, and the vehicles that carry them, are potential sources of pests and diseases for a farm. Introducing a pest or disease that is not already present on the farm can have a major impact on productivity – apart from causing animal losses, lifetime production can be reduced, the costs of control can be significant, the sale of milk or animals may be restricted, and some diseases also affect humans.

When transported, animals are exposed simultaneously to a variety of stressors including fasting and water deprivation, increased handling, a novel environment and heat stress. Stress reduces the immune system's capacity to fight disease making animals more susceptible to new infections, while silent carriers of bacterial and viral diseases may excrete more infectious particles, and so become more infectious to others[1].

The health status of animals coming onto a farm needs to be understood clearly, and backed up with evidence, if claims about disease testing and vaccination are made:

- What is the health status of the farm the animals have come from?
- If the animals have been tested or treated, have they been kept separate from other untested or untreated animals to prevent re-infection?
- What about the journey – was the truck clean before animals were loaded, were they off-loaded anywhere during the trip, were other animals with unknown health status also on the truck?

Once the animals arrive on the farm they should be kept isolated from other animals on the property for several weeks and their health status monitored. This should be seen as an opportunity to protect the animal health status of the farm by avoiding the inadvertent introduction of a disease or pest.

Pests and diseases can also get onto a farm via effluent from stock trucks, vehicle and farm machinery undercarriages and wheels, or contaminated boots and equipment. Visitors coming onto the farm should arrive with clean protective clothing and equipment, especially if they are working with animals, or in areas where animals will be. Effluent from stock trucks should be regarded as high risk to the farm's animal health status, especially when the animals that produced the effluent are unknown.

Many diseases can be spread through effluent including bacterial diseases such as Salmonella, Johnes' Disease and tuberculosis, viral diseases such as Bovine Viral Diarrhoea (BVD) and rotavirus, and parasites including anthelmintic-resistant parasites.

Biosecurity measures to prevent the entry of pests and diseases, and to limit their opportunity to establish and spread, will reduce the risk. Such measures include:

- Select animals for purchase carefully
- Isolate new animals on arrival for several weeks
- Inspect newly-arrived animals regularly and seek advice if there are signs of disease
- Reject all stock truck effluent – if stock truck effluent is accepted, understand the risks involved, as treatment does not make it completely safe to spread on pastures

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- Have good general hygiene procedures, e.g. do not let effluent build up in yards, use disinfectants where required, wash off boots and overalls regularly, keep equipment used for treating animals clean
- Limit visitors to the farm and to the animals in particular
- Isolate any sick animals
- Ensure boundary fences are secure and contact with neighbouring animals is prevented.

Preparing dairy cows for transport

It is generally recommended that cattle are stood-off green feed for a period of at least four hours before transport. Withholding green feed and grain supplements in the hours before travel may improve the animal's comfort during transport, because high blood cortisol levels from transport stress will cause gut stasis and possibly bloat if the rumen is full of highly fermentable feed.

Withholding green feed is also proposed as a means to reduce the liquid content of the effluent produced during transport and so limit its spillage onto highways; but whether this view is correct is subject to debate. Withholding feed may at best reduce the payload slightly, allowing savings in truck fuel; but it also increases the risk of metabolic disease, especially for cows in late pregnancy and lactating cows. Where the journey distance is long, a better approach is to pre-condition the animals by feeding a high dry matter feed, such as good quality hay or baleage, for several days in preparation for transport. This type of feed also simplifies magnesium supplementation as magnesium oxide can be mixed with water and spread over feed. Magnesium should be supplemented at a rate of 80-100 g elemental magnesium/cow/day for up to a week before transport.

Unlike monogastric animals (e.g. humans), the volume of a cow's rumen fill is not greatly reduced by food withdrawal for 4-12 hours – it just becomes more liquid as food particles move through the digestive tract. Evidence for this is found in cows' daily liveweight fluctuations. The general pattern is that they gain weight during the day-time, and lose it overnight. When a group of 20 cows in late lactation were weighed twice daily for three weeks, their average daily change was 5.8% of liveweight (range through time: 1.7-9.1%;)[5], i.e. a 500 kg cow had an average daily fluctuation of around 11 kg.

It is also unlikely that withholding green feed for 4-12 hours before a journey will reduce the amount of faeces produced during the journey. Feed particles stay in the rumen for 35-40 hours while being broken down, while the total transit time through the cow's gastrointestinal tract is between 50 and 80 hours. Feed type has the greatest influence on gut passage. Fresh pasture passages faster because of its higher water content, but still takes more than a day to pass through the digestive tract. Feeding hay or silage with low water content over several days before transport is much more effective in reducing the liquid content of truck effluent than withholding green feed for a few hours before travel.

When preparing dairy cows for transport, the need to protect the udder and prevent mastitis should also be considered. There is a high chance that teats and udders will be contaminated with manure and mud which increases the risk of Streptococcus mastitis.

If cows are still lactating, then teats should be sprayed carefully with a good quality disinfectant following the last milking before the trip. All teats should be fully covered by the spray.

If cows have been dried off several weeks before transport then most teat canals will have closed which will reduce the risk. If cows are to be transported soon after drying off then their udders are best protected with either dry cow treatment or an internal sealant, followed by teat spray, immediately after their final milking.

Transport Tetany: A condition where prevention is better than cure!

Transport Tetany is a metabolic disease that occurs during or immediately after a long journey. Affected cows show signs that are very similar to hypomagnesaemia or grass staggers. While some respond to treatment if administered early, this disease is greatly complicated by the stress of transport and it is difficult to treat. The survival rate of cows that become recumbent is generally poor[6].

Well-fed cows in late pregnancy are at greatest risk, but recently calved and lactating cows are susceptible and young stock can also be affected. Cows in the final weeks of pregnancy and early lactation are under stress from the metabolic demands for milk production, and the added stress of transport increases the risk of disease.

The exact process, whereby otherwise healthy cows are affected by this condition, is not well understood. High cortisol levels due to transport stress and dehydration are thought to alter mineral and metabolic balance, and blood levels of magnesium, calcium and phosphorus fall. Increased sweating during transport and loss of saliva may also contribute to the imbalance[7].

The clinical signs of transport tetany are very similar to grass staggers – restlessness, excitability and aggression, teeth grinding and staggering. Abortion may occur as a complication. If the animal becomes recumbent then the gastro-intestinal tract becomes static, heart rate increases and breathing is rapid and laboured. Recumbent animals usually become comatose, and die within three to four days. Risk factors include:

- Body condition – fatter cows are more susceptible
- Stage of pregnancy – cows in late pregnancy are more susceptible

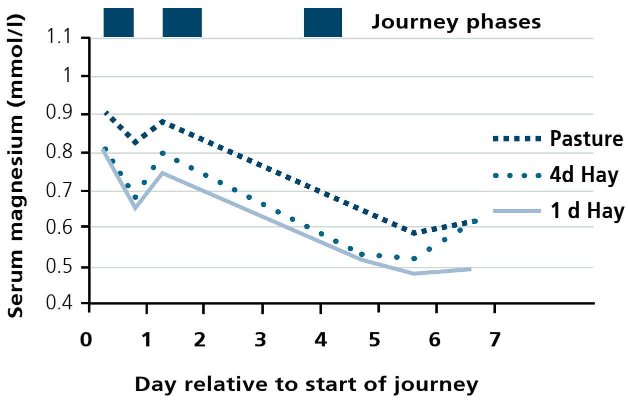
- Over-feeding in the hours immediately before transport
- Duration of travel without food and water available – longer journeys have higher risk
- High environmental temperatures during transport – factors such as over-crowding on trucks, and poor ventilation exacerbate the problem
- Unrestricted access to water and exercise immediately after arrival[6].

The effects of differing pre-transport diets were investigated by Fisher et al (1999)[8]. They observed cows that were six months pregnant during transport between the North and South Islands with three different pre-transport feeding regimes. Eight days before transport the cows were given a drench of 120 ml of 60% magnesium pidolate and magnesium oxide in water was spread onto feed at a rate of 85 g elemental magnesium per cow per day for four days before transport. The journey was divided into three 8 hour segments, interspersed with two rest stops of at least 12 hours, where cows had access to feed and water.

Cows lost 6-9% of their liveweight during the journey, and even 48 hours after arrival were still 3% lighter than their pre-journey weight. The pre-journey feeding regime did not influence this weight change. Serum beta-hydroxybutyrate (BOH) levels, increased during the journey and were still elevated at 48 hours after arrival. This suggests that cows had mobilised fat reserves.

Serum magnesium concentrations also declined during transport, especially following the later phases, and had not recovered even by 48 hours after arrival at the final destination (Figure 1).

Figure 1: Serum magnesium concentrations in pregnant non-lactating dairy cows during and following transport between the North and South Islands. Pre-transport dietary treatments were pasture (18 kg DM/day; Pasture), very restricted pasture (1.8 kg DM/day) with hay (12.2 kg DM/day) for four days (4d Hay), or restricted pasture (12 kg DM/day) for three days followed by hay alone (32 kg DM/day) on the day before transport (1d Hay; Fisher et al., 1999; reproduced with permission of the New Zealand Veterinary Journal)[9]. Black squares at the top of the graph represent the three journey phases of eight hours each which were (consecutively) from Waikato to the first rest station in Manawatu, from the first to the second rest station in Marlborough, and from the second rest station to the final destination in Canterbury.



Take home messages:

- If long-haul transport, especially of pregnant animals, cannot be avoided, then pre-transport preparation needs to include feeding a moderately restricted diet that contains adequate magnesium (80-100 g elemental magnesium/cow/day) for several days before transport
- On longer journeys there should be adequate rest periods during which cows are fed and watered
- If cows are lactating then apply teat disinfectant carefully after the milking before travel
- If cows are dried off immediately before transport, protect the udder with dry cow treatment and/or an internal teat sealant, and teat disinfectant
- Care should be taken to ensure that truck ventilation is adequate for the conditions, and to avoid overcrowding and excitement
- Limit access to water for 24 hours after arrival and avoid making cows walk long distances after travelling.

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Is protein supplementation needed during summer?

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Summary

- The decision to feed supplements in summer should be the same as at other times of the year – to maintain adequate rotation lengths and pasture residuals
- Energy is the first limiting nutrient in summer in most circumstances
- Protein is rarely limiting in New Zealand during summer
- Nutrition models suggest that a protein deficit is unlikely to limit production until dietary crude protein is less than 12% DM (e.g. when low protein feeds are more than 50% of the diet)
- Determining the requirement for supplementary protein is difficult because it involves many factors
- As protein supplements tend to be very expensive, the requirement for additional protein must be clear and the response profitable.

Introduction

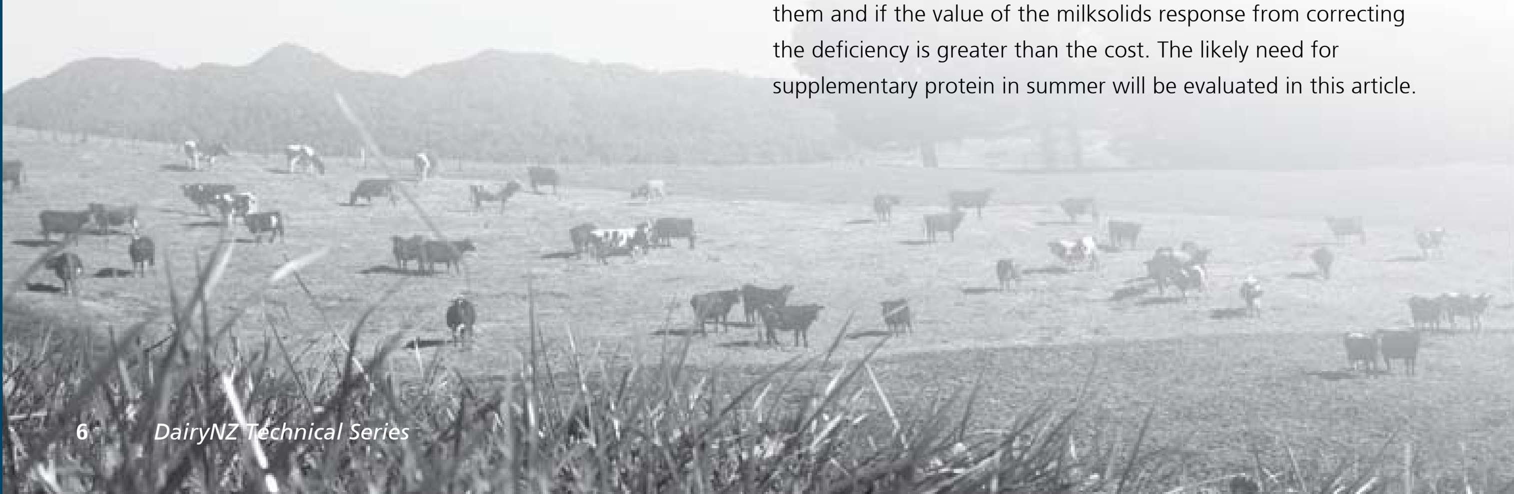
The principles of profitably supplementing cows during the summer are similar to those recommended at other times of the year; cows should only be supplemented when:

- there is insufficient pasture or crop to maintain an ideal grazing rotation (i.e. long enough for the pasture to grow three live leaves[1]) and/or
- pasture residuals are less than 3.5 cm (7 clicks on the rising plate meter or 1,500 kg DM/ha on the winter formula)[1,2].

However, the type of supplement required may be different in summer to that required in other seasons.

The unique point of discussion about supplementary feeding in summer tends to be around cow requirements for protein. Pasture protein concentrations tend to be less in summer than in spring and autumn[3]; this problem has been exacerbated in recent dry summers in the North Island and can also be a problem when water restrictions are imposed in irrigated regions. Coupled with this, many of the feed supplements used on dairy farms tend to be low in protein.

However, protein supplements tend to be very expensive; therefore, it is important to assess if there is a genuine need for protein supplements before making the decision to purchase them and if the value of the milksolids response from correcting the deficiency is greater than the cost. The likely need for supplementary protein in summer will be evaluated in this article.



What is protein?

The lean body mass of an animal – the muscles, organs, intestines – consists mainly of protein and water[4]. Although cows have an available store of energy in fat, there is very little protein available from stores. Therefore, cows need a constant supply of protein from their diet.

Nutritionists use multiple terms when referring to protein. **True Protein** is the feed fraction that is digested to amino acids in the small intestine and absorbed. In dairy cows, true protein reaching the small intestine is a mixture of feed protein and microbial protein (i.e. protein contained in the microorganisms that have passed from the rumen). True protein reaching the small intestine is referred to as **Metabolisable Protein**. This is the protein fraction that is important for tissue repair, growth and production.

The protein referred to in dairy cow nutrition is generally **Crude Protein**. Crude protein is a measure of the amount of nitrogen (N) in a feed (Crude Protein = 6.25 x N) and reflects a mixture of true protein and **Non-Protein Nitrogen** (nitrogen containing compounds that do not contain amino acids: e.g. urea). Because all protein contains nitrogen and because the rumen microorganisms in a pasture-based diet utilise nitrogen and not protein, it is an effective indicator of nitrogen availability for dairy cows. Approximately 90% of the protein in pasture is available for degradation in the rumen (**Rumen Degradable Protein**), but much of this is not degraded as it passes from the rumen too quickly. This is available to the cow as **Undegraded Dietary Protein** or **Bypass Protein** in the small intestine (see figure).

Is protein important?

All animals require protein for the repair and maintenance of body tissues[4]. Growing animals need additional protein for muscle and organ development and lactating cows require additional protein for milk protein synthesis. In addition to this, rumen microbes need a source of nitrogen (i.e. crude protein) to maximise the digestion of feed in the rumen; low dietary crude protein levels will reduce feed digestibility, DM intake and milk production.

How much protein does a cow need?

Common recommendations of protein requirements are simple:

- 18% crude protein in early lactation,
- 16% crude protein in mid-lactation,
- 14% crude protein in late lactation, and
- 10-12% crude protein when dry.

Although good rules of thumb, these recommendations are **not** correct for pasture-based systems. In reality, cow requirements for protein are much more difficult to determine than these simple rules indicate. Requirements depend on many factors. For example:

- energy status of the cow – cows losing body condition require more dietary protein to maximise milk production than cows gaining condition

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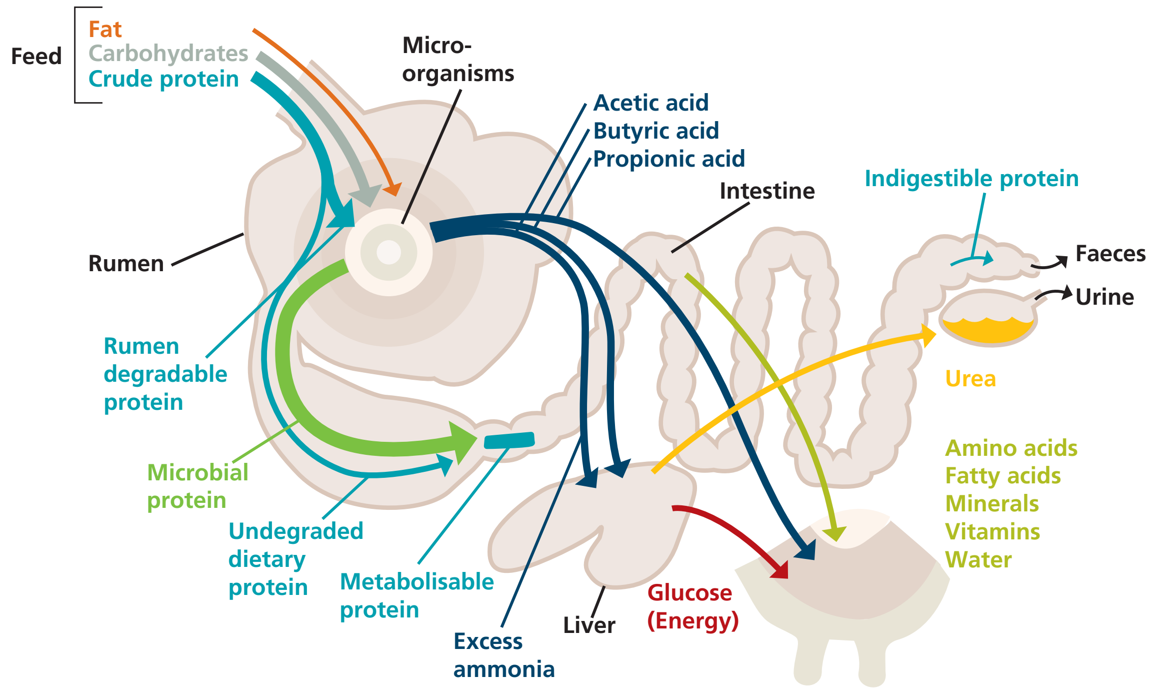
Protein digestion and metabolism



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- milk production level – higher milk production results in a greater demand for dietary protein
- metabolisable energy (ME) content of the feed – cows offered high ME feeds require higher levels of dietary crude protein[4] (see Table 1) and, in particular, rumen degradable protein
- the amino acid makeup of the protein – some supplements result in a deficiency of particular amino acids
- ambient temperature – heat stressed cows expend energy trying to cool and, so, are less likely to require protein supplements for milk production. Where a lack of protein is limiting production during hot weather, bypass protein becomes more important
- the amount of energy the cow must expend in non-production purposes (e.g. distance walked from the shed to the paddock) – cows with longer walking distances partition more energy to activity and are less likely to require protein supplements.

Examples to consider:

1. if ambient temperature averages 25°C, a cow eating 8 kg DM of typical summer pasture and 8 kg DM of maize silage has sufficient protein in the diet for maintenance, activity and milk production up to 1.1 kg MS; metabolisable energy is the limiting nutrient. However, if ambient temperature averages 15°C, the diet is likely to be deficient in protein and milk production will be less than predicted from intake of ME.
2. if pasture is reasonably high in ME (11.5 MJ/kg DM) but low in protein (12% DM crude protein), supplementing with more than 5 kg DM of maize silage, for example, in summer will probably create a protein deficiency. However, if pasture is of poor quality (10 MJ ME/kg DM) with the same crude protein content, the diet does not become deficient in protein until the cow is eating more than 8 kg DM maize silage/day.
3. if cows are eating high quality-low protein pasture (11.5 MJ ME/kg DM and 12% crude protein) and are supplemented with 8 kg DM of maize silage, the diet will be deficient in crude protein if they are walking 2 km/day but not if they are walking 4 km/day.

Summer pasture and the need for supplementation

The large number of factors contributing to actual protein requirements makes it very difficult to provide general advice on the adequacy of a diet for crude protein during summer.

The concentration of both metabolisable energy and protein decline in pasture during late spring and summer[3] and this is exacerbated during periods of moisture stress. Therefore, it is possible that dietary crude protein will limit production in some situations during summer, particularly if cows are producing more than 1.2 kg MS/day.

To aid with decision making, possible nutrition scenarios were modelled using the Cornell Net Carbohydrate and Protein System and are presented in Table 1. This is a nutrition model that has been validated for use in grazing[5]. In the simulations, pasture crude protein concentration was low (12% DM), but pasture quality varied from good (11.5 MJ ME/kg DM) to poor (10 MJ ME/kg DM). Various supplementary feeding scenarios are considered and possible changes to the ration to avoid protein deficiencies are presented in Table 1.

In general, the model simulations indicate that dietary protein must be very low (less than 12% DM) for cows to benefit from a protein supplement. This is substantially less than the 16% crude protein recommended in the simple nutrition recommendations mentioned previously and only occurs in extreme circumstances. Predicted availability of metabolisable energy (**ME-MS**) and metabolisable protein (**MP-MS**) for milksolids production from the model are presented in Table 1. In almost all circumstances, the dietary factor limiting milk production is energy. In the scenarios where protein is limiting milk production, grass silage and/or PKE can be used to overcome the deficit without the need for an expensive protein supplement (e.g. soybean meal, fishmeal).

Is there a benefit to supplementing cows with a protein supplement when the diet is lacking protein?

Milk production responses to correcting dietary protein deficiencies are presented in Table 1. For example, on Diet 3, cows consume enough ME to produce 1.37 kg MS but there is only sufficient metabolisable protein reaching the small intestine to provide for 1.26 kg MS. By correcting the deficiency (Diet 5 and 6), cows should be able to produce approximately 1.40 kg MS. This response is consistent with research results from New Zealand[6], wherein cows produced an additional 0.11 kg MS when a dietary protein deficiency was corrected through feeding 1.4 kg DM of soybean meal.

The profitability of correcting the low diet crude protein will depend on the price of available supplements, the actual response and the milk price. Because protein supplements (e.g. soybean meal, fishmeal, canola meal) tend to be very expensive, in general, high priced protein supplements will not return sufficient value in an average summer to justify their use.

Table 1. Amount of metabolisable energy and metabolisable protein available for milksolids production when cows are fed different diets (**ME-MS** = metabolisable energy available for milksolids production: **MP-MS** = metabolisable protein available for milksolids production). When ME-MS is red, cows will benefit from energy supplements if they do not have enough pasture. When MP-MS is in red, the diet is deficient in protein and extra energy will not increase milk production without supplementary protein.

Ingredient	Pasture	Pasture silage	Maize silage	PKE	Soybean meal	Ration-ME MJ/kg DM	Ration CP %DM	Potential MS from energy (ME-MS)	Potential MS from protein (MP-MS)
ME, MJ/kg DM	See below	10.3	10.5	11	12				
Crude protein, %DM	12	16	8	14	52				
11.5 MJ ME pasture									
Diet 1	16					11.2	12.0	**1.47**	1.61
Diet 2	11		5			10.9	10.8	1.41	1.40
Diet 3	8		8			10.7	10.0	1.37	**1.26**
Diet 4	8		6	2		10.7	10.8	1.37	**1.32**
Diet 5	8	2	4	2		10.8	11.8	**1.38**	1.45
Diet 6	8		7		1	11.0	12.7	**1.42**	1.65
Diet 7	8		4	4		10.7	11.5	1.36	1.37
The above scenario is unlikely, as high quality pasture (high ME) will, in general also contain reasonable crude protein levels (greater than 15%)									
10.75 MJ ME pasture									
Diet 8	16					10.4	12.0	**1.26**	1.61
Diet 9	8		8			10.3	10.0	1.25	1.26
Diet 10	5	3	8			10.2	10.8	1.23	**1.20**
Diet 11	5	5	6			10.2	11.8	**1.22**	1.26
Diet 12	5	3	7	1		10.3	11.2	1.24	1.25
10 MJ ME pasture									
Diet 13	16					9.9	12.0	**1.12**	1.51
Diet 14	11		5			10.0	10.8	**1.14**	1.28
Diet 15	8		8			10.0	10.0	1.15	1.14
Diet 16	8	1	7			10.0	10.5	1.15	1.17
Diet 17	8		6	2		10.1	10.8	**1.17**	1.23

Is there a benefit to supplementing cows with urea when the diet is lacking protein?

Urea is 46% N and, therefore, contains 288% crude protein (crude protein = N * 6.25). In general, there will be no benefit from supplementing cows that are deficient in dietary protein during summer with urea[6]. This is because the rate of release of energy from the feeds offered (e.g. pasture, pasture silage, maize silage, palm kernel extract) is too slow to make use of the rapid release of nitrogen from the urea[6]. If feeding more rapidly fermented carbohydrates (e.g. grain, molasses, or fruit waste), urea may help to overcome the deficiency in protein and improve the digestibility of the feed. Care must be taken when supplementing with urea. In reality, urea should only be supplemented as part of a balanced mixed ration.

Conclusions

Nutrition modelling suggests that it would be rare for a diet offered to cows during summer in New Zealand to be deficient in crude protein unless more than 50% of the diet is a low protein supplement (e.g. maize silage or cereal grains). Instead, the nutrition focus at this time should be on providing cows with the cheapest (c/MJ ME) form of high quality energy available when pasture residuals are less than 1,500 kg DM/ha and/or pasture cover is declining. In some regions, where cereal grains are competitively priced and available, it may be worth considering the fibre to non-fibre carbohydrate content of the supplement[7].

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Recently published by DairyNZ

DairyNZ researchers publish their findings in high calibre national and international journals, so they remain at the leading edge of dairy industry research.

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Winter forage crops:

an important feed source in South Island dairy systems

Dr Dawn Dalley, DairyNZ Regional Scientist, South Island

Summary

- Wintering requires a planned approach to meet feed supply and demand
- Crop choice is important as it impacts on the yield that can be achieved and, therefore, the land area required, and also on the amount of feed supplement required to balance the diet
- Not achieving the potential crop yield through poor crop management increases the cost of wintering and increases the risk of not achieving pre calving body condition score targets
- Attention to detail throughout the planning, establishment, growing and grazing stages is essential for good outcomes
- Growing winter crops on the milking platform is unlikely to increase whole farm profitability due to the opportunity cost of milk production foregone while the paddock is out for cropping
- Reasons other than pasture renewal may justify growing winter crops on the milking platform. These reasons include: land development, control of wintering, better transitioning onto crops, and protecting pastures during spring.

For South Island dairy farmers, feeding cows in winter provides a number of challenges not encountered in other dairying regions of New Zealand. The main issue is the inability to grow sufficient pasture during winter to meet feed requirements of the cows. Winter pasture growth is usually less than 10 kg DM/ha/day[1], which makes pasture-based wintering an impractical option due to the area of land required to accumulate sufficient pasture to meet herd feed requirements. This is also a period when the poorly drained southern soils become waterlogged making grazing difficult and potentially costly if treading damage reduces subsequent pasture production.

It is estimated that, as wintering in the South Island contributes 20-25% to farm working expenses[2], it is important to get it right. Forage crops are generally considered to be a better economical option for wintering cows, however their profitability is highly dependent on crop yields[3], and crop yields are dependent on the climatic conditions, paddock cropping history and crop management[4].

Typically, dairy wintering systems in the southern regions of the South Island are based on grazed crops such as kale, swedes and more recently fodder beet, which provide large quantities of high quality feed from a relatively small area.

An average yielding swede or kale crop of 12-15 t/ha will cost 8-10 c/kg DM to grow[5], with the cost per kilogramme of DM consumed likely to increase further depending on utilisation rates. Utilisation rates can range from 40%-90% depending on crop type and cultivar, sowing date and rate, grazing method, climate, and soil conditions[6].

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More recently, fodder beet has been grown as an alternative to kale and swedes but establishment and maintenance costs are higher than for brassicas due to the chemicals required for weed and pest control. For crops grown at the Southland Demonstration Farm in 2009, fodder beet cost $2330/ha to establish (11 c/kg DM at 21 t DM/ha), compared with only $1100 and $1093 for kale and swedes respectively[5,7]. Consequently, higher yields are required to achieve similar costs per kg DM. Yields as high as 30 t DM/ha have been reported (G Judson, pers. comm.). Beukes *et al*. (2011)[8] used a modelling approach to examine the cost effectiveness, exposure to climate induced risk, and major economic drivers of four selected wintering strategies – forage crops, pasture, standoff and housed. The forage crop system was most exposed to climate induced risk primarily due to the impact of climate variation on crop yield. The overall profitability of the systems was similar; however the costs and savings were incurred in different areas depending on the system.

The long term financial viability of forage crop wintering relies on the ability to achieve high forage crop yields repeatedly. Most of the production costs for the crop are committed in the early stages of crop development, but the difference between a poor yield and an acceptable yield is usually associated with effective use of weed and pest control, and fertiliser[4]. The higher the yield achieved, the lower the cost of production per kg of DM, and the smaller the area of land required. If the yield potential of the crop has been reached, additional inputs will have a negative impact on profitability as establishment costs increase for no further increase in yield. The repeated cultivation of land for crops results in some land becoming unsuitable for cropping due to loss of soil structure, weed infestation, and increase in soil borne diseases. It is, therefore, important that soil physical properties are monitored by visual soil assessment[10], good crop rotations are established and paddocks are not repeatedly cropped[11].

Grow a good crop

S. Lee (pers. comm.) compared the relative diet costs (i.e. crop plus supplement) of fodder beet and kale with and without irrigation in Canterbury (Table 1) and calculated the cost of crop failure on feeding costs. Crop failure was defined as achieving only 75% of the expected yield. Because of the higher supplement requirement with fodder beet to minimise nutritional disorders[9] the total diet costs for irrigated fodder beet are similar to irrigated kale. Lower crop yields through poor crop management can significantly increase the cost per kg DM (Table 1).

Where to grow the crop?

Farmers have the choice of using forage crops on the milking platform or growing them on a support block or contracting a grazier. It is often taken for granted that grazing off-farm incurs more cost than if cows were grazed on the milking platform, and that those wintering cows on the milking platform are substituting land and income. Cottier (2000)[12] compared costs and returns for a range of wintering systems and concluded that leasing a neighbouring paddock for growing the crop returned the highest economic farm surplus, followed by wintering off with a grazier, leasing a support block, owning a support block and finally wintering on crops on the milking platform.

Table 1. Estimated costs ($/ha) of fodder beet and kale diets under irrigated and dryland conditions in Canterbury when achieving 100 and 75% of potential crop yield (S. Lee pers. comm.).

	Fodder beet		Kale	
	Irrigated	**Dryland**	**Irrigated**	**Dryland**
Growing cost ($)	2000	2000	900	900
Capital charge for land ($)	2400	1200	2400	1200
Silage at 30 c/kg DM ($)	5025	3417	700	423
TOTAL Costs ($)	9425	6617	4000	2523
Feeding ratio (crop:supplement)	60:40	60:40	85:15	85:15
Potential yield (t DM offered)	25	17	15	8
Silage (t DM offered)	16.75	11.39	23	14
Total DM offered (t)	41.75	28.39	17.3	9.4
Cost/kg DM offered (100% of potential yield)	22.6	23.3	23.1	26.8
Cost/kg DM offered (75% of potential yield)	31.4	27.1	31.0	34.3

There are a number of opportunities that farmers should consider to help them decide the value of winter forage crops in their dairy farm system. These include:

- Land redevelopment and pasture renewal
- Control of cows during the winter period
- Transitioning of cows onto crop prior to winter
- Protecting pasture from treading damage during early spring.

Land development and pasture renovation

Incorporation of winter forage crops into the dairy farm system provides an opportunity to develop land through contouring, increasing soil fertility or installation of drainage. It also provides an opportunity to break weed and insect pest cycles. Bryant *et al.* (2010a)[13] used the Farmax Dairy Pro model[14] to investigate the profitability of incorporating kale on the milking platform as part of a pasture renewal process. They concluded that an additional 10% increase in pasture production from the new grass paddock would be required from the cropping to make it worthwhile. The reasons for the poor performance of the kale in this scenario were attributed to the high assumed wastage, low yields for the period the paddock was out of the rotation and poor quality (10.5 MJ ME/kg DM). Their results suggest growing crop on a support block is the best option, similar to Cottier (2000)[12], as crop grown on the milking platform removes that area from the grazing rotation for more than a year and does not provide enough extra feed to substitute for the lost pasture production.

Control of cows during the winter period – managing risk

To achieve high performance from the milking platform, an effective control over feed inputs is required. Substandard experiences with outside parties i.e. cows being returned early or not achieving their pre-calving body condition score targets often result in farmers deciding the risk of sourcing feed externally is too high. As a result, they grow forage crops on the milking platform or a support block that is either leased or owned. Richards (2006)[15] reported that achieving greater business control was the major driver for dairy support land purchase in Canterbury. All of the farmers interviewed used their support land for wintering.

Transitioning of cows onto crop prior to winter or off crop prior to calving

Cows may take more than two weeks to adjust to maximum feed intake following a diet change from predominantly pasture to a diet that contains 50% or more of forage brassica or fodder beet. The aim of an effective adaptation or transition period is to develop a rumen microbe population that can cope with higher levels of non-structural carbohydrates, lower levels of fibre and the presence of possible anti-nutritional factors such as nitrates and S-methyl cysteine sulphoxide[5]. Inclusion of forage crops on the milking platform, as part of a pasture renewal programme, allows cows to be transitioned onto the winter crop prior to dry off. Allowing cows access to crop for 1-2 hours a day in the final two weeks of lactation minimises the risk of animal health issues when cows move onto their winter diet, especially if this is on a support block or with a grazier. It is important to offer the same crop during the transition period as will be offered during the winter. The same crops can be used in late winter to feed cows prior to transitioning back onto pasture before calving.

Protecting pasture from treading damage during early spring

Pugging damage has been shown to cause long-term (18 months) declines in soil physical properties by increasing bulk density and decreasing pore size and hydraulic conductivity[16]. The effect of soil compaction caused by a single intensive grazing during a wet day in August can depress pasture production by 20-80%, depending on the soil type, with effects lasting between 4-8 months[17]. Winter crop paddocks on the milking platform can be used during very wet conditions to minimise the damage made to the milking platform pastures.

Summary

Winter forage crops are an integral part of many dairy systems in the South Island, providing high quality feed during periods of low pasture growth. The long term financial viability of such systems relies on the ability to repeatedly grow and utilise high forage yields. Attention to detail with paddock selection, crop establishment and grazing management are critical to successful forage crop wintering.

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Maize for South Island dairy farmers?

Mid-south Canterbury is regarded as the southern limit of reliable maize production[1] in the South Island. However, farmers in Southland are growing maize for silage[2]. Maize is best adapted to warm climates and is intolerant of frosts therefore when considering growing maize in the South Island there are a number of factors that need to be considered:

Cultivar maturity

Early season hybrids (comparative relative maturities (CRM's) of 75-80) tend to yield less because they have fewer and smaller leaves and need fewer days to reach maturity. They are however more likely to reach maturity before being killed prematurely by early autumn frosts, reducing the risk of crop failure. Although later maturing cultivars (CRM's 105-110) have the potential to produce better silage yields in warmer climates, this potential cannot be expressed in climates with cool, short seasons. Pioneer[3] reported South Island maize silage yields ranging from 15 to 32t DM/ha across a number of seasons, cultivars and locations.

Location

Wilson[1] reported significant variability between locations in their suitability for maize. Areas in the north (Riwaka and Blenheim) and lower altitude, coastal locations in central Canterbury (Rangiora and Lincoln) had levels of risk acceptable for silage crops. Higher altitude inland locations and areas further south (Hororata, Winchmore and Timaru) were not suitable because maize crops often failed to complete growth due to low temperatures and limited season length, even when early maturing cultivars were sown. Days to maturity are lowest for crops grown in Takaka (124 days) and highest in Timaru (177 days)[3].

Sowing date

Crops should not be sown in spring until the soil temperature has risen above 10°C. Wilson[1] reported that silage yield was less sensitive than grain yield to delayed sowing, however they still recommended that all cultivars should be planted as early as possible to minimise the risk of crop failure. Plastic mulch can be used to accelerate crop development and reduce the crop's duration to maturity by up to 14 days[4]. To realise the full potential of using plastic mulch it should be combined with an early sowing date (late September) and longer maturity hybrid (CRM 105-110 days)[4].

Conclusion

The decision to grow maize for silage production in the South Island comes with higher risk mainly because of the variability in temperature and frost occurrence among seasons and the sensitivity of crop development rate to temperature. If considering growing maize consult an agronomist specialising in maize production to ensure the best cultivar is sown at the right time to minimise the risk of crop failure.

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Summer-active grasses:

What are they and how can they be controlled?

Katherine Tozer and Trevor James, AgResearch

What are summer-active grasses?

Summer-active grasses have a C_4 photosynthetic pathway which allows them to grow faster than other grasses in response to increasing temperatures and solar radiation, given adequate rainfall to establish. Their water-use efficiency is much higher than other grasses enabling them to tolerate drought conditions once established.

Some C_4 species, such as summer grass (*Digitaria sanguinalis*), and yellow bristle grass (YBG, *Setaria pumila*) are restricted mainly to the northern and coastal regions of the North Island[1]. These are two of the most prevalent summer-active grasses in Waikato, the Bay of Plenty (BOP) and coastal Taranaki dairy pastures. They dominate the natural seed banks in dairy pastures, along with other C_4 grass weeds[5, 6]. Yellow bristle grass has the potential to spread further throughout the North Island and even in eastern regions of the South Island.

It is a weed of crops in North America and other countries[3] and has only recently become a problem in North Island dairy pastures[4]. Yellow bristle grass and summer grass both originated in Eurasia and China[2, 3].

Their impact on dairy pastures is discussed later.

How to identify summer grass and yellow bristle grass

Key characteristics of YBG[2] are shown in Figure 1:

- Seed head is a cylindrical 'spike' 2.5-10 cm long (Figure 1a)
- Upright annual growth habit: 25-45 cm high
- In open pasture its first leaves are typically parallel to the ground (Figure 1b)
- Emerging leaf rolled (Figure 1b)
- Leaves are hairless and slightly rough at the edges
- Leaves are yellow-green to green in colour
- Long hairs are present at the base of the leaves (Figure 1c)
- Leaf sheath is flattened and hairless and often turns reddish purple from the base
- Ligule is a ring of hairs about 1 mm long (Figure 1c) - this ring of hairs is found where the leaf blade joins the part of the leaf surrounding the stem
- No ears (auricles) protrude at the junction of the leaf blade and sheath
- Bristles in the seed head are initially green but soon change to a golden-brown (Figure 1f)
- Most other *Setaria* species have fewer bristles in their seed heads.

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Key characteristics of summer grass[2] are shown in Figure 2:

- First leaves are broad and hairy (Figure 2a)
- Emerging leaf is rolled (Figure 2a)
- Seed head is an umbel (umbrella like) and up to 30 cm across (Figure 2b)
- Ligule is membranous, 1-2 mm long and blunt – it is found where the leaf blade joins the part of the leaf surrounding the stem (Figure 2c)
- Leaf blades are very hairy underneath when young but there are only a few long hairs at the base when the plant is mature
- Prostrate growth habit (Figure 2d).

What are the impacts of yellow bristle grass and summer grass?

- These grasses outcompete sown pasture grasses and cows will sometimes avoid them once seed heads emerge, reducing available feed on offer. They also provide poor quality forage once seed heads are produced and their nutritive value is much less than that of ryegrass (Figure 3). In one recent study, metabolisable energy (ME) and organic matter digestibility (OMD) of YBG, summer grass and ryegrass were similar in December. However the ME and OMD of both YBG and summer grass were lower than that of ryegrass in January, February and March. Crude protein of both YBG and summer grass was also less than that of ryegrass in February and March (Katherine Tozer, unpubl. data).
- Yellow bristle grass can impair livestock performance and animal welfare. In Europe, dairy cattle reduced their intake and milk production and developed mouth ulcers when fed hay containing more than 95% YBG. It was thought that the harsh bristles in YBG seed heads caused the mouth ulceration and reduced forage intake[7].

Figure 1. (a) Yellow bristle grass seed head, (b) seedling, (c) hairs at the base of the leaf, (d, e) seeding plants and (f) seeds.

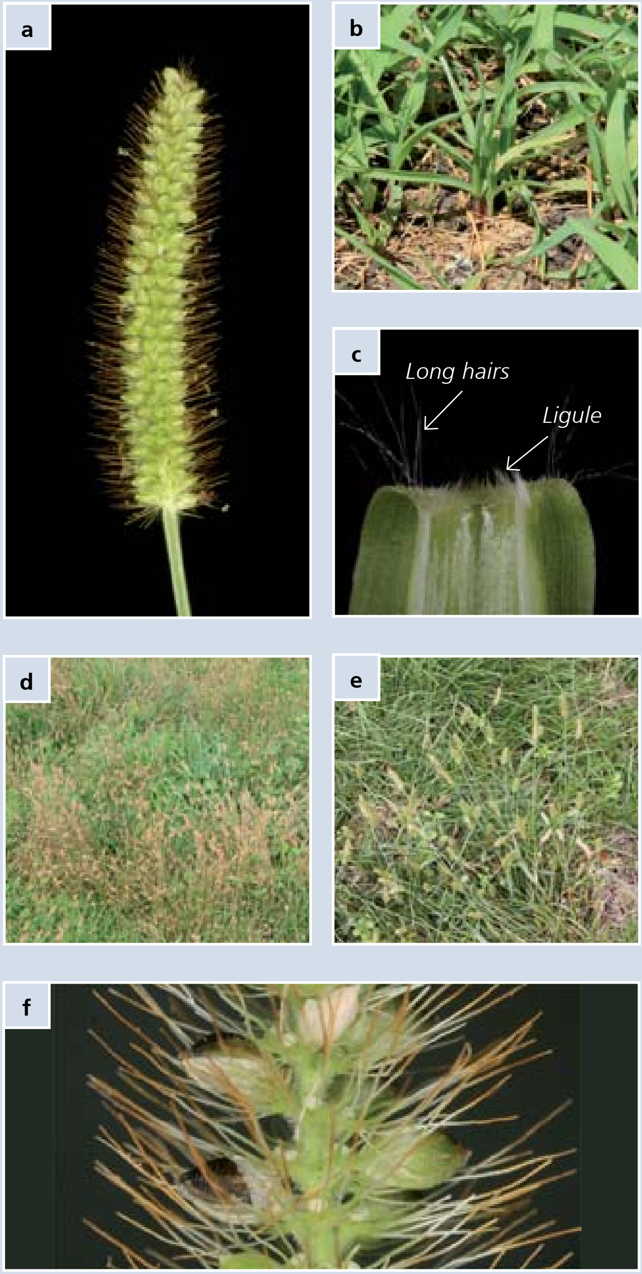


Figure 2. (a) Summer grass seedling, (b) seed head, (c) hairs at the base of the leaf and (d) mature plant.

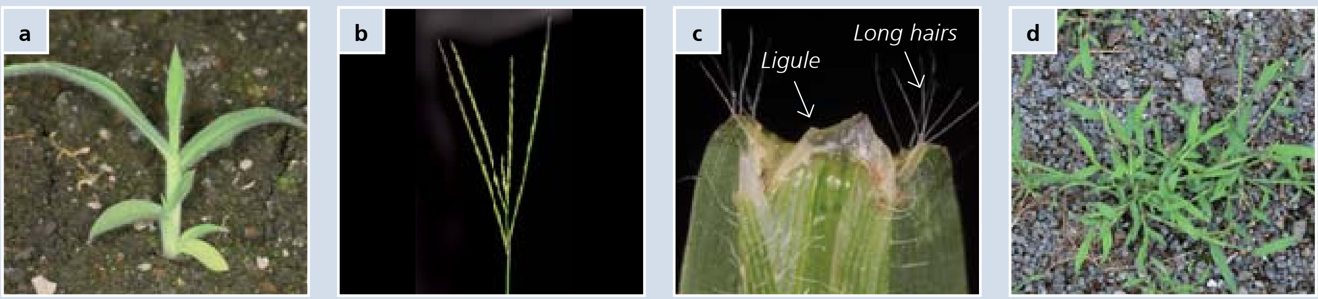
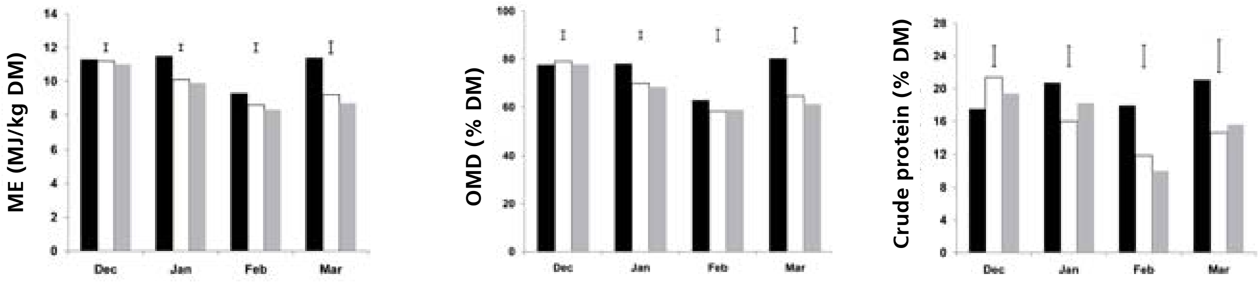


Figure 3. Ryegrass (■), summer grass (□) and yellow bristle grass (■) metabolisable energy (MJ/kg DM), organic matter digestibility (% DM) and crude protein (% DM) content in Waikato dairy pastures, from December to March. LSD bars are shown.



In Waikato dairy pastures over the last four summers, summer-active grass content (and broadleaved weeds content) have increased as sown species content declined. This is shown in Table 1, which demonstrates the large decline in ryegrass content after the severe drought in the central North Island in 2008. Summer-active annual grasses (especially YBG and summer grass), as well as clover, filled the gaps created by ryegrass mortality.

Table 1. Percent ground cover of ryegrass, white clover, YBG, summer grass and broadleaved weeds in 39 Waikato dairy pastures assessed each February.

Ground cover (%)	2008	2009	2010	2011
Ryegrass	55	40	35	42
White clover	7	11	25	16
YBG	4	11	11	12
Summer grass	5	16	9	11
Broadleaved weeds	4	9	12	11

It has been estimated, using the nutritive value data in Figure 3, that an 11% drop in milk production would occur if 25% of a cow's diet comprised YBG and/or summer grass in a ryegrass-clover pasture (Chris Glassey, DairyNZ, pers. com.)

What is their life-cycle?

YBG and summer grass undergo rapid germination and establishment, and produce seed heads within 6 to 8 weeks of germination. Timing of germination varies from year to year depending on temperature and rainfall. In Waikato and BOP, germination normally peaks in late November/early December, with seed heads emerging in late December/early January.

YBG produces soft seeds but they remain enclosed by an outer casing (called the palea and lemma) which offers some protection to the seed. Summer grass seeds are also soft. YBG produces fewer, but larger, seeds per plant than summer grass. This larger seed size gives YBG a competitive advantage and may be one of the reasons why YBG is replacing summer grass in some areas. YBG seeds can survive passage through a cow and can germinate in dung. They can also survive for three months in an effluent holding pond or in hay.

After seeds have matured and fallen from the seed head, they remain dormant for a short time before they can germinate. Most seeds germinate in late spring/early summer following their production; there is little carry-over of seed into successive years. In one study, no YBG seed survived three years of burial in soil[8].

What can we do about these weeds?

The *Yellow bristle grass ute guide*[9] enables identification and provides control options for YBG. The same principles apply to other summer-active grasses such as summer grass. The following control options are available:

Management on roadsides

- Spray roadside patches with glyphosate. The timing of application is important; spray just before Christmas or as the first seed head emerges
- Try and create a thatch of dead plants to stop further YBG germination
- Residual herbicides have the potential to prevent germination of YBG
- Grub and dispose of individual plants, taking care not to dump plants in clean areas as seed heads on the plant may be mature and seeds may be able to germinate
- Avoid grazing roadsides where YBG is present as the seed can survive passage through the cow and germinate in the dung
- Don't make hay from vegetation containing YBG; seeds may survive and feeding out the hay will spread the seed

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- Making wrapped balage will kill the seeds, provided the balage is left for three months. Further research is required to determine if seeds are killed after a shorter time period in wrapped balage.

Management of small infestations

- Apply glyphosate to the infestation but note that other weeds may quickly fill the gap
- Glyphosate can be used at all stages of growth but will not kill the YBG seeds if the bristles have already turned yellow
- Manual removal is a very good option if possible
- Fence off to avoid seed being spread
- Do not graze when the seed head is visible as this is too late; seeds can spread and germinate in dung
- Be vigilant as YBG will germinate throughout the summer as conditions (e.g., rainfall) allow.

Management of large infestations

- Use a selective herbicide[10]. Note that more than one application is likely to be required to control late germinating YBG plants
- Avoid grazing a clean paddock after stock have been exposed to YBG infested paddocks
- Renovate a pasture following the DairyNZ 'Pasture renewal guide.' Using treated seed and the appropriate endophyte are important.

Management by pasture renewal

- Yellow bristle grass seed production must be prevented for at least two summers before a new pasture is sown. YBG must not be allowed to set seed and replenish the seedbank during this preparation period
- Use crops in which YBG can be readily controlled, such as:
  - maize (use Latro as a post-emergence spray)
  - chicory (use Sequence as required)
  - turnips (use Sequence before crop canopy closure)
  - lucerne or other legumes (use Sequence as required).
- Annual ryegrass or winter cereals can be grown between the summer crops
- Be active in controlling weeds in the new pastures and manage them carefully to prevent weed invasion.

Grazing management

- Avoid overgrazing and opening up pastures which will lead to weed invasion. Studies have shown that the seedbank in dairy pastures is dominated by weeds which will readily invade a pasture[5,6]
- Avoid moving stock from an infested paddock to a clean paddock
- In dry years, provide supplementary feed as required to preserve pastures (i.e. prevent overgrazing) and prevent weed ingress

Table 2. Efficacy of Puma S on yellow bristle grass (YBG).

	Rate (ml/ha)	% control				YBG plants/m²
Treatment date		**24.3.11**	**1.4.11**	**12.4.11**	**21.4.11**	**21.4.11**
Untreated	-	0	0	0	0	22
Puma S	500	50	63	70	88	2.3
Puma S	750	54	70	81	89	1.3
LSD (5%)		10.7	15.4	11.3	7.9	3.46

Treatments were applied in March 2011 in 250 L water/ha. Herbicide was applied when most YBG plants had several flowering panicles. Percent control was a visual assessment of the reduction of plant size and vigour compared to untreated pastures. Recommended rate for Puma S is 750 ml/ha in ryegrass seed crops.

- Yellow bristle grass will not be controlled through grazing because mature seed heads are produced between grazings in a typical 21-day dairy rotation[11]
- Reduction of stocking rate may be required to achieve some of the above.

Current knowledge on chemical control

During the summer of 2010/11, an existing herbicide with excellent efficacy on YBG was identified. The herbicide, Puma S (69 g/litre fenoxaprop-P-ethyl), is primarily active on annual C_4 and other weedy grasses. Early trials showed that it gave excellent control of large, multi-tillered YBG plants when they were treated pre-flowering (Table 2). It also gave good control of plants that had been trimmed back to 30 mm to represent heavy grazing. Puma S did not damage either perennial ryegrass or white clover; there was also no impact on perennial ryegrass dry matter production when applied at the recommended rate (750 ml/ha) or twice the recommended rate (Figure 4). Puma S is currently registered for use in ryegrass seed crops.

Unfortunately, Puma S has a 42 day non-grazing period after application in pastures. In collaboration with the manufacturers, Bayer Crop Science, the research emphasis this coming season will be to obtain herbicide residue data with the aim of reducing the non-grazing period, and to conduct both small plot and paddock size demonstrations to evaluate the efficacy of Puma S in a range of situations.

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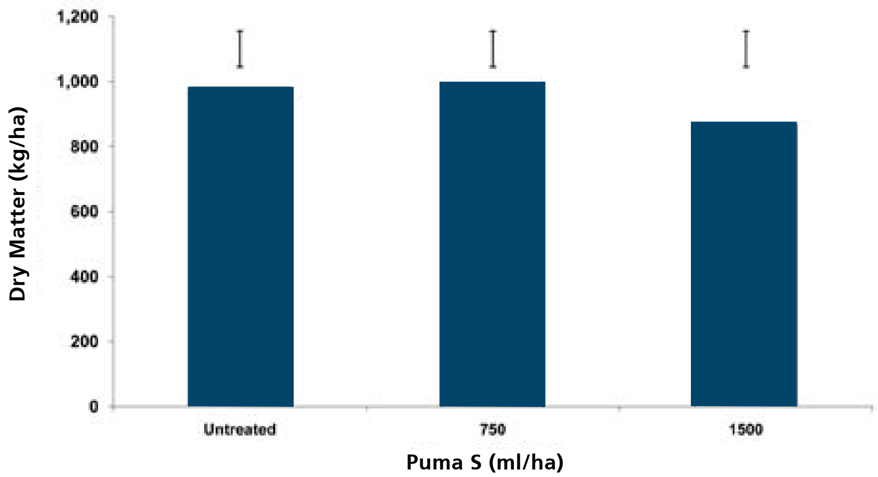
Figure 4. Ryegrass dry matter production (kg/ha) 3 weeks after application of Puma S herbicide. Recommended rate for Puma S in ryegrass seed crops is 750 ml/ha. LSD bars are shown. The graph shows that Puma S did not affect ryegrass production; DM production was similar for the untreated and Puma S treated plots.



Focus on international research

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

Farina and others (2011). Pasture-based dairy systems increasing milk production through stocking rate or milk yield per cow: pasture and animal responses.
Grass and Forage Science 66: 316-332

Australian research indicated that increasing milk production per hectare through a higher stocking rate made more effective use of supplements than using them to increase milk yield per cow. The higher stocking rate led to higher efficiency of conversion of supplements to milk. Cows in the systems targeting high milk yield per cow partitioned more of their energy intake to body condition. There was no effect of treatment on reproduction.

DairyNZ comment: These results are consistent with farm systems studies undertaken in New Zealand, in which supplements used strategically to fill feed gaps in high stocking rate systems were profitable.

Dessauge and others (2011) Effects of nutrient restriction on mammary cell turnover and mammary gland remodeling in lactating dairy cows. *Journal of Dairy Science 94:4623-4635.*

The study aim was to determine the effect of a severe nutrient restriction from two weeks before calving until 11 weeks post-calving on mammary gland physiology. Feed restriction decreased milk fat, protein, and lactose yields by approximately 40% and led to lower plasma insulin-like growth factor-1 and higher growth hormone concentrations. Restricted cows had lighter mammary glands and less total DNA, highlighting a decline in mammary cell number because of the feed restriction. In conclusion, nutrient restriction decreased milk yield in lactating dairy cows, due to decreased activity and number of mammary cells.

DairyNZ comment: These results are consistent with results from experiments in New Zealand, with the reduction in mammary cells and cell activity explaining, in part, why cows that are restricted in early lactation "do not peak". These results help predict responses to supplements when cows are restricted.

Dong and others (2011) Diet-induced bacterial immunogens in the gastrointestinal tract of dairy cows: Impacts on immunity and metabolism. *Acta Veterinaria Scandinavica 53:48*

Dairy cows are often fed high grain diets to increase milk production and this can cause ruminal acidosis. When this occurs, a bacterial endotoxin is released in the rumen and the large intestine. Resulting immune responses increase body condition score loss and reduce milk fat content and milk fat yield.

DairyNZ comment: When improperly fed, high grain diets can cause ruminal acidosis and are associated with low milk fat yield. Grains and other high starch or sugar feeds should be introduced gradually and not fed at more than 6 kg DM/day (in two feeds) except in exceptional circumstances.

Guinard-Flament and others (2011). Lactose in blood plasma and the ability of dairy cows to tolerate once-daily milking in terms of milk loss and milk recovery. *Journal of Dairy Science 94: 3446-3454.*

During once-a-day milking (OAD), cells in the udder become leaky, allowing the passage of lactose from milk into blood. This study reports that blood lactose concentration, measured before or during a short period of OAD, is not a suitable indicator of a cow's daily milk production or ability to tolerate OAD; however, it may be useful to predict a cow's ability to recover their milk production after switching back to twice-a-day milking (TAD).

DairyNZ comment: New Zealand studies demonstrate considerable variation between cows in their immediate and long-term milk production losses (%) due to short-term OAD. Differences between cows cannot be predicted by the daily milk production (kg) and composition during TAD; however, carry-over losses are less in cows that have smaller immediate production losses and greater daily OAD milk yields (kg). Several studies suggest that the greatest producers during TAD remain the greatest producers during and after a short period of OAD.