Issue 30

June 2016

Technical Series IN BRIEF

Kick-starting the milking season

Italian ryegrass as part of a pasture renewal plan can boost spring production

DairyNZ

COLOSTRUM MANAGEMENT | PASTURE MANAGEMENT RESEARCH | THE POTENTIAL OF GM FORAGES

Contents

For full versions of the papers presented in this edition of *Technical Series In Brief* visit

dairynz.co.nz/techseries

We appreciate your feedback

Email technicalseries@dairynz.co.nz or call us on 0800 4 DairyNZ (0800 4 324 7969). Alternatively, post to: Technical Series, Private Bag 3221, Hamilton 3240.

ISSN 2230-2395

DNZ04-030

Authors

David Stevens

David Stevens works as a senior scientist with AgResearch at Invermay in farming systems research. This latest research comes from the Pastoral 21 programme at the Telford Polytechnic farm.

Emma Cuttance

Emma Cuttance is a dairy cow veterinarian and researcher at Veterinary Enterprises in Te Awamutu. She is currently completing her Masters in Veterinary Science, majoring in epidemiology and writing a thesis on management of facial eczema in dairy cattle. Emma is passionate about doing trial work that helps farmers improve welfare and productivity on their farms.

Kevin Macdonald

Kevin is a senior scientist with DairyNZ and has focused on the underlying principles of efficient farm management. He is an advocate of low cost dairying ensuring that dairy farm systems are sustainable and focused on the underlying principles of efficient farm management. He was the co-author of 'Condition Scoring Made Easy' a highly successful booklet distributed to all NZ dairy farmers

Greg Bryan

Greg Bryan, principal scientist, at AgResearch Ltd is the science team leader of plant biotechnology in the Forage Improvement Group and is the chief technology officer of ZeaKal Inc, a plant biotechnology subsidiary. Dr Bryan is inventor on 12 issued and pending patent applications. He is currently focused on commercialising biotechnology applications in grass and legume forage species, and is leading a multidisciplinary team of scientists to develop high energy and increased biomass forage cultivars.

Italian ryegrasses can boost spring pasture production

Italian or short-rotation ryegrasses offer a pasture renewal opportunity which can kick-start the milking season, according to research led by AgResearch senior scientist David Stevens and scientist Andrew Wall.

Key findings

- Short rotation ryegrasses have greater cool season growth potential than perennial ryegrass.
- However, they have shorter lifespans and are less persistent.
- Using short-rotation ryegrasses as part of a pasture renewal strategy can boost spring pasture production, decreasing reliance on supplements.
- Researchers used shorter grazing intervals to maintain pasture quality.

David Stevens, AgResearch
Andrew Wall, AgResearch

Short rotation ryegrasses have potential to provide extra production to spring-calving dairy farm systems. They have a greater cool season growth potential[1,2] and have superior dry matter (DM) production over winter and early spring when compared with perennial ryegrass[3]. Some studies have also indicated that herbage may be of a higher feed value during the winter and early spring period[4, 5, 6].

Short-rotation ryegrasses could help address low pasture growth rates in early spring and their higher DM production could translate into increased pasture DM intake and increased milk production. The greater cool season activity of short-rotation ryegrasses also allows these species to take up more ▶

plant-available nitrogen (N) in the soil over late-autumn, winter, and early-spring, when the risk of N leaching is greatest[7, 8].

However, there has been little research done to test short-rotation ryegrass performance on farms, where environmental and managerial conditions can prevent pasture species growing to their full potential[9, 10, 11]. Also, short-rotation ryegrasses do have some drawbacks including typically having a short lifespan (1-3 years) and persistency issues in dry summer conditions, especially if over grazed in summer. From the limited number of paddock/whole-farm system evaluations using short-rotation ryegrasses on seasonal dairy farms, the results have varied considerably[2, 12, 13].

Based on this, the greatest benefit from short-rotation ryegrasses would probably be as part of a pasture renewal programme, augmenting perennial ryegrass-based pastures to meet feed supply requirements of seasonal spring-calving dairy farm systems.

Using short-rotation grasses as part of a pasture renewal programme

We evaluated early-spring pasture supply and milk production of a seasonal calving dairy farmlet, where 20-30 percent of the milking platform was planted in short-rotation ryegrass as part of an annual pasture renewal programme.

The trial was conducted at the Telford Farm Training Institute in Balclutha, New Zealand, as part of the Pastoral 21 Next Generation Dairy Systems research funded by MBIE, DairyNZ, Fonterra, DCANZ and Beef + Lamb NZ.

A 39ha demonstration farmlet was established carrying 110 cows over the milking season, peaking at 2.8 cows/ha during November. Planned start of calving was August 24, with an aim to have all cows calving at BCS 5 or greater. Cows were dried off in April/May at a minimum BCS of 3.5. The herd was rotationally grazed, with pasture and supplement allocated on a daily basis.

Both whole-crop cereal silage and short-rotation ryegrass (cultivars Shogun NEA endophyte and Tabu nil endophyte) were planted on this farmlet as complementary forages to the existing perennial ryegrass-based pastures. The crop (barley) was sown in mid-to-late November, harvested in mid-February, and fed to cows in autumn as a supplement to fill any feed supply deficit.

The short-rotation ryegrass was used as a two-to-three year pasture option following the crop and sown shortly after the crop was harvested.

More grass grown

Short-rotation ryegrasses provided more feed in spring, as was predicted (Table 1). This increase of 10kg DM/ha/day translated into more grazing days/ha, as reflected in the grazing record and the lack of supplement fed, but not significantly different milk production per cow (19.1kg compared with 19.2kg milk/day for perennial ryegrass pastures). This may have been due to the pasture allocation/grazing management processes, with frequent switching of grazing between the two pasture types.

Additional analysis, however, indicated an upward trend in milk production when more continuous grazing days of short-rotation ryegrass were able to be achieved in any two week period. This effect added another 0.103kg milk/day for every extra full grazing day. This indicates that a greater proportion of the farm should be sown in short-rotation grasses in order for their traits to be more fully expressed and to allow the cows to adjust to the different feed type. A balance between perennial and short rotation ryegrass will be best.

Table 1. Net pasture growth rates (kg DM/ha/d)

Season	Short-rotation ryegrass	Perennial pasture
Winter	6	7
Spring	47	37
Summer	37	39
Autumn	19	20

Managing short-rotation ryegrasses

The pasture growth of the short rotation ryegrasses was significantly greater in spring. However, more N fertiliser was used on the short-rotation ryegrass (approximately 60kg N/ha) than on the perennial pastures (approximately 30kg N/ha). The extra N was used in late spring to encourage the development of new tillers in the post-heading phase in an attempt to improve summer production and persistence. This would have boosted summer production of the short rotation ryegrass. Using the industry standard N response of 10kg DM/kg N, the extra N applied would equate to 3kg DM/ha/d grown by the short rotation ryegrass in summer. This may explain why there was no difference between the perennial and the short rotation ryegrass in summer, when lower production from short rotation ryegrass would be expected.

Winter growth of the short-rotation ryegrass appeared to be affected by the establishment technique. The planned approach of sowing after harvesting the crop led to relatively late sowing and emergence dates (late March and early April). This meant pasture was still too immature for grazing before autumn rains saturated the soil, resulting in the pastures entering winter as recently germinated seedlings. In the final year of the study, a change to under-sowing the crop with the pasture mix in spring created a pasture that provided two grazings in autumn, increasing total DM production of the short-rotation ryegrass. This tactic is also likely to improve pasture production in the first winter.

Due to the higher potential growth rate of short-rotation ryegrasses in spring, shorter grazing intervals were needed to prevent the rapid development of seedhead as pasture cover increased above approximately 2600kg DM/ha in spring. We found that, if left to accumulate above 3000kg DM/ha, the feed quality declined and the targeted post-grazing residuals of 1500 kg DM/ha were harder to achieve.

References

1. Thom, E. R., and A. M. Bryant. 1996. Use of Italian ryegrass on seasonal dairy farms in northern New Zealand: 2. Milk production. New Zealand Journal of Agricultural Research 39: 237-244.

2. Chapman, D. F., J. Tharmaraj, and Z. N. Nie. 2008. Milk-production potential of different sward types in a temperate southern Australian environment. Grass and Forage Science 63: 221-233.

3. www.nzpbra.org (accessed 18th March 2016)

4. Hickey, M. J., and G. S. Baxter. 1989. Winter feed value of 'Grasslands Moata' tetraploid Italian ryegrass in Southland. Proceedings of the New Zealand Grassland Association 50: 225-230.

5. Cosgrove, G. P., J. L. Burke, A. F. Death, M. J. Hickey, D. Pacheco, and G. A. Lane. 2007. Ryegrasses with increased water soluble carbohydrate: evaluating the potential for grazing dairy cows in New Zealand. Proceedings of the New Zealand Grassland Association 69: 179-185.

6. Sun, X. Z., G. C. Waghorn, and H. Clark. 2010. Composition and in sacco degradation characteristics of winter growth of Lolium perenne, Lolium multiflorum and Lolium perenne × multiflorum ryegrasses. Proceedings of the New Zealand Society of Animal Production 70: 206-212.

7. Monaghan, R. M., L. C. Smith, and R. W. Muirhead. 2016. Pathways of contaminant transfers to water from an artificially-drained soil under intensive grazing by dairy cows. Agriculture, Ecosystems & Environment 220: 76-88.

8. Selbie, D. R., L. E. Buckthought, and M. A. Shepherd. 2015. The challenge of the urine patch for managing nitrogen in grazed pasture systems. Advances in Agronomy 129: 229–292.

9. Jacobs, J. L., and S. L. Woodward. 2010. Capturing the benefits of alternative forages for increased dairy farm profitability, pp. 292-304. In: Meeting the challenges for pasture-based dairying (Eds. Edwards, G.R., Bryant, R.H.), Proceedings of the 4th Australasian Dairy Science Symposium, 31 August- 2 September 2010, Lincoln University, Christchurch, New Zealand.

10. Kerr, G. A., D. F. Chapman, E. R. Thom, C. Matthew, A. Van Der Linden, D. B. Baird, E. Johnston, and J. R. Corkran. 2012. Evaluating perennial ryegrass cultivars: improving testing. Proceedings of the New Zealand Grassland Association 74: 127-136.

11. Rawnsley, R. P., D. F. Chapman, J. L. Jacobs, S. C. Garcia, M. N. Callow, G. R. Edwards, and K. P. Pembleton. 2013. Complementary forages–integration at a whole-farm level. Animal Production Science 53: 976-987.

12. Brookes, I. M., and J. A. Lancashire. 1979. Production of milk and milk components by cows grazing different ryegrass cultivars. Proceedings of the New Zealand Grassland Association 41: 123-129.

13. Thom, E. R., and R. A. Prestidge. 1996. Use of Italian ryegrass on seasonal dairy farms in northern New Zealand: 1. Feed production and persistence. New Zealand Journal of Agricultural Research 39: 223-236.

Colostrum management: Giving calves a great start to life

Colostrum builds calves' non-developed immune systems which is essential for the future productivity of a herd. Why is it so hard to ensure calves get quality colostrum when they need it and what management practices can help? Vets Emma Cuttance and Katie Denholm explain.

Key findings

- Failure to absorb enough immunoglobulins from colostrum in the first 24 hours of a calf's life can make a calf susceptable to disease and death.
- This failure known as Failure of Passive Transfer (FPT), is relatively common.
- Good management practices can limit the chance of FPT (see page 6).
- Farmers can test for prevalence of FPT and for the quality of their cows' colostrum.

Emma Cuttance, Veterinarian
Katie Denholm, Veterinarian

Calves are born with a poorly developed immune system. Therefore, they must absorb immunoglobulins from colostrum across the intestinal wall to obtain immunity until their own immune system becomes functional. This process is most effective in the first 24 hours after birth and is often referred to as 'passive transfer'. Calves that fail to absorb enough immunoglobulin in those first 24 hours are said to have suffered from Failure of Passive Transfer (FPT).

FPT can result in increased mortality rates, disease and long-term reductions in animal productivity[1].

The prevalence of FPT in calves has been reported as being 19-40 percent worldwide[2, 3, 4, 5]. In 2015, a study using 4000 dairy calves from nine different regions across New Zealand indicated that the average prevalence of FPT at various intervals during the spring calving period was 33 percent, with prevalence on-farm ranging between five percent and 80 percent[6]. This indicates many calves are not getting enough good quality colostrum soon enough after birth.

Why do calves get failure of passive transfer?

- Feeding colostrum with inadequate levels of immunoglobulin.
- Feeding insufficient volumes of colostrum.
- Feeding colostrum too late after birth.
- Bacteria contaminating colostrum at harvest, during storage or at feeding. Coliforms (bacteria from faecal material) are the most detrimental of the bacteria for immunoglobulin absorption[7].

Why can feeding enough high quality colostrum be a challenge?

- Time and staffing constraints at calving time, especially with highly compact calving patterns, can make it difficult to ensure new born calves receive enough high quality colostrum shortly after birth. The 2015 study of 105 dairy farmers showed that only 22 percent pick up calves twice a day.
- Colostrum immunoglobulin concentrations and colostrum volumes are extremely variable in dairy cattle[8, 9, 10].
- Pooling colostrum is common practice on New Zealand dairy farms, but individual cow variation can result in low immunoglobulin concentrations.
- In the 2015 study, colostrum quality was found to be poor. Only 10 percent of the 298 colostrum samples, collected at multiple times during the calving season, had immunoglobulin concentrations over the recommended levels and only 11 percent of samples had acceptable bacterial contamination levels.

Leaving the calf on its mother versus tube-feeding – which is best?

Leaving a calf with its mother should ensure it gets fresh, warm, high quality colostrum very soon after birth, right? Not necessarily. National and international work suggests that:

- The risk of FPT is higher when calves are left to suckle dams compared with when they are removed promptly and fed enough high quality colostrum in the calf shed.
- If colostrum feeding and storage equipment is hygienic and pooled colostrum is 'clean' (low bacteria counts) and managed well, calves may be less likely to get health problems since the mother is a source of infection

Tubing animals means calves get a known quantity of colostrum within a known time frame but:

- It can lead to milk pooling in the rumen which leads to a poorer immunoglobulin absorption.
- Tube feeding poor quality, contaminated colostrum will increase the risk of FPT occurring.

Testing for failure of passive transfer

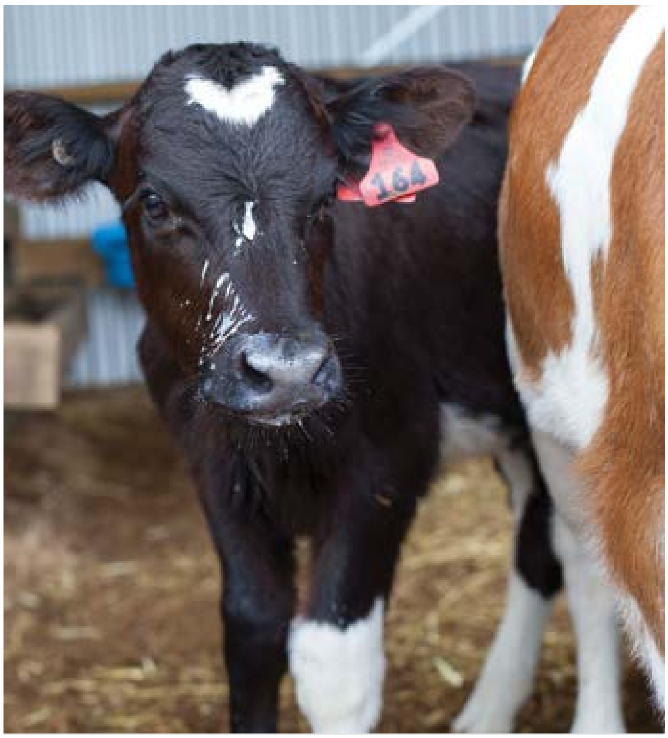
Regardless of whether calves are left on their mothers, every calf is tube fed or calves are put onto feeders, the following management steps can be taken to measure and prevent FPT:

Step 1:* *Test your calves for FPT

You can test for the prevalence of FPT by blood sampling 12 healthy calves (not scouring or dehydrated), between 24 hours and seven days of age, for laboratory analysis of total protein. It is recommended that this is done both at the beginning and peak of calving when the prevalence of FPT is typically higher.

Step 2:* *Test colostrum for quality

You can use a BRIX refractometer to test your colostrum quality. BRIX readings of over 22 percent indicate high quality immunoglobulin colostrum. You can start by testing the pooled colostrum. If this is of poor quality you will need to test individual cows as they will give very different results. Testing individual cows only takes 5 seconds using a BRIX refractometer and can be easily worked into your management protocols. ▶



Best practice management of calves

- Feed new born calves 10 percent of their bodyweight (4 for a 40kg calf) of "gold" colostrum within the first 6 to 12 hours of life[11]. It's most effective to give smaller feeds more frequently (i.e. two feeds within the first 12 hours of life).
- Test the quality of colostrum from individual cows and only feed new born calves gold colostrum from cows that have BRIX readings of over 22 percent. If pooling colostrum, select only healthy cows. Be aware that pooling colostrum increases the risk of infecting calves with contagious diseases such as Johnes.
- Use hot soapy water to clean all equipment and buckets, as this will remove colostrum fatty residues leading to bacterial contamination.
- Store colostrum in a lidded drum or vat and stir regularly. Ideally, colostrum should be refrigerated (at 4°C)[18 12].
- If refrigeration is not possible, add a chemical preservative agent to the colostrum, such as potassium sorbate at a rate of 1 percent by volume of a 50 percent solution. Colostrum should be fed within two to three days of collection.
- Continuing to feed colostrum to calves beyond the initial 24 hours (after the calf gut 'closes') may also have advantages, as immunoglobulin can bind to infectious agents in the gut, limiting disease prevalence and severity[13, 14]. It is also a highly nutritious feed.
- Vaccinating your herd three to six weeks before planned start of calving with a product such as Rotavec or Scourguard will boost specific antibody levels in colostrum.

References

1. Tyler, J. W., S. M. Parish, T. E. Besser, D. C. Van Metre, G. M. Barrington, and J. R. Middleton. 1999. Detection of low serum immunoglobulin concentration in clinically ill calves. Journal of Veterinary Internal Medicine 13: 40-43.

2. Wesselink, R., K. J. Stafford, F. J. Mellor, S. Todd, and N. G. Gregory. 1999. Colostrum intake by dairy calves. New Zealand Veterinary Journal 47: 31-34.

3. Beam, A. L., J. E. Lombard, C. A. Kopral, L. P. Garber, A. L. Winter, J. A. Hicks, and J. L. Schlater. 2009. Prevalence of failure of passive transfer of immunity in newborn heifer calves and associated management practices on US dairy operations. Journal of Dairy Science 92: 3973-3983.

4. Bielmann, V., J. Gillan, N. R. Perkin, A. L. Skidmore, S. Godden, and K. E. Leslie. 2010. An evaluation of Brix refractometry instruments for measurement of colostrum quality in dairy cattle. Journal of Dairy Science 93: 3713-3721.

5. Trotz-Williams, L. A., K. E. Leslie, and A. S. Peregrine. Passive immunity in Ontario dairy calves and investigation of its association with calf management practices. Journal of Dairy Science 91: 3840-3849.

6. Cuttance, E. L., W. A. Mason, K. S. Denholm, and R. A. Laven. 2016. Comparison of tests for determining the prevalence of FPT in New Zealand dairy calves. Submitted to New Zealand Veterinary Journal

7. Godden, S. M., D. J. Smolenski, M. Donahue, J. M. Oakes, R. Bey, S. Wells, S. Sreevatsan, J. Stabel, and J. Fetrow. 2012. Heat treated colostrum and reduced morbidity in preweaned dairy calves: Results of a randomised trial and examination of mechanisms of effectiveness. Journal of Dairy Science 95: 4029-4040.

8. Morrill, K. M., E. Conrad, A. Lago, J. Campbell, J. Quigley, and H. Tyler. 2012. Nationwide evaluation of quality and composition of colostrum on dairy farm in the United States. Journal of Dairy Science 95: 3997-4005.

9. Morin, D. E., P. D. Constable, F. P. Maunsell, and G. C. McCoy. 2001. Factors associated with colostral specific gravity in dairy cows. Journal of Dairy Science 84: 937-943.

10. Bartier, A. L., M. C. Windeyer, and L. Doepel. 2015. Evaluation of on-farm tools for colostrum quality measurement. Journal of Dairy Science 98: 1878-1884.

11. Vermunt, J. 2002. Calf rearing Part 1: Principles of calf rearing from birth to weaning. Vetscript 15(4): 4-6.

12. Stewart, S., S. Godden, R. Bey, P. Rapnicki, J. Fetrow, R. Farnsworth, M. Scanlon, Y. Arnold, L. Clow, K. Mueller, and C. Ferrouillet. 2005. Preventing bacterial contamination and proliferation during the harvest, storage and feeding of fresh bovine colostrum. Journal of Dairy Science 88: 2572-2578.

13. Lorenz, I., J. F. Mee, B. Earley, and S. J. More. 2011. Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal 64: 10.

14. McDougall, S., and A. Cullum. 1999. Effect of feeding colostrum of high immunoglobulin content on calf growth rates and disease. Proceedings of the Society of Dairy Cattle Veterinarians of the NZVA Annual Conference, pp. 33-45.

Back to the future – making pasture work for you this spring

DairyNZ senior scientist Kevin Macdonald and principal scientist John Roche explain why research performed decades ago is especially relevant this season.

You can manage cows through winter and spring without purchased feeds through:

- correct stocking rate
- achieving target pasture cover and crop yields
- achieving target cow body condition scores at the start of calving
- using the spring rotation planner which dictates area of the farm allocated/day.

Kevin Macdonald, DairyNZ
John Roche, DairyNZ

New Zealand's grazing system – *"the eighth wonder of the world"*

In the 1970s and 1980s, a team at Ruakura led by Dr Arnold Bryant undertook grazing experiments that were to revolutionise the way pasture was managed through winter and spring[1,2,3]. The system matched herd demand through assigning the correct calving date and stocking rate with a store of pasture (i.e. cover at calving) and crop and an assumed winter growth rate. Discipline in following recommended winter-spring rotation lengths meant that pasture growth and quality were maximised.

Cows were well fed and on a 'rising plane of nutrition' going into mating, and any feed deficits, due to colder or wetter than normal winter conditions, were small and short lived.

Considering the need to minimise expenditure this year, it is important to revisit this work and understand its applicability for farming today.

The four pillars of successful grazing

Bryant and his co-workers identified four important factors to optimise winter-spring grazing management:

Two were strategic:

1. Calving date
2. Stocking rate

Two were operational:

3. Autumn pasture management and the ideal cover at calving
4. Area allocated/day during winter and the development of the spring rotation planner

Strategic management decisions around stocking rate and calving date have already been decided for this season, but they should be reconsidered in spring to determine if they are optimum for future years.

At this point in time though, we can still optimise farm management through winter and spring and minimise our reliance on purchased feeds by focusing on pasture management.

1. Autumn pasture management and the ideal cover at calving

In 1984 Arnold Bryant reported that the objectives for autumn pasture management are to:

1. Provide sufficient high quality feed for early lactating cows
2. Ensure cows are at target body condition at calving.
3. These dual aims should be achieved with minimum pasture damage.

Adapting the recommendations of Bryant and co-workers, the optimum pasture cover at calving is 2,300-2,400kg DM/ha.

To establish optimum pasture cover in July-August,

a) rotation length needs to be extended from 40 days in April to 90 days a month before calving, where herds were wintered on-farm, or

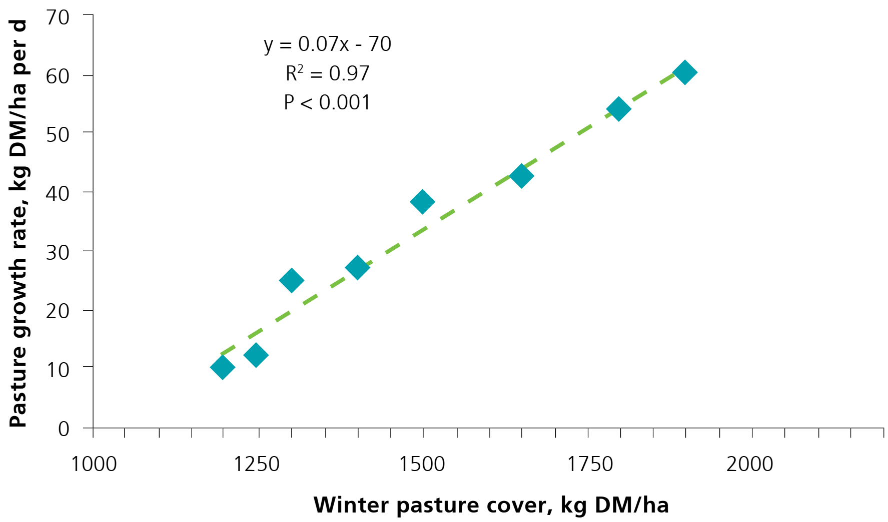
b) the majority of cows have to be removed from the farm for 60-75 days, if off-wintering.

In the Ruakura research, a rotation of 80-120 days between April/May and July resulted in 10-15 percent more milk before Christmas when compared with a rotation length of less than 50 days. This is because growth rate during winter increased with average pasture cover (Figure 1): for every 100kg DM increase in pasture cover, growth rate increased 7kg DM/day, providing the daily requirements of a dry cow or more than half the requirements of a milking cow during the first month in milk.

The increase in pasture cover at calving was a result of lengthening the rotation in the autumn and this was achieved by allocating a set amount of area/day for grazing using the autumn planner (Figure 2). The allocated area has to feed all stock on the farm, so the farmer needs to adjust the number of cows milking and dry to ensure a) dry cows are adequately fed to gain body condition and b) milking cows receive enough feed for maintenance and milk production.

As the area allocated/day declines each day, the number of lactating cows must decline also. The autumn planner assumes that growth rate equals herd demand during the month before calving. In warmer regions, the rotation length does not need to increase as early, while in colder regions cows must be removed from the milking platform to allow the farm to recover.

Figure 1. Relationship between pasture cover during winter and average pasture growth rate in the Waikato. For every extra 100kg DM/ha pasture cover, pasture growth rates increased 7kg DM/ha per day.



2. Spring pasture management

In 1986, Bryant and L'Huillier reported on an experiment which compared a low pasture cover at calving with an ideal scenario and investigated two management strategies:

a) maintain a slow rotation and allocate the available pasture each day, or

b) increase the area allocated to ensure that milking cows were well fed.

The main result of the experiment is presented in Figure 3. When the rotation was sped up, average farm cover declined and did not return to optimum until December. In other words, a short-term advantage in per cow feeding resulted in a large feed deficit for four months. In fact, for a 100ha farm, the difference in pasture availability was 178 t DM or approximately 500kg DM/cow (at 3 cows/ha). At $200/t DM, that is equivalent to more than $35,000/year.

Figure 2. The autumn planner dictates how much area can be allocated each day. This area is rationed between dry and lactating cows to ensure dry cows are allocated enough for condition score gain, while the milkers are allocated enough for maintenance and milk production. The provided example is a 100ha farm.

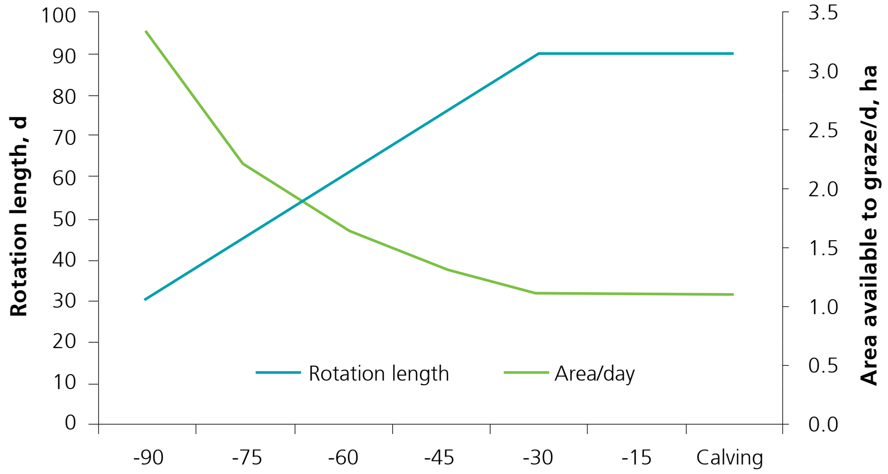
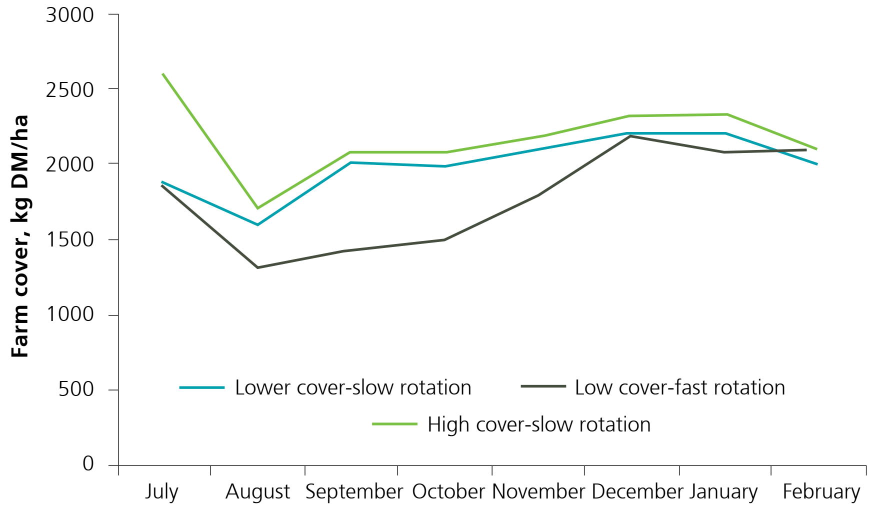


Figure 3. The effect of rotation length in a feed deficit during spring on the long-term pasture cover (i.e., feed availability). Maintaining a slow rotation will return pasture covers to the target much sooner than a fast rotation during a spring deficit. Even though feeding cows more may seem like the right thing to do (fast rotation), it will result in lower covers for longer and extend the length of time to balance date. Adapted from Bryant & L'Huillier (1986)[2].

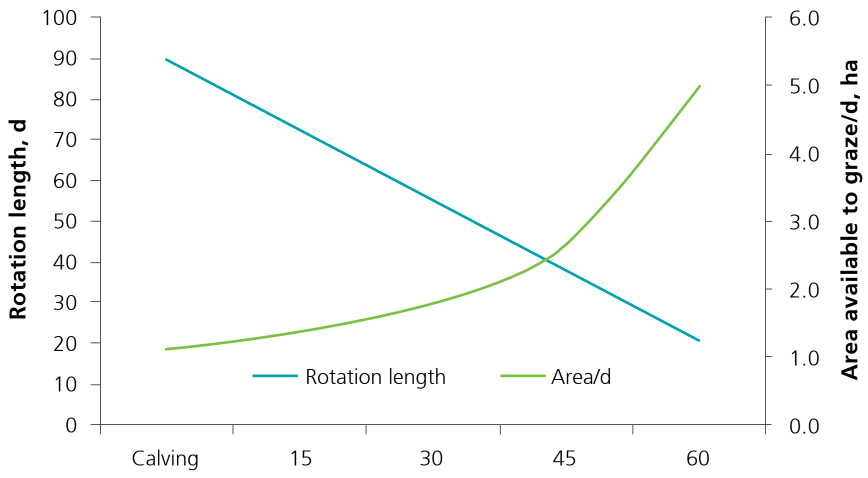


This experiment led to the development of the spring rotation planner (SRP), which took the 'guess-work' out of pasture allocation during spring. The SRP is ingenious in its simplicity. Like the autumn planner, the SRP assigns a specific area/day, and this area increases each day (Figure 4). At the outset, area allocated/day is small because all cows are dry. As the number of cows calved increases, so too does the area allocated. However, dry matter intake of milking cows is still low (approximately 13-15kg DM for a 500 kg cow). The SRP accounts for the increase in cow dry matter intake by rapidly increasing the area allocated/day from 30 days post-calving.

An important aspect of the SRP is that it can be used throughout New Zealand, irrespective of stocking rate, breeding worth of the herd, breed of cow, or amount of purchased feed used. A line between rotation length at calving and desired rotation length at balance date dictates how much of the farm should be grazed each day.

Detractors of the SRP refer to it in terms like 'controlled starvation'. This is nonsense! The SRP is a way to optimise pasture management. It does not determine whether you feed supplement or not. That is a decision each farmer must make based on feed availability at that time and looming feed deficits. However, by sticking to the SRP, you will minimise the size of the feed deficit and the amount of feed that will have to be purchased.

Figure 4. The SRP dictates how much area should be allocated each day from calving to balance day. The farmer must ration this area between dry and lactating cows. The area allocated increases with time, matching the increasing number of cows calved and the increasing dry matter intake of the cows. The provided example is a 100ha farm.



Conclusions

Although there is no recipe for farming, successful farm businesses have a strategic plan that limit their exposure to external forces. Biologically, this means a stocking rate and calving date that suits the pasture growth profile, while, from a business perspective, it means limiting risk to changes in variable expenses (e.g., purchased feed).

Vital components of this plan are the autumn planner and the spring rotation planner which both ensure that pasture growth and utilisation is optimised, and limit external risk as much as possible.

References

1. Bryant, A.M. 1984. Feed and management strategies at Ruakura. Proceedings Ruakura Farmers' Conference.38: 20-24

2. Bryant, A.M. and L'Huillier, P.J. 1986. Better use of pastures. Proceedings Ruakura Farmers' Conference. 40: 43-51

3. Bryant, A.M. 1990. Optimum Stocking and Feed Management Practices. Proceedings Ruakura Farmers' Conference. 42: 55-59

4. Bryant, A.M., and Macdonald, K.A. 1983. Relationships between amount of feed on the farm, and autumn-winter grazing management and cow performance. Proceedings of the New Zealand Society of Animal Production 43: 93-95

5. Macdonald, K.A. 1997. Profitable Dairying. The Dairyman. Supplement, occasional publication. September 1997

GM ryegrass plants regenerating in tissue culture prior to transfer to a containment glasshouse.

Superior forages could result from GM technology

Improving productivity through superior feed is vital for the dairy industry. AgResearch has developed genetically modified (GM) forages with dramatically faster growth rates and more metabolisable energy(ME). Limits on GM experimentation in New Zealand mean the next stage of research, field and animal trials, may take place off shore.

The work was led by AgResearch science team leader, plant biotechnology, Greg Bryan and principal scientist Nick Roberts.

Key findings

- It is essential to improve our forage species to increase productivity.
- Advancement in forage performance through plant breeding has created productivity gains of less than 1 percent a year.
- AgResearch has developed genetically modified (GM) forages with significantly greater energy content and growth rates.
- Results from glasshouse experiments indicate these forages could dramatically improve productivity at the same time as reducing greenhouse gas (GHG) emissions.
- Field and animal nutrition trials are necessary to confirm the value of these novel forages for New Zealand's pastoral industry.

Greg Bryan, AgResearch

Improving our feed supply

Have we maximised the productivity of our pastoral based system? Without new technology, the best farmers probably have. There are a number of farmers that could make increases in productivity by adopting existing technology and management practices. However, once done, they too will face limitations to further productivity gains.

So what technology could make major improvements in productivity without significantly increasing the cost of production or the environmental footprint of dairy farming? ▶

One answer is reducing the cost of our feed supply through better performance of our forages. In 2013, the cost of our feed supply was approximately $1.50 per kg milksolids[1]. This is the one area with significant potential to reduce cost.

It is no surprise then, that the pastoral sector in New Zealand places a strong emphasis on improving the performance of our forages. The genetics of perennial ryegrass and white clover are complex and provide a challenge for breeders trying to make improvements in dry matter yields and forage quality. The annual improvement in forage productivity has been below 1 percent and there is little evidence that this has led to improvements in animal nutrition[2].

AgResearch breakthrough

Recently, a significant breakthrough in forage biomass and energy concentration has been achieved by AgResearch using GM. The plant biotechnology team at AgResearch has developed a technology to enhance photosynthesis[3] in ryegrass plants by increasing levels of lipids (fat molecules) in leaves.

Growth rates faster

The crucial advance out of the technology named High Metabolisable Energy (HME) is significantly enhanced growth rates of these plants. Perennial ryegrass plants have been developed in the glasshouse that have 25-40 percent faster growth rates. This is due to increased CO_2 assimilation, so effectively more efficient photosynthesis. In a model plant species (the equivalent of the lab rat for plant scientists) called Arabidopsis, the increase in carbon assimilation is 24 percent[3]. In HME perennial ryegrass lines in Figure 1, the increase in carbon assimilation is 20 percent.

More metabolisable energy

HME ryegrass is also likely to have more ME (about 10 percent) available for conversion by animals. This has yet to be determined from animal feeding trials, however, in a trial of ram lambs, groups of animals were drenched with additional lipid to simulate HME forage. Lambs with a lipid intake of 8 percent ate 16 percent less forage than pasture-only control lambs but achieved the same live-weight gain. The forage conversion efficiency increase in the high lipid animals was 30 percent[4]. This experiment used ram lambs on ideal pasture. HME forages may have greater benefits for lactating animals.

The enhanced growth rates of HME ryegrass is demonstrated in Figure 1. Simulated grazing has been conducted in pot trials in the glasshouse. Over a period of 30 months plants were clipped every three to four weeks and allowed to regrow. The simulated grazing has been repeated over 30 times and the enhanced growth rate was consistent.

Figure 1. Ryegrass high metabolisable energy (HME) lines with biomass yield increase.

Simulated grazing trial: A. Shoots two weeks after cutting back. The first three rows of pots (WT, VC and DGAT) are control lines. The row of pots labelled WT are non-genetically modified ryegrass CV. Impact. The row of pots labelled VC are genetically-modified but do not contain the HME genes. The row of pots labelled DGAT are an early version of the HME technology and do not have the same biomass increase as the HME plants. The three independent genetically modified HME lines are the three rows of pots on the right (Lines 1 and 2 grow about 40 percent faster than the controls). B. Examples of the roots of the plants from panel A and the HME plants have significantly enhanced root systems.

How does HME work?

There is limited genetic variation in plants for leaf lipid levels and the normal level of lipids in forage plant leaves is about 3.5 percent. The HME technology enables the accumulation of seed like oil bodies in the green tissue of plants and increased lipid production. HME plants have 8 percent total leaf lipids and therefore more potential ME. The increased lipid production results in recycling of CO_2 in the cell which leads to significantly increased CO_2 assimilation. The enhanced photosynthesis results in accelerated plant growth (by up to 50 percent in some cases) and therefore more biomass and resulting dry matter.

Benefits for dairy production

It is unknown exactly how much of the enhanced growth rate and energy benefit measured in glasshouse experiments will translate to plants grown in the field. These experiments need to be performed in carefully designed replicated field trials in multiple environments over two or more seasons. It is important to determine if the plants are more or less susceptible to stress, insects, disease, have normal reproduction, and assess their response to water stress.

It will also be essential to conduct animal nutrition trials to measure animal performance, safety, metabolism, determine the fate of the additional lipids in animal products, measure greenhouse gas emissions and identify if there are any negative effects.

AgResearch has conducted modelling to explore the potential of HME forages in a dairy and beef and lamb production system. The modelling and laboratory work conducted so far includes the following potential benefits: a 12 percent increase in MS production, improvements in animal fecundity, possible increases in liveweight gains, 17 percent decrease in N_2O emissions, 15-30 percent decrease in methane emissions, more options for pasture management due to greater pasture growth rates, improved drought tolerance due to enhanced root systems and improved water use efficiency. It is also possible changes in milk and meat lipid composition may provide human health benefits due to an improved ratio of unsaturated to saturated fat.

The trade-offs for adopting GM crops in New Zealand

The arguments for and against the adoption of GM crops in New Zealand are numerous. To date, GM crops grown overseas do not provide a compelling value proposition for New Zealand as the species (corn, soybean, canola, cotton, papaya) are not significant crops in New Zealand. For these reasons there has not been a significant need to debate the merits of these technologies in New Zealand.

New Zealand forage species are specialised for temperate pastoral grazing systems and do not have the massive acreages of the main arable crops corn, soybean and cotton. This has meant that forages have not been a major focus of the developers of these arable crops. It has been necessary for New Zealand to develop technology directly applicable to its pastoral grazing system. The HME technology developed by AgResearch using government funding is 'home grown' and free from any commercial constraints of the main GM crop producers.

AgResearch is currently investigating options to test these forages offshore with a tentative start date of 2017.

References

1. DairyNZ Economic Survey 2014-15 dairynz.co.nz/publications/dairy-industry/
2. Crush, J. R., S. L. Woodward, J. P. J. Eerens, and K. A. Macdonald. 2006. Growth and milk solids production in pastures of older and more recent ryegrass and whiteclover cultivars under dairy grazing. New Zealand Journal of Agricultural Research 49: 119-135.
3. Winichayakul, S., R. W. Scott, M. Roldan, J-H. B. Hatier, S. Livingston, R. Cookson, A. C. Curran, and N. J. Roberts. 2013. In Vivo Packaging of Triacylglycerols Enhances Arabidopsis Leaf Biomass and Energy Density. Plant Physiology 162: 626-639.
4. Cosgrove, G. P., C. B. Anderson, T. W. Knight, N. J. Roberts, and G. C. Waghorn. 2004. Forage lipid concentration, fatty acid profile and lamb productivity. Proceedings of the New Zealand Grassland Association 66: 251-256.

Science snapshot

DairyNZ levy funded or supported science

Grazing dairy cows have decreased immune function during the first week after calving[1]

During the transition from pregnancy to lactation, the functioning of the immune system is altered in high-yielding dairy cows in housed systems overseas. These changes coincide with an increased risk of mastitis and metritis. An experiment was undertaken to understand what happens to cows' immune system during calving in New Zealand.

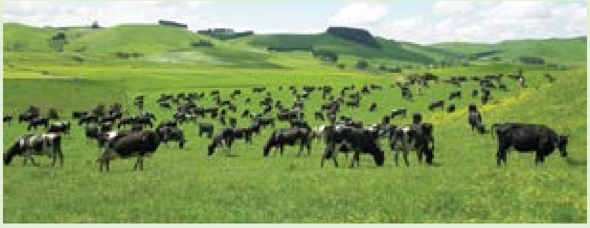
Grazing dairy cows were serially blood sampled between three weeks before calving and three weeks after calving. The profile of immune cells was determined to see if they changed across calving and the effectiveness of the immune system was assessed by challenging cows' blood in the laboratory.

The number of immune cells involved in the production of antibodies (known as B cells) was greater post-calving compared with pre-calving, as expected because of the increased production of antibodies for colostrum production. The number of immune cells that react quickly to infected or stressed cells (known as Natural Killer cells) also increased post-calving - a response that has previously been linked to endometritis. When activated, immune cells produce chemical messengers called cytokines that help the immune system to do its job. The level of these compounds can be used to evaluate the effectiveness of the immune system. In this study, shortly after calving, the production of these chemical messengers decreased, while the production of cytokines associated with 'dampening' the immune effect increased. Although the capacity of the immune system to function properly returned to normal during the first month after calving, the results reflect a state of reduced immune function in moderate-yielding, pasture-based transition cows, which is similar to that described for higher-yielding housed cows. Understanding this change in immune function will increase our ability to prevent infectious diseases.

Treatment with a nonsteroidal anti-inflammatory drug after calving may improve transitioning[2]

The metabolic changes that the dairy cow must undergo around calving are significant and cows mobilise large amounts of body condition (energy reserves)to meet the greater energy needs, particularly during the first week post-calving. Excessive condition score loss, however, is associated with greater metabolic disease and reduced milk production and reproduction. In addition, large-scale mobilisation of body condition can create a chronic inflammation, similar to that experienced in human obesity, increase maintenance costs and reduce the ability of important tissues to do their job (e.g., the liver to produce glucose). This study investigated the effect of administering a non-steroidal anti-inflammatory drug (NSAID) during the first week after calving on liver and adipose tissue function.

Results indicate that cows had a chronic inflammation post-calving and that the mobilisation of body condition was contributing to this inflammation. The natural inflammatory state that occurs after calving was not affected by NSAID administration. However, the NSAID did alter the expression of key genes in the liver that indicated an improvement in the cows' ability to produce glucose and to manage the large amount of fat coming from body condition mobilisation. Further research is required to determine strategies to manage the chronic inflammation in grazing dairy cows post-calving.



References

1. Heiser, A., A. McCarthy, N. Wedlock, S. Meier, J. Kay, C. Walker, M. A. Crookenden, M. D. Mitchell, S. Morgan, K. Watkins, J. J. Loor, and J. R. Roche. 2015. Grazing dairy cows had decreased interferon-γ, tumor necrosis factor, and interleukin-17, and increased expression of interleukin-10 during the first week after calving. Journal of Dairy Science 98(2): 937-946.

2. Vailati Riboni, M., S. Meier, N. V. Priest, C. R. Burke, J. K. Kay, S. McDougall, M. D. Mitchell, C. G. Walker, M. Crookenden, A. Heiser, J. R. Roche, and J. J. Loor. 2015. Adipose and liver gene expression profiles in response to treatment with a nonsteroidal antiinflammatory drug after calving in grazing dairy cows. Journal of Dairy Science 98(5): 3079-3085.