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Foreword

G'day..!

On behalf of the Organising Committee I would like to welcome you to the 2016 Australasian Dairy Science Symposium (ADSS) to be held at main campus of The University of Sydney, NSW, Australia from 16th to 18th November 2016.

The ADSS is a biennial event held alternatively in New Zealand (previously Hamilton in 2014) and Australia (previously Melbourne in 2012).

At the 7th Australasian Dairy Science Symposium, it will be our greatest pleasure to showcase the very latest advances in all aspects of dairy science across the Australasian region!

The University of Sydney is a proud research, teaching and education/training provider in all aspects of dairy science. At ADSS2016 we will put together a wide-ranging, enriching and exciting program featuring keynote presentations from Europe, North America, and the Australasian region on plant and animal sciences and productive and sustainable farm systems.

For international participants, there is hardly a better place in the world to visit at that time of the year than beautiful Sydney..! You may want to plan ahead and bring your family for a holiday to experience the incredible beauty of this magnificent city, its harbour, pristine beaches and so many other attractions....And why not use the opportunity to extend the trip and visit other places in Australia!

Professor Sergio (Yani) Garcia
Chair, Organising Committee
ADSS 2016



Conference Organising Committee

Cameron Clark	University of Sydney
Danny Donaghy	Massey University
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The Australasian Dairy Science Symposium wishes to acknowledge the outstanding support of the following organisations:



ABSTRACT THEME:

Cows, Plants and Interactions

Dry Matter intake and feeding behaviour of grazing dairy cows offered a mixed ration with or without canola meal

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Variation in dry matter intake (DMI), feeding behaviour and milk production were measured in grazing dairy cows fed partial mixed rations with (PMR+C) and without (PMR-C) canola meal. In each of spring (early lactation) and autumn (late lactation) 32 Holstein-Friesian dairy cows were offered two amounts of the two diets in 2x2 factorial experiments lasting 24 d. Amounts of supplement were low (8 and 6 kg DM/cow.d for spring and autumn, respectively) versus high (14 and 12 kg DM/cow.d for spring and autumn, respectively). The PMR-C ration comprised wheat grain (60%, DM basis), maize grain (19%) and lucerne hay (22%). The PMR+C ration was the same except some wheat grain was substituted with canola meal (22%). Both rations were isoenergetic with a grain to forage ratio of 78:22 (DM basis).

All cows were also offered a restricted pasture allowance (11 and 13 kg of DM/cow.d to ground level, in spring and autumn, respectively). These experiments found that the variation in total DMI among cows was approximately 12% (CV, range 10.3 to 27.4 kg DM/cow.d) and this variation was not affected by ration type or amount of supplement. Reducing the amount of supplement increased pasture eating time and a subsequent increase in pasture DMI. While feeding PMR+C tended to increase overall eating time ($P < 0.077$), there was no corresponding increase in total DMI or milk production.

This research suggests that altering ration type and amount of supplement are not strategies to consider when trying to reduce the variation in intake among cows.

Milk production from late lactation cows grazing temporally and spatially separated monocultures of plantain and pasture

Lisa Box¹

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¹ Lincoln University

Feeding dairy cows a diet of 50% plantain (*Plantago lanceolata*) as spatially separated monocultures with perennial pasture has been shown to increase milk production and reduced urinary N output compared to feeding ryegrass-white clover pasture alone. However, pure swards of plantain and pasture in the same paddock may be difficult to manage, and alternative herbage allocation methods are sought.

This study measured milk production and urine-N concentration for late lactation dairy cows offered a daily allocation of 50% plantain and 50% pasture either as (1) spatially separated monocultures in the same paddock (spatial separation), or (2) plantain allocated following morning milking and pasture allocated following afternoon milking (temporal separation). There were 3 replicate groups of 4 cows in each treatment, with cows offered a total daily allocation of 30 kg DM/cow/day above ground level over a 14 day period. Milk solids production was greater ($P=0.001$) for spatial (1.53 kg MS/cow/d) than temporal (1.37 kg MS/cow/d) separation.

Apparent DM intake (15 kg DM/cow) and urine N concentration (g N/L) was similar between treatments. Under conditions of the experiment, allocating plantain temporally resulted in lower milk production. When offering a diet of 50% plantain - 50% pasture, this experiment suggested allocation for greatest milk production is best achieved through spatial separation.

Milk yield and milk composition varies with milking order for pasture-based dairy cattle.

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Pasture varies in its chemical composition from leaf to stem and cattle prefer to eat the leaf fraction. In pasture-based dairy systems, cows predominantly walk back to pasture voluntarily after each milking, with the first cattle arriving to pasture hours before the last.

Here we discover the impact of milking order on milk yield and milk composition for dairy cattle offered grazed ryegrass pasture across two experiments. For the first experiment, individual cow milk yield data were recorded for six farms over 8 months. Cows milked first produced, on average, 4.5L/cow/day more ($P<0.01$) than those cows milked last in the order, equating to 20% more milk volume. Differences in milk production from the first to last cows between farms ranged from 14 to 29%.

In experiment 2, the impact of milking order on milk composition was determined in addition to milk yield for three of the six farms. The first cows in Farm 1 produced more ($P<0.05$) milk (8%), protein (12%), and SNF (4.5%) yield and less lactose (1.9%) content. For Farm 2, the first cows produced more milk (11.3%), SNF (7.4%) and lactose (7.1%) yield and less milk protein (1.9%) and SNF (3%) content. For Farm 3 the first cows produced milk with greater fat (5.7%) and protein (2.7%) content. This work highlights the opportunity to optimise pasture allocation within herds to increase nutrient use efficiency for improved farm profit and environmental outcomes.

Perennial ryegrass breeding and the scaling issue: A review of systems experiments investigating milk production and profit differences between cultivars

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A review of published systems studies was undertaken to investigate the ability of improved ryegrass cultivars to impact on animal production and profitability at a farm level. In New Zealand, DairyNZ have developed the forage value index, an evaluation system that ranks ryegrass cultivars according to their estimated impact on the profit of dairy farm businesses relative to older ryegrass cultivars.

Advances in plant breeding have resulted in substantial genetic gains that have improved herbage yield and nutritive value, along with plant persistence and animal health. However, there is a lack of documented evidence that using improved ryegrass cultivars will result in increased animal production and profitability at the farm level; consequently many farmers lack confidence in pasture renewal programs.

A number of previously-published systems studies, due to compromises or complications in design or management, have resulted in masking or enhancing differences due to unfair comparisons between cultivars, leading to inconclusive results. This review addresses these management and methodical issues and identifies how future systems studies could be better managed to allow genetic differences between cultivars to be expressed and animal production responses from cultivars to be achieved. This review will inform a proposed systems study that aims to provide evidence that the assumptions used to calculate forage value index values are robust and realistic under farm management conditions.

Social dominance and milk production of grazing dairy cows offered herbage at low and high allowance

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¹ *Lincoln University*

This experiment examined whether separating dominant and subordinate cows affected production and behaviour, and the relationships between dominance and production measures, by using grazing cows, offered herbage at low and high herbage allowance. In experiment 1, a total of 252 multiparous Friesian x Jersey dairy cows in 3 groups grazing perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.) pasture were observed for 3 months to determine their dominance value.

Dominance was positively correlated with age, live weight and milk production. In experiment 2, 48 cows that were classified as dominant and subordinate from experiment 1 on basis of aggressive interactions were divided by two factors; i.e. dominant and subordinate cows grazed together or apart with high (16 kg DM/cow/day above 3.5 cm) or low high (12 kg DM/cow/day above 3.5 cm) herbage allowance.

Milk yield and milk solid production were greater in dominant than subordinate cows (16.55 vs. 13.72 kg/cow/day and 1.58 vs. 1.33 kg MS/cow/day), but unaffected by whether dominant and subordinate cows grazed together or apart. Dominant cows spent more time lying than subordinate cows. The results suggest social dominance affects milk production of cows, but there was no benefit of separating cows based on dominance value even when low allowance enhanced competitive interactions.

Demonstrating the value of herd improvement

Michelle Axford¹

¹ *Australian Dairy Herd Improvement Scheme*

For over 30 years, Australian farmers have steadily achieved genetic progress for Balanced Performance Index; an economic index that includes milk, fat, protein, survival, fertility, cell count, milking speed, temperament, feed saved and type traits. Currently, the rate of genetic gain for Holsteins is \$8.10 profit/cow/year (\$11.40 and \$9.00 for Jersey and Red Breeds respectively) (ADHIS, 2015). However, progress could be more than double (Lacey and Coats, 2013).

ImProving Herds is a large scale collaborative project that aims to equip Australian dairy farmers to make quick, clever decisions to increase herd performance and deliver increased profits.

Over the life of the three year project, researchers will conduct a series of investigations in co-operation with thirty-four focus farms spread throughout dairying regions of Australia. Investigations include a cost:benefit analysis of genotyping heifer calves, the relationship between genomic based breeding values and first lactation performance, the performance of high versus low genetic merit animals and the value of herd recording to improved farm performance and profit.

This paper describes the selection and initiation of focus farms and early findings.

Diurnal variation in urine nitrogen concentration

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¹ *AgResearch Ltd*

In pasture-based dairy production systems urine patches are the main source of nitrogen (N) losses via leaching or volatilisation. We tested the hypothesis that urine N concentration would vary throughout the day, associated with patterns in feed intake and digestion. Such variation would identify scope for feeding management as an option for reducing N leaching. Eighteen groups (9 in autumn and 9 in spring) of multiparous Friesian x Jersey cows (n=6; 220±26 and 228±24 days-in-milk, in autumn and spring, respectively) were sequentially withdrawn from the main herd and managed as a single group grazing ryegrass-only pasture for 3 days.

Cows were offered a fresh allocation of pasture after each milking, sufficient to consume 16 kg DM/cow/d. On day 3, urine samples were collected at 7:00 am (morning milking), 11:00 am, 3:00 pm (afternoon milking) and 6:00 pm, and subsequently analysed for the concentration of N. The concentration of N was higher ($P<0.001$; $LSD=0.6$) at 11:00 am (6.5 g N/L) and 6:00 pm (6.0 g N/L) than at either 7:00 am (5.4 g N/L) or 3:00 pm (5.1 g N/L).

The concentrations of N were higher in urine samples collected approximately 3 hours post allocation of fresh feed when cows have grazed actively and consumed the majority of the herbage available, than prior to feed allocation. This suggests that feeding management, such as removing cows to stand-off after 2-3 h grazing, could reduce N losses by reducing the deposition of high-N concentration urine.

Methane emissions from dairy cows fed fodder beet

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The use of fodder beet in New Zealand (NZ) dairy farming is increasing because it has high yield per hectare, high nutritive value, low nitrogen content and is adapted to most climatic regions of NZ. Fodder beet has a very high non-fibrous carbohydrate concentration which could affect rumen fermentation and reduce enteric methane emissions.

The objective of the current study was to determine methane (CH₄) emissions from dry dairy cows grazing either fodder beet with 6 kg grass silage dry matter (DM)/d or forage kale with 3 kg barley straw DM/d (Exp. 1) and from dairy cows in early lactation grazing ryegrass dominated pasture alone or supplemented with 3 kg DM/d of fodder beet bulbs (Exp. 2). All CH₄ measurements were made using two GreenFeed automated head chamber systems and DM intakes (DMI) of individual cows were calculated based on energy requirements for maintenance and production.

Measurements were from 22 animals per treatment for 18 d during August/September 2015 (Exp. 1) and from 16 animals per treatment for 19 d during November/December 2015 (Exp. 2). Dry cows grazing fodder beet produced 17% less CH₄ (g/d) and had 27% lower CH₄ yield (g/kg DMI) compared with cows grazing forage kale. Lactating cows supplemented with fodder beet bulbs produced 12% less CH₄ (g/d), had 3% lower CH₄ yield (g/kg DMI) and 14% lower CH₄ intensity (g/kg milk fat + protein) compared with cows grazing pasture only. These results imply that feeding fodder beet to dairy cows can mitigate their methane emissions.

Milksolids production of dairy cows grazing lucerne, pasture and lucerne-pasture temporal forage allocations.

Grant Edwards¹

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Milk production, milk composition and urinary nitrogen excretion of dairy cows fed pure lucerne, perennial ryegrass-white clover pasture or a temporal sequence where lucerne was offered in the morning and perennial ryegrass-white clover pasture in the afternoon. Three grazing trials were carried out on an irrigated site in early (one trial, Early) and mid-lactation (two trials, Mid1, Mid2). In each 14 day trial, 3 replicate groups containing 6 cows, were transitioned to each treatment prior to measurement. Once transitioned, milksolids (MS) production was unaffected by pasture treatment in all three trials, averaging, 2.31, 1.90, and 1.68 kg MS/cow/d for Early, Mid1 and Mid2, respectively.

Although milk yield was higher in pure lucerne than pasture during Mid1 (22.7 vs 20.2 litres/cow/day respectively), this was offset by lower milk protein percentage in lucerne (3.67%) than pasture (4.03%) so that total milksolids production was similar across treatments. Despite no differences in milk production, there was consistently higher urine N concentration and estimated urinary N output g/day in lucerne (359 to 408 g/d) and the lucerne-pasture temporal allocation (234 to 312 g/d) than pasture (146 to 263 g/d). These findings show that under irrigation conventional ryegrass and clover pasture offers fewer production and environmental risks compared with lucerne pasture

Nutritive characteristics and selection by dairy cows grazing four perennial pasture grasses

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Previous research has documented nutritive characteristics and selection differentials for dairy cows grazing perennial ryegrass (*Lolium perenne* L.) based pastures, but there has been little comparable research on alternate pasture grasses.

The aim of this study was to compare nutritive characteristics and selection differentials achieved by dairy cows grazing four pasture grasses in late winter and late spring. The study utilised an established field experiment with four replicates of monoculture swards of perennial ryegrass (cv. Bealey), cocksfoot (*Dactylis glomerata* L. cv. Savvy), prairie grass (*Bromus willdenowii* Kunth. cv. Atom) and tall fescue (*Festuca arundinacea* Schreb. cv. Jethro) at Ellinbank in west Gippsland, Victoria. Eighty individual tillers per plot were sampled to ground level immediately pre- and post-grazing in late winter (July-August, vegetative tillers only) and late spring (November-December, vegetative and reproductive tillers sampled separately) 2015. Tillers were dried at 65°C for 72 h, with nutritive characteristics determined by near-infrared spectroscopy.

For vegetative tillers in both seasons, perennial ryegrass had the highest metabolisable energy (ME) concentration and lowest neutral detergent fibre percentage of all species. The selection differentials for vegetative tillers varied across species and seasons but were highest for crude protein percentage while there was little evidence for selection of higher ME concentration. The selection differentials reflected the vertical distribution of nutrients in the tillers.

In spring, reproductive tillers had consistently lower nutritive characteristics compared to vegetative tillers. These results provide new information to assist in developing grazing guidelines for alternate pasture grasses.

Quantifying the ruminal degradation of nutrients in three cultivars of perennial ryegrasses sampled in early spring

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The Australian dairy industry is characterised by pasture-based feeding systems, with supplementary feeding used at times of the year when pasture quality and quantity are limiting. Perennial ryegrass (PRG) is the pasture species most commonly used on farms in south-eastern Australia, with a range of cultivars available. Perennial ryegrass cultivars differ in ploidy status (diploid or tetraploid), flowering date and endophyte inoculation status, all of which influence the productivity and persistence of each cultivar.

The objective of this experiment was to quantify the rate of ruminal degradation of nutrients in three contrasting PRG cultivars (Victorian SE, Bealey NEA2 and Trojan NEA2) harvested in early spring from three dairying regions of Victoria, all with contrasting environments (Gippsland, northern Victoria and south-west Victoria). Ruminal nutrient degradation was determined by *in situ* incubation of nylon bags containing these cultivars in the rumen of six non-lactating, rumen-fistulated Holstein-Friesian cows.

Initial results for DM loss across the three regions for Victorian SE, Bealey NEA2 and Trojan NEA2 were 90.5%, 92.4% and 89.8% after 72 h, respectively. After incubation for 8 h, DM loss was greater than 50% for all cultivars across the three regions. Results for organic matter (OM), nitrogen (N), acid-detergent fibre (ADF) and neutral-detergent fibre (NDF) will provide a more comprehensive degradation of nutrients in these cultivars during early spring.

These results will complement data of the nutritive characteristics of PRG cultivars to assist in determining optimal feeding strategies for grazing dairy cows by complementing nutrient supply from supplements with that from pasture.

The effect of pre-graze mowing on milk production of dairy cows grazing diverse pastures managed under contrasting spring defoliation regimes

Grace Cun¹

Grant Edwards¹ and Racheal Bryant¹

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Strategies to increase herbage DM production are sought for dairy systems. One proposed strategy is tactical spring defoliation with higher post-grazing heights. However, the effect of these strategies on milk production needs to be determined. Irrigated, diverse pastures in Canterbury NZ containing perennial ryegrass, white clover, chicory, plantain and lucerne were managed over two grazing rotations in spring under normal (grazed to 3.5 cm), or lax management (grazed to 5 cm and allowed to grow until early inflorescence development of ryegrass). On the third grazing rotation, a milk production study was conducted.

Thirty six, mid lactation Friesian x Jersey dairy cows were allocated to three replicates, each containing four cows. Cows were randomly allocated to three treatments: (1) normal grazing (NORM); (2) lax grazing of standing herbage (LAX); (3) lax grazing with pre-grazing mowing of herbage (MOW). Cows were offered a daily herbage allocation of 35 kg DM/cow above ground level, with milk production measured over 8 days. Pastures managed under lax management had higher pre-grazing herbage mass (~3622 kg DM/ha) than pastures managed under normal management (2641 kg DM/ha) but all treatments had similar ME (12.18, 12.31, 12.26 MJ ME/kg DM for LAX, MOW, NORM, respectively).

Milksolids production was lower for cows grazing pastures managed under LAX and MOW (2.42 and 2.33 MS/cow/day, $P < 0.001$, respectively) compared to NORM (2.53 MS/cow/day). Results suggest that grazing management to leave higher post-grazing height resulted in lower milk production and that this was not improved by pre-graze mowing.

The role of stoloniferous red clover cv. Rubitas in establishing irrigated grass based pastures

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Irrigated dairy pastures go through three phases, establishment, production and decline. What occurs during the establishment phase influences the subsequent phases. In established productive pasture a symbiotic relationship exists between clover root nodules and the nitrogen (N) fixing bacteria rhizobia. Nitrogen becomes available to grasses during the production phase, as roots are replaced or nodules are cast off. During the establishment phase, grass/clover root interactions are less understood.

In a series of pasture establishment experiments red clover (RC; *Trifolium pratense*) cv. Rubitas and white clover (WC; *T. repens*) cv. Bounty were sown as companion legumes with perennial ryegrass (PRG; *Lolium perenne*) cv. Reward, phalaris (PA; *Phalaris aquatica*) cv. Advanced AT and Atlas, and coloured brome (CB; *Bromus coloratus*) cv. Exceltas. Pot experiments, showed Rubitas when sown with PRG or PA compared to PRG or PA sown alone, produced higher grass DM yields. A field experiment also showed Rubitas sown with PRG increased grass yield during the establishment phase compared to PRG sown alone.

In comparison, WC cv. Bounty sown with grasses showed no increase in grass yield during establishment, compared to grasses sown alone. Preliminary results suggest Rubitas increases the yield of companion grasses during the establishment phase, although by what mechanism is unknown. Establishing legume roots have been shown to exude substances reported to attract bacteria required for nodulation. The increased yield of establishing grasses sown with Rubitas could be attributed to grass roots sharing clover root exudates.

Future research will investigate possible sharing interactions.

ABSTRACT THEME:

Feed Production and Feeding Systems

A decision support tool for autumn management

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A successful pasture-based system is based on matching feed supply and feed demand in a profitable manner. Making the right management decisions in autumn is essential, not just to optimise current season performance but to ensure key performance indicators such as cow body condition score or average pasture cover are not compromised in the upcoming season.

There are many tactical management strategies to consider during autumn to ensure performance and profitability is maximised in the current and next season (e.g., feeding crops, purchasing or using available supplementary feeds, reducing milking frequency, grazing young stock, culling, or drying off cows). The complexity of trade-offs between all these factors from January to calving, and the need to assess the impact of each of these on seasonal performance led to the development of the DairyNZ Autumn Management Calculator.

The calculator is an energy- based model that calculates the profitability of different management strategies in pasture-based systems. Feed demand is initially set to ensure target body condition is achieved, and can then be altered using variables such as milking frequency, number of cows in milk and stock grazing on-farm. The assumption is made that energy supply comes from grazed pasture and crop first, followed by conserved forages, with the opportunity to fill gaps with purchased feed.

Ultimately, the Autumn Management Calculator acts as a decision support resource for farmers during this period by comparing the economics of different management strategies in the current season.

Effect of moisture stress on the growth and recovery of four perennial ryegrass cultivars

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The effect of moisture stress on single perennial ryegrass plants of four cultivars (Aberdart AR1, Bealey NEA2, One50 AR37, Trojan NEA2), was investigated in root tubes from mid-April to the end of June. During the six week treatment period, well watered plants received 500 mls daily while water was withheld from moisture-stressed plants. During the four week recovery period, all plants received 500 mls three times each week.

At the end of the treatment period, there were differences between cultivars in tiller production, shoot mass, water soluble carbohydrate (WSC) content of shoots, and root mass. However, there was no effect of moisture stress on these variables.

At the end of the recovery period, previously moisture-stressed plants showed an increase in leaf emergence by 39%, shoot mass by 29%, and low molecular WSC content of shoots by 31% compared to unstressed controls, but a decrease in root mass (at a depth of 30-60 cm) by 33%. There were differences between cultivars in tiller production and in WSC content of shoots. The effect of moisture stress on root depth depended on the cultivar.

The effect of moisture stress on growth was similar for most cultivars, and was greatest during the recovery period. Management guidelines often focus on avoiding overgrazing during drought. The results suggest that avoiding overgrazing immediately after drought may be just as critical for recovery given that the greatest responses to moisture stress were detected during this period.

Genetic gain in perennial ryegrass

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The Australasian dairy industry is largely based on grazed pastures dominated by perennial ryegrass. While genetic gain in animals has been a major source of productivity gains, genetic gain in perennial ryegrass is less well understood and poorly quantified.

The key question being addressed in this experiment is: how much gain has been achieved in whole pasture production from perennial ryegrass breeding, from the 1970's to the present day?

Twenty-four perennial ryegrass cultivar/endophyte combinations spanning four decades of plant breeding (from Nui released in 1970 to modern day material) were sown with white clover, in a pasture field trial at two sites in New Zealand, Waikato and Canterbury.

Cultivars included mid-, late- and very late-flowering diploids, and late- and very late-flowering tetraploids which allowed genetic gains over time within functional types and genetic gains delivered by broadening the range of functional types (notably, into late-flowering diploids and tetraploids) to be determined.

Data on seasonal and annual dry matter yield, and changes in pasture nutritive value resulting from direct manipulation of ryegrass characteristics (such as heading date, or ploidy) or indirect outcomes (e.g. grass-clover interaction) were collected. Economic values were applied to performance data providing an estimate of the economic merit of each cultivar allowing the gains in expected farm profit, resulting from improved pastures genetics, to be quantified.

Milk production and urinary nitrogen excretion of dairy cows fed increasing levels of fodder beet bulb as supplement in early lactation

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*Omar Al-Marashdeh as of 1 November 2016 new speaker who is not a co-author
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The objective of the study was to examine the effect of supplementing pasture with increasing amounts of fodder beet bulb (FB) on milk production and urinary nitrogen excretion of early lactation dairy cows. Forty Friesian×Jersey cows (60 d in milk and 465 kg liveweight) were allocated to four treatments: pasture only, and pasture plus 1.5, 3.0 or 4.5 kg DM FB/cow/day (n =10 cows per group).

Cows grazed on the treatments for 30 days, with milk production measured from day 15 to 30. Fodder beet was fed in bins in the paddock following morning milking with cows moved to a new herbage allocation as soon as the target post grazing pasture height of 3.5 cm was met. Milk fat percentage and milk protein percentage increased with increasing FB in the diet (fat%: 4.91, 5.23, 5.75 and 6.04; protein%: 3.65, 3.92, 4.26 and 4.00%, for 0, 1.5, 3.0 and 4.5 kg FB, respectively).

Milk yield decreased with increasing levels of FB (25.3, 24.7, 24.6 and 23.6 kg/cow/day, for 0, 1.5, 3.0 and 4.5 kg FB, respectively), so that milksolids per cow was unaffected by FB supplementation (mean 2.31 kg MS/cow/day). Urinary N concentration and estimated urinary N excretion declined with increasing levels of FB (0.7, 0.56, 0.42 and 0.38 %N; 337, 217 and 136 g N/day, for 0, 1.5, 3.0 and 4.5 kg FB, respectively). Results suggest FB bulb supplements may offer an effective strategy to maintain milk production and reduce urinary N excretion.

Optimising summer defoliation residual height to maximise perennial ryegrass (*Lolium perenne* L.), chicory (*Cichorium intybus* L.) and tall fescue (*Festuca arundinacea* Schreb.) persistence and performance under different irrigation levels

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Dairy production in temperate southeast (SE) Australia is challenged by the strong seasonality of pasture growth, with summer dry matter yields being as low as 5-10% of annual production in dryland systems. Soil moisture deficits often lead to low pasture growth and even production from irrigated pasture can be compromised by hot conditions during the summer months. Dairy systems in temperate SE Australia are significantly affected by reductions in pasture growth rates, as 60-70% of the diet of most dairy cows is derived from perennial ryegrass (*Lolium perenne* L.), which has low tolerance to hot and dry conditions.

Overgrazing during summer feed deficits is hypothesised to increase heat stress in irrigated pasture, based on the assumption that the reduction in leaf area associated with lower defoliation residual heights limits the transpirational cooling capacity of the sward. Under both dryland and irrigated conditions, the reduced shading effect provided at lower defoliation residual heights, could also exacerbate crown and soil temperature. A recent study undertaken in north-western Tasmania quantified interactions between soil moisture availability and height of defoliation (35-, 55-, 115-mm) on summer growth and persistence of perennial ryegrass, chicory (*Cichorium intybus* L.) and summer-active tall fescue (*Festuca arundinacea* Schreb.).

Soil moisture treatments included two levels of irrigation (20-mm of irrigation applied at every 20- or 40-mm rainfall deficit (evapotranspiration minus rainfall)) and a dryland treatment. Relationships between defoliation residual height, leaf area, and crown temperature under dryland conditions were also examined.

Sunflower oil supplementation decreased over 21% of methane emission from Holstein x Gyr lactating dairy cows grazing tropical grass

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The objective of this study was to evaluate the effect of sunflower oil supplementation on crossbred Holstein x Gyr dairy cows grazing tropical pasture. Lactating dairy cows were fed *Brachiaria brizantha* pasture managed under rotational grazing. Sunflower oil was supplemented to cows using concentrates with inclusion (14.9% DM) or not (0% DM) of sunflower oil. Dietary crude fat were 13.8% and 2.4%, respectively (DM basis).

The experimental design was a randomized block with two repetitions of pasture area with two treatments (0% and 14.9% of sunflower oil supplementation - DM basis) and four replications (cows) per treatment per block. Sixteen lactating cows Holstein x Gyr (240 ± 10 days in milk, 524 ± 57 kg of live weight, 11.2 ± 2.3 kg/d of milk) were used in this study. Methane emissions was estimated by the SF₆ (sulfur hexafluoride) tracer technique. Data were analyzed using a mixed procedure of SAS where dietary treatments, blocks and cows were considered as fixed effects, and cow within block as random effect. Methane emission expressed as g CH₄/day and g CH₄/kg of dry matter intake (DMI) decreased 21.5% (P=0.06) and 20.2% (P=0.03), respectively, on cow supplemented with sunflower oil compared to unsupplemented cows.

There was no effect (P=0.29) of sunflower oil supplementation on CH₄ emissions expressed as g CH₄/kg of milk. Lactating dairy cows grazing tropical grass pasture supplemented with 14.9% sunflower oil (DM basis) demonstrate a potential for mitigating methane emissions without negatively affecting cow performance.

White clover: The forgotten ingredient of high producing pastures?

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The nitrogen-fixation and animal nutrition benefits of white clover growing in a mixture with perennial ryegrass are very well established. However, reviews published 2 decades ago demonstrated that threshold clover contents required for improved animal productivity are seldom reached in intensive pasture-based livestock systems. In the intervening 20 years, the role of clover has received scant further attention in research. Current guidelines for dairy pasture production in New Zealand largely ignore the contribution that white clover can make to total pasture DM production.

We compare total annual DM yields from ryegrass monocultures and grass/clover mixtures at two levels of N fertiliser input from two experiments conducted for three years under intensive dairy cattle grazing. Furthermore, we compare yields of ryegrass and white clover monocultures with the yields of grass/clover mixtures from two experiments conducted for one year under mowing. In both cases (grazing and mowing), one experiment was conducted in Waikato (dryland) and one was conducted in Canterbury (irrigated). Of the eight individual years of total DM yield data available from this suite of experiments, the main effect of clover (mixture versus ryegrass monoculture) was significant in every case. Across all experiments and years, the mean yields of the grass/clover mixture and the ryegrass monoculture were 12.2 and 9.8 t DM/ha per year respectively.

The effects of environment, N fertiliser, ryegrass genetics, white clover genetics and their interactions on pasture clover contents and yields will be reported, and the implications of the results for pasture management practices will be discussed.

A complementary forage system can be used to intensify production on irrigated dairy farms in the Hunter Valley

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Irrigated pasture based dairy farms in the Hunter Valley are under pressure from several sources including the potential of reduced water availability, more variable milk price, increase in concentrate price and increase in land values. As a result of these pressures, dairy farmers in the region have had limited options to purchase more land or increase concentrate feeding. This leaves many dairy farmers to question how to increase production from the land that they currently manage.

To address this issue a modelling study was conducted that investigated the biophysical production, economic and business risk of using a complementary forage system (CFS), leasing land or increasing purchased feed to boost production on four commercial dairy farms used as case studies. The CFS comprised of a Maize (*Zea mays* L), Forage Rape (*Brassica napus* L) and Field Pea (*Pisum sativum* L) grown in rotation to suit the individual case study farm requirements. The use of an increase in purchased feed and a CFS resulted in an increase in physical production and operating surplus on a per hectare basis compared to the base farm.

Leasing land does not appear to be a viable option to increase operating surplus based on the assumptions used in this model. When the Business Risk of the farm system changes were modelled the CFS resulted in a higher operating surplus at any given probability for all four case study farms compared to the other options.

Alternatives to palm kernel expeller as a supplementary feed option for dairy cows in New Zealand

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Farm-scale models were integrated with spatially discrete estimates of pasture production to examine the potential farm and regional implications of removing palm kernel expeller (PKE) as a supplementary feed from Southland dairy farms.

Two farm production systems representing the majority of dairy farms in the region were modelled: a System 3 (D3; mid intensification) and a System 4 (D4; mid to high intensification) farm. Within each system, the impact of four PKE options were explored: (i) a control with PKE (Baseline); (ii) no PKE with fewer cows producing the same amount of milk per cow as Baseline (FC); (iii) no PKE with the same number of cows producing less milk per cow (LM); and (iv) replacing PKE with barley grain (Replace). Barley grain provides for similar flexibility (timing of purchase and feeding), and can be sourced locally.

Faced with the need to remove PKE as a dietary ingredient, farmers would benefit from adopting the FC option; farm operating profits were only reduced by 3% (compared with 30% of D4 farms adopting the LM option) relative to the Baseline farms.

The relatively narrow range of mean annual nitrate-nitrogen (N) leaching losses (estimates ranged from 30 to 33 kg N ha⁻¹) reflects similar estimates of N intake and N excreted in urine across the modelled options. Substantial amounts of barley grain would need to be transported into the region or produced locally by changes in current land use to replace palm kernel expeller.

Effects of pasture allowance on milk production responses to increasing intakes of partial mixed rations in spring

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Milk production was measured in Holstein-Friesian cows offered low, medium or high allowances of ryegrass pasture (15, 25 or 40 kg DM/cow.day to ground level) and receiving different amounts of supplement (6, 10, 12 or 14 kg DM/cow.day) as a partial mixed ration (PMR).

The 28-day experiment was conducted in spring (early lactation). Two groups of six cows received each of the 12 combinations of pasture allowance and PMR amount. The PMR comprised wheat grain (38%, DM basis), maize grain (18%), lucerne hay (22%) and canola meal (22%). Pasture DM intake increased with allowance and decreased as the amount of supplement increased.

At the low pasture allowance, energy corrected milk (ECM) yield increased linearly by 0.9 kg ECM per additional kg of supplement DM. Cows offered the medium and high pasture allowances produced the same amount of ECM, which increased linearly by 0.8 kg ECM per additional kg of supplement DM. At the lowest amount of supplement, cows offered the medium and high pasture allowances produced an additional 4.7 kg ECM/cow.day compared to cows on the low allowance (1.4 kg ECM/additional kg DM pasture consumed).

At the highest amount of supplement, cows offered the medium and high pasture allowances produced an additional 2.9 kg ECM/cow.day (1.0 kg ECM/ additional kg pasture DM consumed).

These data show milk production responses to PMR are higher when pasture allowance is low but that, at the amounts of supplement offered, there was no milk production advantage in offering allowances greater than 25 kg DM/cow.day.

Feed intake and growth performance of dairy calves fed either low or high volumes of whole milk

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In the United States and Europe, accelerated pre-weaning growth in heifer calves achieved by feeding large quantities of milk is shown to be related with improved lifelong performance. We aim to revisit the milk feeding system of calves to improve performance of replacement dairy heifers in New Zealand pastoral system.

We tested the hypothesis that low milk fed calves will not consume enough solid feed to match growth from calves fed larger amounts of milk. Eighty four calves (Friesian x Jersey, 7±2 days of age) were weighed (40.9±0.8 kg) and divided into 14 pens (6 calves per pen). Calves in 7 pens were randomly allocated to low volumes of milk (4 L per day: LoMilk) while the rest were fed high volumes (8 L per day: HiMilk) for 63 days and gradually weaned by day 73. In each pen, pelleted starter, chopped grass hay and water were offered ad libitum. Daily feed intake and weekly body weight (BW) were recorded until 91 days.

During pre-weaning, the HiMilk calves grew heavier (91.6±1.6 vs. 85.4±1.6 kg) than LoMilk calves. LoMilk calves consumed more solid feed than HiMilk calves before weaning. In summary, greater solid feed intake in LoMilk calves was not able to support BW equal to those achieved by HiMilk calves before weaning.

The HiMilk calves maintained advantage in BW (114.4±2.0 vs. 110.5±1.9 kg) until 91 day of trial. Further work is underway to examine the effects of milk feeding on future growth, physiological functioning and mammary gland development in replacement heifers.

Improving perennial ryegrass persistence, productivity and utilisation in irrigated dairy pastures in northern Victoria, Australia

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Perennial ryegrass is the predominant species sown in irrigated dairy pastures of northern Victoria, Australia, however there are concerns that its persistence, dry matter production and utilisation are below its potential for the region - particularly in summer when irrigation water may be limited and air temperatures are high. Two projects are underway at DEDJTR Tatura, to investigate ways to improve perennial ryegrass performance either by using better-adapted genotypes or by undertaking specific irrigation and grazing options over summer.

In the first study, 36 different perennial ryegrass cultivar and endophyte combinations are being evaluated under grazing over three years on a local dairy farm. The objectives of this study are to determine how much genetic gain has been achieved in perennial ryegrass over recent decades and to determine the value of using improved cultivars. This project also has an experimental site in western Victoria and is linked to projects in Ireland and New Zealand.

The focus of the second project is on ways to improve the ability of perennial ryegrass to survive periods of limited irrigation over summer. This project involves three field experiments (two grazed and one mown) where a range of ryegrass genotypes and associated endophytes are being studied. Two different summer irrigation and grazing strategies are also being evaluated.

Information from these two projects will improve our understanding on ways to ensure that plant production, persistence and utilisation is maximised in perennial ryegrass dairy pastures in northern Victoria.

Increasing species diversity in unirrigated ryegrass swards improves biomass production

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Species diversity in grazed swards can improve sward production and stability when compared to traditional binary combinations. In dairying regions faced with regular seasonal soil moisture deficits, and incentive to reduce reliance on inputs (nitrogen fertiliser, irrigation) to maintain a low cost of production, the inclusion of complementary species in grazed swards warrants investigation.

A four-year, grazed, small plot experiment was conducted to evaluate biomass production, nutritive value and sward stability. Design was a 2x6 factorial of 2 grasses, perennial ryegrass (PR) or tall fescue (TF), sown with white clover in 6 species combinations: no additional species (Control); with red clover (LG1); lucerne (LG2); chicory and plantain (HB); timothy and prairie grass (GR); or a mix of all additional species (MIX). Annual dry matter (DM) production was greatest from PR compared to TF swards (13.4 vs 12.9 t DM/ha/y respectively, $P < 0.05$) owing to superior production in winter, spring and autumn.

The addition of other species' to TF did not improve DM yield. However, additional species improved DM yield by 0.8 - 1.3 t DM/ha/y in PR, with the greatest improvement observed with HB and MIX. The improved nutritive value of PR-HB and PR-MIX equated to an additional 9 - 13 GJ metabolisable energy (ME)/ha/y harvested compared to the PR-Control sward. Including herbs and additional legumes reduced the ingress of weed species into PR but not TF swards.

In summary, results show improved DM and ME yield from including herbs and legumes in grazed perennial ryegrass swards in a non-irrigated environment.

Individualised feeding of concentrate supplement to dairy cows

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Approximately one third of New Zealand dairy farms have in-shed feeding systems, a quarter of which can feed cows individually. Farmers believe there are production benefits with individualised feeding but are uncertain about the most profitable feeding strategies. An experiment investigated the potential for improved milk production response to supplements in herds fed according to milk yield, compared with herds fed at a flat rate.

Eight herds were formed by ranking all cows into three production groups according to milk yield (high, moderate and low), and randomly assigning cows from each production group to each herd. During the four week experiment, four herds were offered concentrate supplement at a flat-rate of 4kg/cow per day. Four individually fed herds were offered an average of 4kg/cow per day of supplement, with high, moderate and low production groups offered 6, 4 or 2kg/cow per day, respectively.

Milk yield was recorded daily, and milk composition, liveweight and BCS were recorded weekly. There was no increase in herd milk production, liveweight or BCS using individualised feeding compared with flat-rate feeding of the herd and when the same total amount of supplement was fed. Milk production was the same within each production group, therefore where more supplement was eaten, less pasture was consumed, resulting in the same dry matter intake.

This study indicated that individualised feeding does not improve profitability compared to flat rate feeding.

Irrigation and nitrogen fertilisation impact the nutritive value of maize grown for silage

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The digestibility of maize silage can decrease with increasing water application despite an increase in grain yield. Here we determined the changes that occur in the different maize plant fractions when water and nitrogen is applied at varying rates. Maize (Pioneer 31H50) was grown under four irrigation (0, 135, 305 and 480 mm; as nil, low, medium and high) and three N fertiliser (0, 158 and 293 kg/ha; as nil, low and high) regimes.

After harvesting, the plants were separated into four fractions, analysed for chemical composition and *in vitro* dry matter digestibility (IVDMD). High irrigation increased fibre concentration in leaf by 10%, in stem by 14%, in cob structure by 28% and in grain by 79% compared to nil irrigation. This increase in fibre occurred at the expense of N and water soluble carbohydrate (WSC) concentration of maize plant as high compared to low irrigation depleted N concentration by 9-59% and WSC by 8-55% from these fractions.

As a result, IVDMD of plant fractions and thus also of the whole maize silage with high irrigation decreased by 4-20% compared to nil irrigation. We conclude that high irrigation increased the amount of fibre in the plant and reduced the nutritive value of maize silage.

Milk production and composition of dairy cows grazing two perennial ryegrass cultivars allocated in the morning and afternoon

Ao Chen¹

Racheal Bryant¹ and Grant Edwards¹

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The objective of the study was to evaluate the effect of the perennial ryegrass cultivar and the timing of pasture allocation on milk production of late lactation dairy cows. A grazing trial using forty-eight Friesian x Jersey cows was conducted for 10 days with 3 replicate groups, each containing 4 cows allocated to four treatments.

The four treatments were two perennial ryegrass cultivars (AberMagic or Prospect) offered either after morning (0830 h) or afternoon milking (1630 h). Cows were offered a daily herbage allowance of 30 kg DM/cow above ground level. AberMagic had a greater concentration of water soluble carbohydrates (WSC, 211.6 vs. 164.7 g/kg) and organic matter digestibility in DM (DOMD, 76.2% vs. 74.0%) compared with Prospect. Herbage DM content and WSC concentration were greater in the afternoon than in the morning (22.3% vs. 18.8% DM; 218.7 vs. 157.7 g/kg WSC). Milk solids yield did not differ among treatments (1.60 kg MS/cow/day).

Apparent DM intake was lower when herbage was allocated in the afternoon (11.97 vs. 12.71 kg/cow/day), suggested better feed efficiency from afternoon allocation. The protein percentage of milk was higher in AberMagic than Prospect (4.09% vs 3.94%). Milk urea nitrogen concentration for Prospect was lower when allocated in afternoon than morning (11.7 vs. 13.2 mg/dl).

The results suggest that in well managed pasture, the effect of cultivar and time of allocation on milk production was small, although may lead to subtle changes in milk composition.

Nitrate–nitrogen accumulation in forage kale grown under varying amounts of water and nitrogen fertiliser rates in shallow soils.

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Grazing of forage kale can cause nitrate - nitrogen ($\text{NO}_3 - \text{N}$) poisoning of ruminants when the crops are exposed to excess N. Thus, N supply should be matched with crop requirements to achieve an optimum combination of yield and N content for given soil water conditions during crop growth. An experiment was conducted on a stony silt loam soil to investigate dry matter (DM) yield and $\text{NO}_3 - \text{N}$ accumulation under varying water and N inputs.

Treatments comprised a factorial combination of two water treatments (rain-fed and full irrigation) and four N rates (0, 75, 150 and 300 kg N/ha). Total DM yield increased with both water and N supply. The $\text{NO}_3 - \text{N}$ concentration increased with N application for both irrigated and rain-fed treatments and differed with plant part. Nitrate-N concentration was higher in the stems than in leaf lamina or petioles. Nitrate-N concentration also varied with the position on the stem, increasing from upper to lower part of the stem.

The weighted $\text{NO}_3\text{-N}$ concentration (≥ 1.52 mg/g) for crops grown at ≥ 150 kg N/ha for the rain-fed crops was higher than the recommended threshold of 1.13 mg/g for feeding any livestock class. The current push for high feed utilisation in forage kale crops, may inadvertently expose livestock to the higher $\text{NO}_3 - \text{N}$ concentrations.

There is a need therefore to find a balance between acceptable feed utilisation and exposure of animals to nitrate poisoning.

Pasture and the theory of diversification

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Diversifying farm activities reduces the business risk of agricultural production.

The aim of this study was to investigate the effect of diversifying forages grown on a dairy farm on total pasture dry matter (DM) yield and variability. This approach is similar to that used to assess the diversification of annual cropping activities, though continual harvest of pasture by grazing animals and the seasonality of pasture DM production complicates the question.

The question investigated was 'How does substituting chicory or tall fescue in increasing proportions in a perennial-ryegrass pasture affect total seasonal pasture DM growth and variability?' The biophysical model DairyMod was used to simulate the growth of perennial ryegrass (*Lolium perenne* L.), chicory (*Cichorium intybus* L.) and tall fescue (*Festuca arundinaceae* L.) monocultures over 30 years for two dryland locations in the high-rainfall zone of southern Australia.

Chicory has the potential to increase mean DM growth during the summer-autumn period. However, this was accompanied by an exponential increase in yield risk in the same period and reduced growth rates during autumn/winter and spring. Strong seasonal correlation between DM yields of tall fescue and perennial ryegrass meant tall fescue did not reduce total DM variability. This study is an initial look at the potential for diversifying pasture species as a strategy for managing business risk in livestock businesses.

Further analysis would include price correlations and variability and consideration of the whole-farm implications.

Rumen degradability characteristics of five commercially relevant starch-based concentrate supplements

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Efficient use of concentrate supplements is a key determinant of productive efficiency on Australian dairy farms. Recent experiments, both in Western Australia (WA) and Victoria, have indicated the potential milk production benefits of using maize grain as an alternative to other starch based concentrates such as wheat.

Use of maize grain on WA dairy farms is currently cost prohibitive; however a number of alternative starch based concentrates are widely used. This experiment used the nylon bag technique to measure the rate of ruminal degradation of maize grain, wheat, NaOH treated wheat, oats and Maximize (a commonly used commercial concentrate for lactating dairy cows in WA). Dry matter (DM) disappearance was measured at 10 different time-points ranging from 0-72 hours post-incubation in the rumens of six non-lactating cows fed a maintenance level diet with a 60:40 forage:concentrate ratio.

Data analysis is currently ongoing; however the cumulative disappearance data for DM, starch and nitrogen (N) at each time-point will allow calculation of rumen degradability and the "a" fraction (instantly degradable), "b" fraction (potentially degradable) and "c" value (degradation rate of "b" fraction in % per hour) for each feed. We hypothesize maize grain will have the slowest ruminal degradability of DM and starch, followed by NaOH treated wheat and maximise pellets, with oats intermediate and wheat rapidly degradable.

The data will assist in identifying alternative starch based concentrate supplements to maize grain with similar degradability profiles that may be more cost effective for dairy producers in WA.

Sowing date affects dry matter yield of fodder beet crops and farm profitability

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A replicated field experiment was established in Lincoln, New Zealand to determine the effect of sowing date on dry matter (DM) yield of fodder beet (*Beta vulgaris* L. cv. "Rivage").

Four sowing dates in 2014 (19 September (Sep-SD), 17 October (Oct-SD), 17 November (Nov-SD) and 15 December (Dec-SD)) were evaluated. Dry matter yield was determined on 15 June 2015. Mean growth rates of an irrigated pasture crop were used to estimate potential pasture DMY lost from spraying out paddocks one month before establishing fodder beet at the respective sowing dates. Assumptions were NZ\$ 2,400/ha for fodder beet and NZ\$ 0.09/kg DM for pasture production. Fodder beet yield was 27 t DM/ha for both Sep-SD and Oct-SD and there was a significant yield with loss later sowing.

The total annual DM yield for pasture only was 19.2 t DM/ha compared with adjusted fodder beet + pasture DM yield of 28.4, 29.5, 25.2 and 25.1 t DM/ha for Sep-SD, Oct-SD, Nov-SD and Dec-SD, respectively. Combined fodder beet + pasture production cost was NZD 0.09/kg DM for Sep-SD and Oct-SD, and increased to 0.11 and 0.12 NZD/kg DM for the Nov-SD and Dec-SD, respectively. Compared with pasture only, farmers would save 10 and 15% on bought-in feed from Nov-SD and Dec-SD, respectively.

Therefore, DM gains from September-sown fodder beet are unlikely due to low temperatures limiting crop growth. Late sowing increases production costs and yield penalty, but potential returns are greater as less supplementary feed will be bought-in, compared with pasture only system.

ABSTRACT THEMES:

Labour, Management and Farm Economics

A comparison of the profitability of a dairy business with alternative investment options

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Investments are generally made on the expectation that an adequate net return will be earned. However, the expected return per dollar invested in different assets will vary. This is because different assets have different characteristics, different expected returns and risks, different levels of liquidity and may be treated differently under tax law. The choices of investors align with their preferences for risk and desired returns over time.

Dairy farming is an investment in assets, such as land and improvements, livestock, plant and equipment, water and people, which are managed to produce milk and ultimately to generate profit and a competitive return on capital. With uncertain seasonal conditions, fluctuating input costs and prices for output, and declining terms of trade, it would be easy to assume that dairy farming necessarily generates lower and more variable returns than non-agricultural investment opportunities in the economy.

In this research, the profitability of a dairy farm case study was compared with alternative investments. Analysing the performance of a dairy business in northern Victoria from 2003/04 to 2014/15 showed the farm performed well compared with other dairy businesses in Victoria and alternative investments, such as shares, bonds and property. Compound return to capital over the 11 years for the dairy farm studied was 12.4% (real); the performance of a robust and well-managed business. Over half the return was from the farming operations and the remainder came from owning assets that appreciated in value, particularly in this case, water.

Investigation into cost of production and milk price for Australian dairy farms over the past nine years

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Across Australian dairy farms there is a wide variation in both farm gate milk price received and cost of production, both within and between years, regions and individual farms. The aim of this study was to analyse the nature of the relationship between a given farm, region or state cost of production and milk price received, based on data from approximately 190 farms in the national Dairy Farm Monitor Project (DFMP).

The DFMP provides independent, standardised, farm-level financial and production information about dairy farm businesses. This paper will report on the nature and cause-effect relationships of those variations, arising from a detailed analysis of the many factors attributed to cost of production and the milk price received on farm. These factors include farm size, region, and feeding system. In the statistical analysis, specific focus was placed on the business and financial risk structures of dairy farms to isolate which factors are most linked to profit.

ABSTRACT THEME:

Physiology, Nutrition, Reproduction and Health

Differential impact of concentrates and rumination level on carbon gas fluxes and milk production of dairy cows in a pasture-based automatic milking system

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The warming effect of ruminant greenhouse gases is an issue of global concern. This experiment tested the potential for abatement of ruminant gases by offering three levels of concentrate to dairy cows of high and low rumination in a pasture-based automatic milking system.

Two uniform groups of cows ($n=30/\text{group}$; milk yield = 352 kg) with consistently high (75th percentile = 6209 min) and low (25th percentile = 47310 min) rumination were randomly assigned to three concentrate treatments offering same temperate pasture (offered at 30 kg DM/cow/d) and grain-based pellet (7 kg DM/cow/d) plus 0, 1.5 or 3 kg DM/cow/d of ground shelled corn. Milk production, rumination, activity, mass flux of CH₄ (Q_{CH_4}) and carbon dioxide (Q_{CO_2}), and dry matter intake (DMI) determined by use of Q_{CO_2} as biomarker, were recorded for 12 d and analyzed with mixed models for a completely randomized design. No effect ($P>0.24$) of rumination on Q_{CH_4} or Q_{CO_2} was detected. Offering 1.5 kg of corn increased Q_{CO_2} , but increasing corn offered to 3 kg reduced Q_{CO_2} ($P=0.02$).

A similar numerical trend ($P=0.13$) to increasing corn feeding was observed for Q_{CH_4} . Offering 3 kg of corn reduced ($P<0.02$) total and pasture DMI, and this decrease was associated with a lower ($P<0.03$) DMI/Activity. Both $Q_{\text{CH}_4}/\text{Milk}$ and $Q_{\text{CO}_2}/\text{Milk}$ decreased exponentially with increasing milk yield, supporting a dilution of emitted gases as more feed energy is sequestered in milk. The results suggest opportunities to manipulate ruminant gas emissions through allocation of concentrates but warrant further investigation to corroborate this finding.

Energy balance of lactating Holstein-Friesian cows with divergent residual feed intake

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Two experiments were conducted comparing energy partitioning in lactating Holstein-Friesian cows selected for high or low residual feed intake which was measured previously as growing calves (RFI_{Calf}). The first used 16 primiparous cows (8 high and 8 low RFI_{Calf}) and the second used 16 multiparous cows the following year (8 high and 8 low RFI_{Calf}). Seven were used in both years (4 high and 3 low RFI_{Calf}).

Cows were housed individually for 4 d in metabolism stalls then in an open circuit respiration chamber for 3 d. Each cow was offered *ad libitum* lucerne hay cubes plus 6 kg DM per day of crushed wheat grain. Individual feed intake, milk yield, milk composition, and faecal and urine output were measured. Methane and carbon dioxide output and oxygen consumption were measured in the chambers. Milk production parameters and intakes of DM, ME did not differ between RFI treatment groups with the exception of milk fat %, which tended to be greater in primiparous cows and milk protein %, which tended to be greater in multiparous cows of high RFI_{Calf} compared with cows of low RFI_{Calf} .

Total tract digestibility of feeds, methane production and heat retention were unaffected by RFI_{Calf} but urine DM output was greater in multiparous high RFI_{Calf} cows. As a result N output was greater in these cows. Divergence in RFI as calves was associated with subtle differences in energy and N balance in both primiparous and multiparous cows.

Exploring the effect of live yeast on lactation performance through its interaction with the rumen microbial meta-transcriptome during sub-acute rumen acidosis.

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Daily inclusion of live yeast (LY) in the ration of lactating cows has been shown to improve animal performance and it has been hypothesised that this is due to the yeast's positive effect on the rumen microbial population. However, limited data is available linking changes in the rumen microflora to performance in response to LY supplementation.

With the recent advancement in molecular techniques it is now possible to investigate this association more closely. Sixteen multiparous, rumen-cannulated lactating Holstein cows were randomly assigned to 1 of 2 dietary treatments (LY, 4 g/d, AB Vista) or placebo (CON). During the first 49 days, all cows received a high-forage (HF) diet and were then abruptly switched to a high grain (HG) diet until the end of the experiment (day 73). SARA was successfully induced in the days following the change in diet. LY inclusion led to significant effects ($P < 0.05$) on dry matter intake (+ 1.7 kg/d), fat corrected milk production (+3.5 kg/day) and improved feed efficiency. Animals also spent 50% less time below a pH of 5.6 where fibre digestion is impaired. Volatile fatty acid profile was also altered towards that indicative of improved fibre digestion.

Metatranscriptomic profiling demonstrated an up-regulation in oxidative phosphorylation pathway and ascorbate and aldarate metabolism with LY. Additionally, LY increased the abundance of enzymes involved in fibre digestion along with the numbers of *Fibrobacter succinogenes* an important fibre digesting bacterium. Further work will be carried out to study effects on other important members of the microbial community.

Pre-calving and early lactation factors that predict milk casein and fertility in the transition dairy cow

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Multiparous Holstein cows (n = 82) of either high or low genetic merit (GM) (for milk fat + protein yield) were allocated to one of two diets that differed in the ratio of rumen-undegradable protein (RUP) to rumen-degradable protein (37% RUP vs. 15% RUP) and were fed from 21 d pre-calving to 150 DIM.

This study evaluated the effects of these diets and GM on concentrations of milk casein (CN) variants and aimed to identify pre-calving and early lactation variables that predict milk, CN and protein yield and composition, and fertility of dairy cows. It explored the hypothesis that low milk protein content is associated with lower fertility. Increased RUP increased milk, CN and milk protein yields. Increased GM increased milk and gamma CN yields and tended to increase milk protein yield. The effects of indicator variables on CN variant yields and concentrations were largely consistent, with higher body weight and alpha amino nitrogen resulting in higher yields, but lower concentrations. An increase in cholesterol was associated with decreased CN variant concentrations, while disease lowered CN variant yield.

A diet high in RUP increased proportion of first services resulting pregnancy from 41 to 58%. Increased pre-calving metabolisable protein (MP) balance decreased the proportion of first services that resulted in pregnancy when evaluated in a model containing CN %, milk protein yield, diet, and GM. Cows producing the lowest quartile of milk protein percentage were 28% less likely to become pregnant during the first 150 DIM.

Responses of dairy cattle to acute heat stress in climate controlled chambers

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The incidence of short term heat wave events is increasing in the dairying regions of Australia, creating a more challenging environment for dairy cows to maintain homeothermy and maintain milk production. Understanding the responses to acute heat stress of lactating dairy cows bred in temperate climates is important as most Australian dairy herds are located in temperate regions. Climate-controlled chambers provide the ability to experimentally induce heat stress conditions and measure individual animal stress parameters in detail, with a view to understanding the subsequent physiological responses.

The objective was to document the responses of lactating dairy cows to a short term acute heat stress challenge using climate-controlled chambers and describe their recovery in the following 14 days. Six cows were exposed to the heat challenge and six cows were housed in thermoneutral conditions for four days. The cows exposed to the heat challenge reduced their milk yield by 57% and their DMI by 28% during the 4-day heat challenge. The rectal and vaginal temperature of the heat stressed cows increased by 2.1°C and 1.8°C from their baseline, respectively. Day 9 of the recovery period was associated with a return to baseline milk yield and DMI for the heat stressed cows. Results of blood plasma metabolites and hormones will provide an insight into the severity of stress that was imposed on the cows.

With these results, we can draw conclusions about the effectiveness of individual animal climate-controlled chambers for measuring stress responses to climatic conditions.

Trans-10 octadecenoic acid concentration in milk fat can be used to predict methane yield of dairy cows.

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There is a need to develop a simple method to predict methane emissions from individual dairy cows. In recent years, a number of researchers have reported correlations between the concentrations of specific individual fatty acids (FA) in milk fat and daily methane emissions (g CH₄/cow.day) or methane yield (MY, g CH₄/kg DMI).

No researchers have reported on the possibility of using the concentration of trans-10 octadecenoic acid (C18:1 trans-10) in milk fat to predict MY. Data from four experiments involving 13 dietary treatments and measurements on 121 cows were used. In all experiments the basal diet was either lucerne (*Medicago sativa* L.) hay or harvested fresh perennial ryegrass (*Lolium perenne* L.), and this was supplemented with canola meal and either corn, wheat, or barley. Methane emissions were measured using either open-circuit respiration chambers or the sulphur-hexafluoride (SF₆) tracer technique. Milk FA were analysed by gas chromatography and individual FA expressed as a percentage of total FA.

The relationship between MY and C18:1 trans-10 was observed to be discontinuous, and a bent stick model was fitted to the data. For C18:1 trans-10 concentrations less than 1% of total FA, MY was described by the following equation: $MY = (24.9 \pm 0.77) - (12.9 \pm 1.73) * C18:1 \text{ trans-10}$, whereas when C18:1 trans-10 concentration was greater than 1%, MY was constant and equal to 10.7 ± 0.59 . The R² of the model was 0.68. In conclusion, C18:1 trans-10 concentration in milk can be used to predict MY.

Whole tract digestibility and nitrogen use efficiency of partial mixed rations with and without canola meal.

Victoria Russo¹

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Increasing the crude protein (CP) concentration of a ration fed to grazing dairy cows can increase milk production. Sixteen spring-calved fistulated cows were housed in metabolism stalls for a 10 day period and offered one of the four treatment diets: (1) PMR low: 8 kg DM of fresh perennial ryegrass (PRG) supplemented with 12 kg DM of a PMR comprised of oaten hay, crushed maize and wheat; (2) PMR med: 12 kg DM of fresh cut PRG and 12 kg DM of PMR; (3) PMR+C low: the same as for PMR low cows, except some wheat in the PMR was replaced with canola meal; and (4) PMR+C med: the same as the PMR med cows, except some wheat in the PMR was replaced with canola meal.

The PMR and the PMR+C diets were isoenergetic, but the canola meal provided extra CP. The DM intake of cows receiving the PMR+C diet was greater than cows offered the standard PMR (21.6 and 20.4 kg DM, respectively $P=0.008$), consistent with an increased energy corrected milk yield (35.3 and 33.2 kg/day, $P=0.003$). The PMR+C med treatment showed a greater ($P=0.010$) whole tract DM digestibility, which could also contribute the milk production benefits of increased protein concentrations in the PMR.

However, the PMR cows had greater ($P 0.011$) nitrogen use efficiency than cows offered the PMR+C indicating that the level of CP fed may be an excess of what can be utilised.

Acetate to propionate ratio in ruminal fluid can predict methane yield of dairy cows

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It has been shown that the DMI of forage-fed cattle can be used to accurately predict their methane emissions with an average methane yield of 20.7 g/kg DM.

However, many animals are fed concentrate-enriched diets that decrease their methane yield (MY, g/kg DM). Methane yield has been reported to be correlated with the acetate to propionate ratio (A:P) in ruminal fluid. This suggests that A:P could be used to predict MY of animals fed forage-dominant as well as concentrate-enriched diets. Data from 8 experiments with a total of 27 treatments were collated, resulting in MY and corresponding A:P data from 248 cows. Forage to concentrate ratio of the diets ranged from 100:0 to 44:55.

Methane was measured either by open-circuit respiration chambers or the sulphur hexafluoride (SF₆) technique. In all experiments, ruminal fluid was collected per os, approximately 4 hours after the start of feeding. Volatile fatty acids in ruminal fluid were measured by gas chromatography. Methane yield of individual cows was strongly positively related to A:P ratio in ruminal fluid $MY = (7.9 \pm 1.00) + (3.6 \pm 0.28) \times A:P$, with Pearson correlation coefficient (r) 0.633.

These findings indicate that A:P ratio in ruminal fluid can be used to predict MY of dairy cows.

Alleles of the bovine histatherin gene are associated with varying somatic cell counts and milk production in New Zealand cattle

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The bovine mammary histatherin gene resides on chromosome 6 in the casein locus and is under the control of a casein promoter.

Twenty haplotype combinations of three SNP alleles of the mammary (mHSTN) gene have been reported to be associated with varying somatic cell counts, milk production and milk composition in Chinese cattle.

The aim of this study was to examine the presence and association of these alleles in New Zealand dairy cows. DNA extracted from 3229 lactating NZ dairy cows was analysed using Sequenom methodology. The alleles segregate at low to intermediate frequencies in the NZ cow population and show a significant and beneficial association with SCC and milk composition.

Effect of different levels of concentrate mixture for growth and puberty in Sahiwal heifers

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The research was conducted at livestock experimental station, Jahangirabad, Khanewal, Punjab province, Pakistan. Sixty three Sahiwal female young stocks (FYS) were divided into three groups (21 FYS, with 7 FYS per replicate were offered green fodder (GF), GF+ Concentrate ration (CR) @0.5% and GF+CR@1% of body weight.

The feeding trial continued till the age at which heifers on all treatments were expected to reach at age of puberty and got pregnant. The experimental parameters were daily dry matter intake, daily gain, body condition score and digestibility of nutrients, age at puberty and cost of production.

The results showed a significant difference in mean dry matter intake, average daily gain, body measurements and feed efficiency. The digestibility of nutrients was greater in green fodder with 1 % of concentrate ration. Sahiwal heifers fed green fodder with 1 % of concentrate ration attained puberty earlier than those fed 0.5 % concentrate ration along with green fodder. Body height, body length and heart girth were found the highest in heifers fed on green fodder with 1 % concentrate ration. Green fodder with concentrate significantly influenced on sexual maturity during pre-pubertal period and body weight at puberty which ranged from 260±17.4 to 290.5±15.2 among different treatments.

Delayed puberty in Sahiwal heifers fed *ad libitum* green fodder in the study might be attributed to low nutrient intake that were not sufficient to meet nutritional requirements of heifers. Cost to gain ratio in heifers was Rs. 97.18, 90.60 and 93.03 on GF, GF+CR@0.5% and GF+CR@1%, respectively.

Effects of dietary fat on fertility of dairy cattle: a meta-analysis and meta-regression

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This study utilized meta-analysis and meta-regression to explore the effects of including fats in the transition diet fertility and production. Meta-analysis was used to integrate smaller studies, and increase the statistical power over that of any single study and explore new hypotheses.

There were relatively few (only 17 studies containing 26 comparisons) highly controlled studies providing detailed descriptions of the diets used that examined interactions between fat nutrition and reproductive outcomes. Reproductive variables evaluated were 'risk of pregnancy' 'proportion pregnant', and 'calving to pregnancy interval'. Production variables examined were milk yield, composition, and body weight. The sources of heterogeneity in these studies were also explored.

A 27% overall increase in pregnancy to service was observed (RR = 1.27; 95% Confidence interval Knapp Hartung 1.09 to 1.45) and results were relatively consistent ($I^2 = 19.9\%$). A strong indication of a reduction in calving to pregnancy interval was also identified, which was consistent across studies ($I^2 = 0.0\%$) supporting a conclusion that overall, the inclusion of fats does improve fertility.

Further exploration of the factors contributing to proportion pregnant using bivariate meta-regression identified increased fermentable neutral detergent fiber and soluble fiber intakes, as well as increased milk yield, increased the proportion pregnant.

Unexpectedly, the estimated energy costs of urea production also had a positive association with proportion pregnant. The limited number of suitable studies for the analysis highlights the need for more work to improve understanding of the critical nutritional factors affecting fertility.

Effects of prepartum dietary cation anion difference and source of vitamin D on dairy cows: vitamin D, mineral and bone metabolism

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This study evaluated the effects of feeding dairy cows diets containing either calcidiol or cholecalciferol (3 mg per 11 kg of diet DM) and positive (+130 mEq/kg) or negative (-130 mEq/kg) dietary cation-anion difference (DCAD) on vitamin D, mineral, and bone homeostasis during transition.

Pregnant Holstein cows (n=79) were blocked by parity and milk yield and randomly allocated to treatments from 255 d of gestation until calving. All groups of cows were then fed the same lactating diet until 49 DIM. Blood was sampled for analysis thrice weekly pre- and post-partum until d 30 of lactation, and at 0, 1, and 2 d post-partum.

Milk yield and composition were recorded for the first 49 DIM. Feeding calcidiol increased concentrations of calcidiol pre- and post-partum, and calcitriol pre-partum when compared with cholecalciferol. Feeding negative vs positive DCAD increased pre-partum concentrations of calcitriol, but decreased calcidiol and cholecalciferol pre-partum, and calcidiol, cholecalciferol and calcitriol post-partum. Post-partum, calcitriol was higher in parous than nulliparous cows. Blood calcium increased in cows fed calcidiol. Calcium concentrations in the negative DCAD group were lower pre-calving, compared with the positive DCAD group, but higher post-partum.

Feeding negative DCAD lowered blood pH, compared to positive DCAD pre-partum, but not post-partum. There was no effect of vitamin D or DCAD on blood osteocalcin, PTH, adiponectin, or leptin concentrations. Nulliparous cows had higher blood concentrations of osteocalcin and crosslaps than parous cows. Cows fed calcidiol produced 3.70 ± 1.2 kg/d more 3.5% fat- and energy-corrected milk than those receiving cholecalciferol.

In vitro evaluation of the methane mitigation potential of a range of grape marc products

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Grape marc is the skins, seeds and stems of grapes remaining after grapes have been pressed to make wine. Interest in using grape marc as a dietary feed additive for ruminants has grown after recent research showed inclusion of grape marc in the diet of dairy cows reduced their enteric methane emissions.

In this research, in vitro fermentations were conducted on twenty diverse grape marcs to evaluate their potential as ruminant feed supplements and in particular, mitigants of enteric methane emissions. The grape marcs, which were sourced from vineyards in South-East Australia, contained a range of red and white grape varieties with different proportions of skins, seeds and stalks, and diverse chemical composition.

For each grape marc, four replicate samples, each of one gram of dry matter were incubated in vitro with rumen fluid. The volumes of total gas and methane produced after 48 hours of incubation were determined. Total gas production ranged from 21.8 - 146.9 ml and methane production from 6.8 - 30.3 ml. Although white grape marcs produced more total gas (81.8 ml) than red grape marcs (61.0 ml) $P < 0.05$, they produced similar amounts of methane. Grape marcs dominant in seeds and stalks produced less total gas and less methane than grape marcs dominant in seeds.

It is concluded that grape marcs differ greatly in their potential as feed supplements for ruminants and in their potential as mitigants of enteric methane emissions.

Metabolic and production responses to calcidiol treatment in mid-lactation dairy cows

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The study of vitamin D in cattle has often focused on its role in calcium and mineral metabolism. However, there is evidence of a wider role for vitamin D in integrated metabolism, in particular, with bone and energy metabolism.

Two studies were conducted to explore relationships between calcidiol supplementation, blood minerals and metabolites in mid-lactation dairy cows. In experiment one, a dose response study was conducted in which 25 mid-lactation cows were fed one of five supplementary calcidiol doses (0, 0.5, 1, 2 or 4 mg calcidiol/day) for 30 d. Increasing calcidiol dose quadratically increased blood calcidiol, 24,25-(OH)₂-D₃, 25-OH-D₂ and phosphate, and linearly increased 3-epi 25-OH-D₃ and milk calcidiol concentrations.

Calcidiol supplementation didn't affect milk yield or composition, body weight or condition score. In experiment two, relationships between blood calcidiol and mineral and metabolite concentrations over time were explored using time series analysis. Ten mid-lactation cows were fed either 0 or 0.5mg calcidiol/day for 27 d with blood samples taken every 3 d.

Feeding calcidiol increased blood calcidiol, 24,25-OH-D₃, and insulin, but decreased 25-OH-D₂. Positive associations were identified between blood calcidiol and other metabolites including cholecalciferol, calcium, osteocalcin, glucose, insulin, NEFA, beta-hydroxybutyrate, cholesterol, magnesium, phosphorus and total protein at varying lags (\pm 0, 3 or 6 d), while negative relationships were identified between calcidiol and 24,25-(OH)₂-D₃ and phosphorus 3 d later. Importantly, strong positive associations between calcidiol and indicators of energy metabolism were identified.

Overall, these experiments provide support for a positive effect of calcidiol treatment on dairy cow metabolism.

Partitioning of dietary nitrogen in response to feeding cereal grain supplements to dairy cows during four periods of an extended lactation

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Although most dairy cows in southeast Australia have a 300 day lactation, there is interest in extending lactations beyond that to mitigate the need for cows to conceive when they are in peak lactation and thus negative energy balance.

This research quantified the partitioning of dietary nitrogen in response to feeding cereal grain supplements to dairy cows during four periods of an extended lactation up to 560 days.

The experiment used two groups of eight Holstein cows in four experimental periods of six days. The four experimental periods commenced at 110, 270, 450 and 560 days in milk (DIM). During each period, cows were kept in individual stalls where they underwent nitrogen metabolism studies.

Cows in a control group received an ad libitum forage-based diet while cows in a second group received 5 kg DM of a cereal grain and the basal forage diet ad libitum. Nitrogen intake (NI) in feed and nitrogen excretion in milk (MN), faeces (FN) and urine (UN) were measured for individual cows. Nitrogen use efficiency (NUE) was calculated as $100 * MN/NI$. Milk nitrogen, UN, FN, retained nitrogen and NUE were positively related to NI. Days in milk was positively related ($P < 0.01$) to UN and negatively related ($P < 0.01$) to MN, FN, and NUE.

Over and above its effects mediated by NI, grain feeding was not significantly ($P > 0.05$) related to MN, UN, FN, RN, or NUE.

The use of exogenous fibrolytic enzymes on improving fibre digestibility and performance of lactating dairy cows

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Decreasing milk prices are exerting considerable pressure on Dairy farmers to look at ways to increase milk from forage by improving fibre digestibility.

Previous research investigating the effect of adding exogenous fibrolytic enzymes (EFEs) to the rations of lactating dairy cows showed considerable promise, especially in rations containing low quality forages.

With the need to improve feed efficiency, the use of EFEs is being re-evaluated. Recent studies have confirmed the mode of action of EFEs on several forages commonly used in Australasian diets. On application, the EFEs create pits in the fibre surface, visualised using Scanning Electron Microscopy (SEM).

The increase in surface area, coupled with the concomitant release of sugars which act as a chemo-attractant, leads to better microbial colonisation, increase in numbers of fibrolytic bacteria and a reduction in the lag time to digestion.

The use of NIR to scan forages, untreated and treated with EFEs, show the effects tend to be greater on forages higher in NDF with an average increase in D-value of 5% equating to an extra 0.8 MJ/kg DM. Animal trials have demonstrated positive effects on performance in both extensive and intensive systems.

On average, milk yield can be increased by more than 1.5 litre/ head/ day and feed efficiency by up to 11%. Milk components are also increased due to increased fibre digestion and microbial growth. In transition cows, energy status is also improved and animals regain body condition more rapidly. Fertility may also be improved and intakes maintained during heat stress.

Use of internal teat sealant in heifers reduces mastitis and increases milk production

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Mastitis in heifers is costly, affecting milk quality and reducing milk production throughout the first lactation.

Several studies have reported the beneficial effects of internal teat sealants (ITS) on mastitis in heifers, but there appear to be no reports on the subsequent effects on milk quality and production.

The consequences of using ITS prior to calving in two cohorts of primiparous heifers (n=189) was compared with four cohorts when ITS was not used (n=287), using detailed bacteriology and herd test production data in a DairyNZ research herd. In years when ITS was used, there were fewer (P<0.001) heifers detected with an intramammary infection at the first milking after calving, and fewer (P<0.001) cases of clinical mastitis detected in the first 30 days of lactation, compared with years when ITS was not used.

During the first eight weeks of lactation, heifers treated with ITS had a lower (P<0.0001) SCC and produced 49kg more milk (P<0.05) and 5kg more milksolids (P<0.05) than non-treated counterparts.

These positive benefits associated with use of ITS may be sufficient to offset costs of the original treatment.

ABSTRACT THEME:

Soils, Nutrients and Environment

A survey of dairy cow wintering in Canterbury

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Low winter pasture growth rates in the South Island dictate the use of winter crops and supplement. Grazed crops represent a significant risk for nutrient loss and are under scrutiny from Regional Councils. However little is known about the extent of different wintering practices. A telephone survey of 238 farms in Canterbury was completed in March 2016. Results indicate a heavy reliance on wintering off the milking platform (91%), mostly on support blocks (66%) managed by the farmer.

Thirty two percent of farms had some crop on the milking platform to feed for transitioning cows prior to winter. Kale and fodder beet were the most common winter crops. On the milking platform, the predominant feed over winter was fodder beet (39%), pasture (29%) and kale (17%). The most common transition crop was fodder beet (67%) with kale second (21%), these crops are an indication of the cows diet during winter. The heavy reliance on winter crops indicate the importance of finding nitrate leaching mitigation options specifically aimed at winter grazed crops.

Bacterial processes associated with soil carbon after application of composted manure to dairy pastures

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We investigated the impact of composted dairy manure on bacterial communities associated with soil carbon in three dairy pastures with support from Western Dairy and South West Catchments Council. Microbial activities in soil are involved in increasing and retaining soil carbon, but some are also involved in loss of soil carbon during degradation of organic matter. Soil bacterial communities respond to addition of manure and compost, and play a role in the incorporation of these carbon resources into the soil matrix.

Soil bacterial communities were characterised using community profiling (semiconductor sequencing of barcoded amplicons generated from the V3-V4 region of bacterial 16S rDNA genes). The presence of carbon degrading functional genes was predicted using the bioinformatics software: Phylogenetic Investigation of Communities by Reconstruction of Unobserved States (PICRUSt). The most abundant bacterial phyla in all three pastures were *Proteobacteria* (33%), *Firmicutes* (14%), *Actinobacteria* (13%), *Bacteroidetes* (10%) and *Acidobacteria* (9%).

There were considerable differences in bacterial community structure among farms with less effect of organic matter amendment within farms. For one pasture, compost addition decreased the relative abundance of *Acidobacteria*. Dairy manure (2t/ha) generally increased the predicted alpha-amylase functional genes compared with composted dairy manure (6t/ha). Other predicted carbon degrading functional genes increased to a greater extent with manure application in a sandy soil compared with a clayey soil; the opposite was observed for the higher level of compost application. For the two sandy soils, there was higher predicted carbon degrading gene activity with the lower level of compost addition.

How much nitrogen is recovered from autumn fertiliser application in a dairy pasture over the growing season?

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Fertiliser nitrogen (N) use efficiency in pasture systems is considered low because of loss as ammonia, from leaching of nitrate, and from denitrification (N_2O and N_2). Applied N can also be temporarily immobilised in the soil, making it available for the plant at a later date. In this study we assessed how much N was recovered in the plant-soil system in a rain-fed dairy pasture from a single application on ^{15}N labelled urea (50 kg N ha^{-1}) over a growing season (autumn to spring) on shallow soils (15 cm) over limestone in southern Australia. Five pasture harvests were conducted and non-labelled urea was applied after each harvest.

Over the growing season, 33% of the ^{15}N was recovered in the pasture. The greatest recovery (16%) occurred in the second harvest (June) when biomass production was high ($1.6 \text{ tonnes (t) dry matter (DM) ha}^{-1}$) under wetter conditions, and this was almost double that from the first harvest (9%) when less pasture was produced (0.3 t DM ha^{-1}). Progressively less ^{15}N was recovered with each subsequent harvest, even when biomass production was high ($>1.4 \text{ t DM ha}^{-1}$). At the end of the growing season 15% of the ^{15}N was found in the soil (13%) and roots (2%), which would become available for the pasture via mineralisation under favourable conditions over time.

While some ^{15}N remained in the system for subsequent use, more than half of the applied N was lost in the growing season.

Comparison of different cereal grains for their *in vitro* total gas and methane production

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A starch rich diet has the potential to reduce rumen methane production, since starch fermentation in the rumen favours propionate over acetate production. Increasing starch supplementation in the diet can also result in a reduction in ruminal fluid pH, thereby also reducing methanogenesis.

However, this can also lead to an increased likelihood of rumen acidosis. It has therefore been proposed that methane production can be reduced without increasing the amount of grain offered, but by feeding cereal grains that contain more degradable starch.

This study consisted of an *in sacco* and an *in vitro* experiment. In the *in sacco* experiment rolled corn, rolled wheat, rolled barley and double-rolled barley were incubated in the rumen of three dairy cows in an incomplete block design. The *in vitro* experiment incubated lucerne (as a control), wheat, corn and barley with different degrees of processing over a 48 h period in a completely randomized design.

Rolled wheat had the fastest rate of *in sacco* degradation of dry matter, crude protein, starch and organic matter. Ground wheat and barley produced less *in vitro* methane yield per unit of degradable dry matter (MZ) than rolled wheat and barley. Ground wheat produced 25% less *in vitro* MZ than ground corn.

It can be concluded that rate of starch degradability had an effect on methane production and that the results from *in sacco* degradability aligned with the *in vitro* methane production with increased grains processing.

Herbage yield and herbage nitrogen concentration of grass, legume and herb species grown at different nitrogen fertilizer rates under irrigation

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An important goal in dairy systems is to increase production while achieving environmental targets associated with lower nitrate leaching.

One approach is to identify forages that grow more at a given level of nitrogen (N) input and/or result in lower N intake per kg DM consumed. However, while N responses are well developed for perennial ryegrass, less information is available for alternative grasses, legumes and herbs. In this study, 12 species (7 grasses, 3 legumes and 2 herbs) were grown at six N fertilizer rates (0, 50, 100, 200, 350 and 500 kg N/ha/yr) under irrigation in Canterbury, NZ.

Herbage yield measurements and N composition were taken over 12 months. As N fertilizer rate increased from 0 to 500 kg N/ha, annual herbage yield increased linearly (5439 to 14757 kg DM/ha in grasses and 7146 to 13177 kg DM/ha in herbs). In contrast, annual herbage yield for legumes was unaffected by N fertilizer rate and ranged from 12316 to 13149 kg DM/ha.

Additionally, there were contrasting responses in herbage N% between species. At all N fertilizer rates, herbage N% was highest in legumes (4.23%), then herbs (3.01%), and lowest in grasses (2.57%). Grasses and herbs N% were unaffected when N fertilizer rates reached 200 kg N/ha, but increased with higher N rates (>200 kg N/ha). However, N% in legumes were unaffected by all N rates.

Results suggest that there were no large benefits in using herbs instead of grasses for reducing N intake.

ABSTRACT THEME:

Technology, Modelling, Data and Automation

Assessing the reliability of short-term dynamic and statistical weather forecasts in simulating hindcast pasture growth rates

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Knowledge of seasonal pasture growth rates helps farm managers with livestock feed budgeting. Previous work using historical climates or dynamic weather forecasts from a global circulation model (GCM) has shown that 30 day forecasts from the latter provide greater skill and reliability in simulations of pasture growth rates measured in the field (Rawnsley et al. 2015).

Here we build upon this work and compare pasture growth rate forecasts generated using data from either historical climates or from the Predictive Ocean Atmospheric Model for Australia (POAMA) to hindcast growth rates from *a posteriori* measured climate data over 30, 60 and 90 day periods at two sites in southern Australia. We showed that for a 30 day forecast, the approach using POAMA data was closer to the hindcast median pasture growth rate, but only at one site. Over a 60 day period, pasture growth rates forecast from historical climates were closer to those hindcast at both sites.

We found that the variability in growth rate forecasts using POAMA data was generally less than that produced using historical climates. This implies more certainty in the growth rate forecasts generated using short-term weather data from GCMs compared with those generated using long-term historical climate data. This work is being developed into a graphical-user interface that is currently available online, allowing users to contrast forecasts of pasture growth rates from several different regions on mobile devices.

Australian AMS KPI Project: Monitoring 9 commercial farms

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This Australian AMS KPI Project will provide the industry with a better understanding of what is achievable on farms with automatic milking system (AMS). Nine farms were monitored on a monthly basis for a 12 month period to obtain key performance indicators relating to milk production, AMS utilisation and farm demographics. The majority of participating farms were milking either Holstein cows or crossbreeds.

Three farms had seasonal calving, two had split calving and the remainder year-round calving. The farms had either three, four or six single box robots, whilst one farm had a robotic rotary. All the farms except one were pasture-based managing either three or four allocations per day. On average over the nine months so far, participating farms milked 199 cows, producing 4,708 kg milk/day with a milk composition of 4.0% fat, 3.3% protein and a somatic cell count of 202,000. Individual cows were milked 2.3 times/day, producing 24.9 kg milk/day and consuming 6.5 kg concentrate/day. Each individual robot performed 122 milkings/day, operating for 14 hours/day and harvesting 1,314 kg milk/day.

There was a wide range in farm performance both within and between farms. This highlights that it is the combination of farm system and farm management that determines the whole farm performance. The NSW Department of Primary Industries has committed to increase the awareness and successful adoption of AMS in Australia. This information might help farmers that are considering investing in this technology have a better understanding of what is achievable with AMS equipment.

Cow milking order and its relationship with production in a pasture-based automatic milking system

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In pasture-based automatic milking systems (AMS) with voluntary cow movement it has been hypothesised that cows milked earlier in the milking order will have higher production than those milked later because they have access to pasture with both higher mass and nutritive characteristics.

This study investigated the consistency of milking order of cows in a pasture-based AMS and its association with milk production per cow at The University of Melbourne, Dookie dairy farm in northern Victoria, during the period October 2014 to April 2015. The farm had a herd of 122 Holstein-Friesian cows on 43 ha of irrigated pasture with three zones. During the study period cows were milked on average 2.2-3.0 times per day. Milking order during the morning milking period was recorded along with daily individual cow milk yield (litres/cow).

The correlation between daily milking order was determined, as was the correlation between order and milk production. A consistent milking order was established in the herd ($r = 0.64$) but the consistency decreased as the lactation progressed. Milking order was statistically significantly correlated to milk production ($p = -0.491$). On average cows in the first half of the milking order produced 5 litres per day more than cows in the latter half of the order.

This suggests that there is potential to utilise milking order to improve grazing management in pasture-based AMS, but further research is needed to quantify the benefits of such a strategy.

Precision grazing management: Using an innovation network approach to match farmer practice with grazing decision support tool design

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The use of pasture measurement tools and decision support software for grazing management remains limited on New Zealand dairy farms. However, effective use of such tools provides opportunities to optimise pasture grown and pasture eaten.

This study used a mixed method qualitative research approach to investigate pasture data and technology use for grazing decision making through interviews and workshops with farmers, rural professionals (RPs), commercial software developers and an expert panel. Results highlighted grazing management-related typologies where different drivers for pasture data collection existed between farm owner/operators and corporate farming operations.

Additionally, interaction between RPs and their clients' pasture data was variable. Some RPs used commercial software products, while others had built their own spreadsheets to enable specific functionality and reporting. RPs reported that many farmers did not perceive sufficient value to spend extra time and effort engaging with measurement and software. However, larger multi-farm businesses were collecting pasture data for use at a governance level as well as for operational decision making. Study participants identified a need for greater integration of software tools to connect in-paddock data capture with real-time decision support.

Also, data integration was needed to enable transfer of information across different platforms for corporate farming operations. The research highlighted a need for farmer-orientated tools that are flexible enough to match seasonal requirements of grazing decision making, such as spring rotation planning and meeting target pasture covers prior to winter. Future research will seek to identify opportunities for matching tool design with farmer practice.

Status and Future Perspectives of Smart Tools for the Dairy Industry

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The pace of technological development is vast, and exponentially increasing. Research suggests that this will also have an ever increasing impact on dairy, with the deployment of drones and sensors as just the beginning.

The demand for formal control has increased greatly in recent years. This was promoted, in part, by an increased awareness about impacts on the environment and subsequent government legislation.

The Centre of Excellence in Farm Business Management is a project managed by Agri One, a joint venture between Lincoln and Massey Universities. This is funded by two Primary Growth Partnership funds: Transforming the Dairy Value Chain and Red Meat Profit Partnership. It is an independent source for information on recent developments in farm management.

Our research into decision making and information management has shown that formalisation and the use of software solutions / apps is largely driven by compliance requirements and the perceived value add.

Albeit, or because of, the large number of smart tools available to dairy farmers a whole different set of challenges arises, namely connectivity, rural broadband and the perceived overload of data / single solutions. In the future, dairy farmers will have to be able to leverage their existing knowledge and combine this with new technologies to remain not only compliant but to stay at the top of their game. Smart systems will start 'talking' to each other (Internet of Things) in order for collected data to have the biggest impact on their business and the agri-food supply chain as a whole.

Use of Audio Stimuli to Induce Voluntary Traffic with Dairy Heifers

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The trial investigated whether it is possible for cow movement to be induced through the use of acoustic conditioning using an animal mounted device. The effect of herd 'dynamics' of cattle from this conditioning was also investigated.

Five heifers underwent testing for six days as part of an 18 day field trial (12 days of conditioning). The six day testing and data collection period involved the heifers being 'called' via a smartphone device mounted on the cheek strap of a halter. Heifers were called either as individuals or as a group. When the audible cue was sent, heifers were expected to traffic from a group holding area to a feeding area (~80 m distance) to receive an allocation of grain based concentrate. Heifers were significantly ($P = 0.001$) more likely to approach the feeding area when 'called' as a group (91% response rate) compared to when they were called as individuals (67% response rate).

When heifers did respond to the 'calling' their time to traffic to the feed area was quicker ($p < 0.001$) when they were called as a group 77.9 (± 55.4) seconds than when they were called as individuals 139.3 (± 89.2) seconds.

The ability of an audio emitting device (mounted on a heifer) to encourage the movement of a small group of heifers to a feed 'reward' was realized, however the development of a commercially viable device may be hindered by the limitations of battery and energy generation technology at present.

Dairy cattle industry and genetic improvement programmes in Thailand

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The dairy industry in Thailand has mainly developed in the last 50 years. In 2015, the population of cattle reached 509,524 across 16,248 farms with the average milking production of 12.80 kg/cow/day.

The dairy system is mainly driven by small scale farmers and cooperative organizations which have support from the Thai government. The predominant breed type is a crossbred of Holstein-Friesian with native or zebu cattle.

An up-grading by artificial insemination with Holstein-Friesian semen has been the main method of herd improvement. At present, the average Holstein-Friesian blood of dairy cattle in Thailand is more than 75%. Genetic improvement is mainly focused on milk production although recently other criteria such as milk composition, reproductive and type traits have also been included in the selection programmes.

Genetic improvement of dairy cattle in Thailand is based on genetic parameter estimates and selection using estimated breeding values. In the current research project, we are analysing the data from three major government dairy cattle farms for estimating genetic parameters and estimated breeding value of milk production and milk composition traits. The data are from 693 animals with an average 100-day milk production of 1774 kg/cow. The results will be presented at the symposium.

The cost of DNA typing is coming down rapidly and the application of molecular technology such as genomic selection is becoming very useful for animal genetic improvement. We will consider the feasibility of application of genetic markers and genomic selection for the dairy industry in Thailand.

Developing new indexes for early detection of clinical mastitis from electrical conductivity data in Automatic Milking Systems

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Mastitis adversely impacts on profit and animal welfare in the Australian dairy industry. Electrical conductivity (EC) is increasingly used to detect mastitis, but with variable results. The aim of this study was to develop and evaluate a range of indexes or algorithms created from EC data for early detection of clinical mastitis.

Four-week data from 31 infected and 120 healthy quarters were used to compare the sensitivity (SEN; target >90%), specificity (SPE; target >90%), accuracy (target >90%) and date of 'alert' by three different approaches such as EC thresholds (range 7.5 to 10 mS/cm), statistical process control (SPC) methods and over 250 indexes created *ad hoc*.

The indexes were developed by combining factors (and levels within each factor), such as % of variation; mean absolute deviation; mean error %; infected/non-infected ratio; all relative to the rolling average (3 to 9 data points) of either the affected quarter or the average of the 4 quarters. Using only EC thresholds resulted in SEN, SPE and accuracy ranging between 55% to 87%, 55% to 87% and 47% to 92%, respectively (threshold 8.5 mS/cm performed best). Top 7 indexes achieved better SPE (range 60 to 96) and accuracy (range 63 to 88) than EC thresholds approach, with SEN ranging between 55% and 77%. SPC method achieved 87% SEN but SPE (50%) and accuracy (57%) were lower than other approaches.

Incorporating other information (i.e. milk yield, blood etc.) may increase accuracy of detection. This study demonstrates the potential to create additional value from existing data.

Identifying systematic variation in the supply of home-grown feed of New Zealand dairy systems

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Pasture is generally recognised as the competitive advantage of New Zealand dairying, but relatively little is known about the volume of home-grown feed, and its variation throughout the country and between years. While regional averages and aggregated benchmarks are available, the increasing availability of more accurate and timely data at a higher spatial resolution suggests the possibility of this information being used more in a decision-making context.

This study used farm data with higher detail and more numerous observations than previous work to identify (by energetics calculation) the level of home-grown feed actually harvested spatially and temporally. It also used modelled data from a climate and soil driven whole farm model to provide an independent measure of regional and temporal variation due to climate and soil interactions. Using both forms of data provided insights into where either the model was deemed to be less accurate (due to measurement error, omitted variables or modelled relationships needing revision), or where there was the potential for farmers to achieve higher levels of harvested home-grown feed.

While there remain errors of measurement in these data-centric approaches, it is anticipated that due to requirements to keep accurate farm, soil and climate records for regulatory reasons will improve data quality over time. This will improve the ability of data-centric approaches to inform strategic decisions and operational management, with potential outcomes being an improvement in profit or increased resilience.

Simulating performance of Australian Holstein grazing cows using a lifetime nutrient partitioning model

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This study explored the ability of a lifetime nutrient partitioning model to simulate individual variability in genetic production potentials of grazing dairy cows in Australia. The model was previously developed and validated by a group of authors in France using data of cows fed total mixed ration.

Generally, the model assumes a universal trajectory of dynamic partitioning of priority between life functions. Genetic scaling parameters are then incorporated to describe genetic variation in cow performance. Performance data of 63 lactating Australian Holstein cows from an experiment, in which the experimental conditions were assumed to allow animals to express their genetic potentials, were used.

Genetic scaling parameters for each animal were derived by calibrating the model to achieve best fit to individual cow records. Curves of body weight, milk fat concentration, milk lactose concentration, and milk protein concentration were fitted with a high degree of accuracy. Daily milk yield and dry matter intake, and weekly mean body condition score were satisfactorily fitted. Intriguingly the result also indicates the current recommendations of energy required for maintenance of pasture-based cows might be under-estimated.

It could be concluded that the model can be used to simulate genetic variability in production of grazing cows although the results need to be treated cautiously as the dataset used is small. Moreover, the model might be used to investigate the impacts of future genetic selection strategies on lifetime performance and efficiency of individual cows on pasture-based system.

The impact of a shaded pre-milking yard on a pasture based AMS

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During hot weather cows typically reduce feed intake and actively seek shade and water to reduce the metabolic stress on their bodies. This can negatively impact on the occurrence of voluntary milking visits to an automatic milking system (AMS) operating with voluntary traffic, thus reducing milking frequency.

Shade is known to be effective in alleviating heat stress in dairy cattle, however, the impact of providing shade at the milking facility of a pasture based AMS on time taken to voluntarily enter a milking unit is unknown.

A herd of approximately 300 lactating cows milked in an AMS was divided into two groups during summer 2016. Each group spent 4 weeks on a SHADE (partially shaded pre-milking yard) and a NO-SHADE (non-shaded pre-milking yard) treatment with two replicates in a cross-over design. Indicators of cow comfort and time spent in pre- and post-milking areas were recorded.

Cows in the SHADE treatment were found to take longer on average to enter the milking unit (12.45 ± 0.82 min, $P < 0.001$) than cows in NO-SHADE. The temperature humidity index (THI) was greater during the second replicate which resulted in cows in the SHADE treatment having significantly reduced respiration rates (1.47 bpm less) compared to NO-SHADE cows and all cows spent more time in pre ($P < 0.001$) and post-milking areas ($P = 0.001$) compared with the first replicate regardless of treatment.

Overall, SHADE appeared to increase cow comfort with increased time taken to enter the milking facility.

Validating the accuracy of an activity and rumination monitor in dairy cows grazing two types of pastures.

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The aim of this study was to validate the data generated by a newer version of an activity and rumination collar based monitoring system (SCR HR-LDn Tag) by comparing it against direct visual observations, for 3 different types of behaviour: grazing, ruminating and low activity (LA, defined as lying or standing idle) for cows grazing either annual ryegrass or chicory-based pastures.

Eight non-lactating cows were fitted with the sensor tags and offered 10 kg DM rye grass/cow per day for 5 days. The experiment was then repeated with cattle offered Chicory. Observations were conducted by two trained observers in 2x60 minute sessions each day to capture the above-described behaviours. Behavioural measurements (visual and electronic) were recorded continuously.

Pearson correlations (r) and lineal regression models (R^2) were used to investigate the relationships between visual observations and data generated from the tags for each observation session (min/cow/session; $n=211$). Different behaviours were analysed separately. Significant correlations were found for the three behaviours (Grazing: $r=0.99$, $R^2=0.99$; Ruminating: $r=0.80$, $R^2=0.64$; LA: $r=0.96$, $R^2=0.93$, with no differences detected between the two forages.

Sensitivity and specificity were also determined for each behavioural state at a per minute level data ($n=6977$) resulting in respectively; 98.3% and 97.3% for grazing, 86.9% and 98.4% for ruminating and 77.5% and 99.1% for LA.

We conclude that the SCR HR-LDn Tag measured rumination, grazing and low activity behaviours with high to very high accuracy in dairy cows for the conditions in the current study.

ABSTRACT THEME:

The Role of Science in Dairying In The Future

The impact of genetic selection on greenhouse gas emissions in Australian dairy cattle

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In Australia, dairy cattle account for approximately 1.6% of the nation's greenhouse gas (GHG) emissions, estimated to be around 9.3 million tonnes per annum of carbon dioxide equivalents (CO₂-eq). Genetic selection has positively impacted on reducing GHG emissions in 2 ways: 1) requiring fewer cows to produce the same amount of milk and 2) lowering emissions per unit of milk produced.

The objective of this study was to evaluate the consequences of current selection practices on carbon emissions using responses to selection for the Australian national breeding objective, the Balanced Performance Index. We estimate that under current rates of genetic gain, the amount of milk-solids (fat plus protein) produced per cow will increase by 1.92 kg/year through selection on BPI and therefore we project will increase from 501kg/cow/year to 520kg/cow/year. If all cows in the current population (assumed to be 1.7 million) improve by this amount then 62,824 fewer cows would be required to produce the same amount of milk-solids. This is equivalent to a reduction of 388,252 t CO₂-eq.

The 2nd area of improvement is the reduction in emissions per unit of milk-solids i.e. a dilution effect on emissions of having more productive cows of 33.62gCO₂/kgMS/year, which is equivalent to 286,359 t CO₂-eq. After 10 years, the total annual impact of dairy selection practices on GHG emissions is projected to be 388,252 + 286,359 = 674,610 t/year, which is about 7.3% of the total current annual dairy emissions.

Where are the researchers? Implications of privatised extension networks

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Researchers have historically been an integral part of the Australian Research, Development and Extension (RD&E) system that has underpinned productivity gains in the Australian dairy industry. Researchers continue to play a critical role in supporting productivity on farm as well as developing innovative products and processes that contribute to farm profitability within an increasingly complex physical and economic world.

However, as privatisation of extension transforms advisory services, the previously strong connections between advisers and researchers are changing. New advisory business structures have become disconnected with researchers creating flow on implications for realising the potential value of research on farm.

Empirical social network analysis was undertaken to understand the effects of privatisation of dairy extension services in significant dairy regions of South West Victoria and New South Wales during 2015 and 2016. The SWV and NSW extension network structures highlight that privatisation is creating a diverse range of dairy advisory providers but few have connections with researchers. This finding is consistent with international research that shows fragmentation between advisory services and research providers following privatisation of advisory services (Klerkx and Proctor, 2013).

The critical disconnect between the advisory system and science has consequences for how advisers, and the farmers they advise, can access and incorporate research knowledge into productive practice. It also has important implications for dairy researchers wanting to ensure their research is applied effectively on-farm. Further work is needed to understand how the weakening of connections between researchers and private sector advisers is affecting dairy productivity and sustainability.

ABSTRACT THEME:

Welfare, Intensification And Value-adding

Future scenarios selection tool for heat tolerance in Australian dairy cattle

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Climate change will impact dairy cow performance. Dairy cattle milk production declines with increasing temperature-humidity index (THI) and there is genetic variation in this decline. We developed genomic predictions of a heat tolerance (HT) phenotype using SNP genotypes. Selection for milk production, a key dairying economic driver, is expected to reduce HT, as these traits are genetically unfavourably correlated.

We developed a future scenarios selection tool, enabling farmers to make decisions that balance selection of current economic drivers with a proposed HT genomic estimated breeding value (GEBV). HT GEBV were predicted for 12,062 cows and 10,981 bulls using an established prediction equation. Public projected daily average temperature and humidity data were used to estimate mean daily THI dairy herds may experience in the future. We expressed HT breeding value in monetary terms: $BV_{HT} = \alpha + \beta_1 \cdot HT + \beta_2 \cdot Milk + \beta_3 \cdot Fat + \beta_4 \cdot Protein$; where BV_{HT} is HT breeding value; $\alpha, \beta_1, \beta_2, \beta_3, \beta_4$ are economic weight of milk, fat and protein, are HTGEBV relative to milk, fat and protein, and β_5 is the heat load (number of temperature-humidity index units exceeding the threshold per year) at a location. HT breeding values were incorporated into the Balanced Performance Index (BPI) as: $BPI = BV_{HT} + \beta_5 \cdot HL$; where BPI is the "modified BPI" breeding value including HT.

A web-based application was developed enabling farmers to visualise herd heat load for a particular year and take steps to make genetic improvement in future generations by selecting bulls and cows that rank highly for the modified BPI.

Training dairy heifers to respond to a sound stimulus in a T-maze setup

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Dairy cattle rely on their acute sense of hearing to receive sound signals, interpret their environment and modify their behaviour.

Applying sound signals to call cattle for milking presents the opportunity not only for dairy farmers to better their lifestyle by alleviating workload, but to also improve cow productivity and welfare.

This study determined the ability of dairy heifers to be trained to follow a 500 Hz, 70 dBA sound stimulus positively reinforced by pelleted grain-based concentrate (GBC). Over 21 days in a symmetrical T-maze six heifers were habituated, side preference tested then conditioned with classical and operant techniques to associate a sound signal with GBC. I

ndividual decision making was tested and herd dominance was examined through a feed-motivation task. Heifers correctly chose the side of the T-maze where sound was emitted 54% of the time on day one of testing which significantly increased to 92% by the final day of the experiment ($P = 0.006$). While correct responses improved with increased training there was little evidence of decreasing time to access the GBC.

Despite five out of six heifers exhibiting side preference to the T-maze, this behaviour did not impact the ability to be trained. There was no influence of dominance on the ability for each heifer to learn the sound signal ($P = 0.35$).

We conclude that heifers have the cognitive ability to respond to a sound signal warranting further investigation into the application of sound stimuli on farm.

ABSTRACT THEME:

Other areas of interest

Effect of timing of pasture and silage allocation on behaviour, feed intake, and milk production of grazing dairy cows during Autumn

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We evaluated the effects of timing of pasture and grass silage allocation on the behaviour and milk production of dairy cows grazing perennial during autumn. Over 57 days, 45 multiparous Holstein-Friesian cows (519 kg live-weight, 24.5 kg milk/d and 57 days in milk) were allocated to three treatment groups: 75% of the herbage and 25% of the silage allowance were allocated in the morning; 50% of the herbage and silage allowance were allocated in the morning; and 25% of the herbage and 75% of the silage allowance were allocated in the morning. All treatments received the complement of herbage and silage in the afternoon.

All groups were strip-grazed with an herbage allowance of 21 kg DM/cow/d, and supplemented with 3 and 3.5kg DM/cow/d of silage and concentrate, respectively. Milk production (kg/d) was recorded at each milking (07:00 and 14:00 h), and daily dry matter intake was estimated using Cr₂O₃. Grazing, rumination and idling times were recorded for each cow over 24h, twice. Treatments did not affect any of the measured variables ($P>0.05$). Milk production averaged 22 kg/d, while total and herbage intake averaged 14.2 and 7.7 kg DM/d per cow.

Averages of grazing, ruminating and idling times were 343, 344 and 683 min/d, respectively. These results suggest that, under the conditions of the present study (low herbage mass and intake, and high level of supplementation), combinations of timing of pasture and silage allocation may not alter feed intake, grazing behaviour, and thereby milk production.

Pre-weaning mammary gland development: The influence of nutrition

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Recent research suggests that enhanced early nutrition can increase future milk yield. We hypothesized that such feeding "primes" the MG to better respond to mammogenic stimuli. This might explain the effect on milk yield. Thirty-six Holstein heifer calves were fed either a restricted milk replacer (MR; 20% crude protein (CP); 20% fat; 0.45 kg powder/head/day) or enhanced MR (28% CP; 25% fat; 1.13 kg powder/head/day) diet for the first 8 weeks of life. Calves were housed individually and pair-fed starter beginning at week 4.

At weaning (week 8), a subset of calves from each diet were sacrificed (n = 6). Half the remaining calves on each diet (n = 6) received an estradiol (E2) implant. At the end of the 10-week trial remaining calves were sacrificed. Enhanced-fed calves had increased weight gains and weaning weights. Enhanced-fed calves had a 5.9 fold increase in mammary fat pad mass and a 7.3-fold increase in mammary parenchyma (PAR) mass. Composition of the PAR was unaltered by diet. Enhanced-fed calves given E2 had the greatest PAR Growth.

Furthermore, enhanced-fed calves had greater estrogen and progesterone receptor expression intensity and increased cell proliferation. These results suggest that early life nutrition can profoundly influence the developing mammary gland and that a nutritive 'priming' mechanism is at play in the MG at this young age. Further analyses are needed to confirm our conclusions.

Smarter Irrigation for Profit - Increasing farm profit through efficient use of irrigation input to dairy pastures

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The dairy industry is the second largest user of irrigation water in Australia. Increasing competition and cost of irrigation water, along with reduced availability and increasing climate variability are key motivating factors to adopt innovative practises and technologies that utilise water as efficiently as possible. The average water usage of Australian dairy farms is 6.3ML/ha, with each ML generating a value of approximately \$430.

Over 75 percent of the dairy farms in Australia are pasture-based systems and in spite of this fact, and recognition that pasture utilisation is a key profit driver in pasture based dairy systems, pasture utilisation across the industry has remained at 50-60 percent of what is potentially possible. Effective management of the spatial and temporal variability in water demand is viewed as the key to optimising pasture production. Automated precision irrigation is now possible with the deployment of cheap sensors, crop models, and irrigation control systems bundled in appropriate built-in technology. This significant step change in irrigation system capability offers an opportunity for a significant step change in irrigation performance for all irrigators.

This paper provides an overview of how detailed monitoring of five intensively managed irrigated dairy farms in Tasmania is being used to review and enhance industry performance benchmarks to increase the adoption of enabling practices and new technologies for pressurised irrigation systems in pasture based dairy systems.

The additional effect of dairy farm intensification on farm operation, economics and risk

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Recent intensification of New Zealand dairy farms appears premised on both increased production and milksolids (MS) price covering the increased capital and running costs resulting from intensification. This paper examines the effect of intensification on production and profitability of a self-contained pasture-fed 330-cow dairy farm (DairyNZ System 1). A resource allocation model analysed increases in the farm's herd from 330 cows through 375, 450, 525, 600 to 700 cows (DairyNZ System 5). Each discrete additional capital investment altered Income and farm working expenses. There were two options: average per-cow production constant or increasing. Each herd-size scenario was run for prices ranging from \$4.20 to \$10/kgMS in order to identify what level economically justified intensification and to estimate price change risk.

It was found that for constant per-cow production, System 2 and System 3 scenarios were more profitable but slightly riskier than System 1 at above \$4.20/kg MS. System 4 was less profitable than Systems 1 - 3 at less than \$7/kg MS. System 5 was the least profitable and riskiest scenario. Where per-cow production increased, Systems 2 - 4 were more profitable and marginally riskier than System 1. System 5 was more profitable than System 1 at over \$7/kg MS but never as profitable as System 4. System 5 was the riskiest scenario. The possibility of Nitrate leaching constraints and GHG levies limits profit above System 3 intensification. The model provides a means to decide a level of intensification using ones perception of future MS prices and attitude to risk.

A novel serological assay for detection of *Mycoplasma bovis* infection in cattle

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Mycoplasma bovis is a contagious mastitis pathogen and its importance has increased worldwide due to its increasing resistance to antimicrobial agents and the lack of an effective vaccine. *M. bovis* has been recognised as a significant pathogen in Australian dairy herds since 2006 and has been found in all dairy regions. The lack of suitable diagnostic tools for extensive screening has hindered our ability to determine its full impact in the cattle industry.

We have developed a novel enzyme-linked immunosorbent assay (MilA ELISA), based on a recombinant fragment of the protein MilA (MBOVPG45_0710) and have shown its potential as an effective diagnostic tool. We assessed its performance by applying Bayesian latent class modelling to MilA ELISA results from 7,448 cattle entering Australian feedlots. Under field conditions in feedlot cattle at a globally optimal cut-off, the diagnostic sensitivity of the assay was 94.3% and its diagnostic specificity was 94.4%.

We also optimised the MilA ELISA to test milk samples from dairy cattle and assessed a Victorian dairy farm with a previous history of *M. bovis* outbreaks in the milking herd but with no current evidence of clinical infection. We found that 28% of the cows tested from the milking herd were positive for *M. bovis* specific antibodies in their milk.

Overall these results suggest that this assay is useful as a diagnostic tool for epidemiological investigations to better estimate the impact of *M. bovis* on animal welfare and productivity and to aid in the development of control measures for *M. bovis*.

Dairy Businesses for Future Climates

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The Australian dairy industry has been on an intensification pathway over recent decades, utilising higher levels of inputs to produce milk, however this pathway has been questioned in light of projections for warmer and more variable future climates.

'Dairy Businesses for Future Climates' was a transdisciplinary research project that investigated the opportunities and trade-offs between dairy farm systems in future climates. Integral to the project's success was the interaction between biophysical, economic and social research teams and regional working groups (RWGs) consisting of industry representatives in the target regions: Fleurieu Peninsula; central Gippsland; and north-west Tasmania.

The RWGs identified a case study farm and three contrasting development options representing relevant systems that 'Intensify' (increased stocking rate and off-farm resources), 'Simplify' (reduced stocking rate and off-farm resources) or 'Adapt' (re-organise current resources) the case study farms. Climate change was predicted to reduce profitability of all options in all regions, but farmers were generally confident to adapt.

Climate change appears to be some impediment to intensification, but it is likely that a range of development options will be implemented depending on the farms' unique resources, skills and goals. Intensify options were also considered more stressful and threatened by the withdrawal of the social license to operate due to animal welfare concerns and environmental issues.

Results highlighted that systems changes to align with projected changes in climate (such as Adapt options) or Simplify the production system are realistic alternatives to the long term trend for intensification for dairy businesses in future climates.

Effect of timing of pasture and silage allocation on nitrogen partitioning and milk production of grazing dairy cows in autumn

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We evaluate the effect of timing of pasture and grass silage allocation on nitrogen partitioning and milk production of dairy cows grazing perennial grass swards during autumn.

Over a period of 57 days, forty-five multiparous Holstein-Friesian cows (519 kg live-weight, 24.5 kg milk/d and 57 days in milk) were randomly allocated to three treatment groups: MHA, 75% of the herbage and 25% of the silage allowance were allocated in the morning; BHA, 50% of the herbage and silage allowance were allocated in the morning; and AHA, 25% of the herbage and 75% of the silage allowance were allocated in the morning. All treatments received the complement of herbage and silage allowance in the afternoon.

All groups were strip-grazed with an herbage allowance of 21 kg DM/cow/day, and supplemented with 3.0 and 3.5 kg DM/cow/day of grass silage and concentrate, respectively. Milk production (kg/d) was recorded at each milking (07:00 and 14:00 h). Milk, food and faecal samples were collected on weeks 7 and 8 to estimate the nitrogen intake and milk, faecal, and urine nitrogen content.

Treatments did not affect milk production, nitrogen intake and urine and faecal N/N intake, averaging 22.0 kg/d, 458g/d, 42% and 32%, respectively. Only milk N/N intake tended to be higher in MHA than BHA and AHA ($P=0.09$; 27.0, 25.0 and 26.0%, respectively).

Therefore, under the conditions of this study, the combinations of timing of pasture and silage allocation did not modify milk production and nitrogen partitioning.

Effect of timing of silage supplementation on feed intake, milk production and grazing behaviour of dairy cows during autumn

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We evaluated the effect of timing of silage supplementation on milk production and grazing behaviour of dairy cows, grazing swards with low herbage mass.

Throughout 63 days, thirty-six multiparous Holstein-Friesian dairy cows (509 kg liveweight, 22.9 kg milk/d, 60 days in milk), were randomly allocated to three treatment groups: 1) MMS, morning maize silage supplementation and evening grass silage supplementation; 2) EMS, morning grass silage supplementation and evening maize silage supplementation; and 3) Control, morning and evening maize and grass silage supplementation in equal amounts.

All groups were strip-grazed with an herbage allowance of 17 kg DM/cow per day offered during evening. Daily silage allocation was 3 kg DM/cow. In addition, all cows received 3 kg DM of concentrate fed twice daily at milking. Dry matter intake was estimated using Cr₂O₃. Grazing, rumination and idling times were recorded over a 24 h period for each cow, twice. Milk production (kg/d) tend to be greater (P=0.07) for MMS compared with EMS and Control.

On average, total (14.4 kg) and herbage (5.4 kg) dry matter intake were not affected by treatment (P>0.05). Grazing time did not differ between treatments (P>0.05), averaging 336 min/d. Morning grazing time tended to be greater in MMS compared with EMS and Control. Afternoon grazing time was greater in Control than EMS (P<0.00), but similar to MMS.

These results suggest that, under the conditions of the present study, supplementing maize silage during the morning alters grazing time and tend to increase milk production.

Effect of timing of silage supplementation on nitrogen partitioning and milk production of grazing dairy cows grazing during autumn

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We evaluate the effect of timing of silage supplementation on nitrogen partitioning and milk production of early lactation dairy cows, grazing perennial swards in autumn.

Over a period of 63 days, thirty-six multiparous Holstein-Friesian dairy cows (509 kg live-weight, 22.9 kg milk/d, 60 days in milk), were randomly allocated to three treatment groups: MMS, morning maize silage supplementation and evening grass silage supplementation; EMS, morning grass silage supplementation and evening maize silage supplementation; and Control morning and evening maize and grass silage supplementation in equal amounts.

All groups were strip-grazed with an herbage allowance of 17 kg DM/cow/day offered during evening. Daily silage allocation was 3.0 kg DM/cow. In addition, all cows received 3.0 kg DM of concentrate. Milk production (kg/d) was recorded at each milking (08:00 and 15:00 h). Nitrogen partitioning was evaluated during weeks 7 and 8; during this period, milk, food and faecal samples were collected once a week to estimate the nitrogen intake and milk, faecal and urine nitrogen.

Milk production tended to be greater for MMS compared with EMS and Control ($P=0.07$), averaging 20.5 kg/day. Nitrogen intake and milk N/N intake were unaffected by treatment ($P>0.05$), averaging 386 g/d and 26%, respectively. Urine and faecal N/N intake were lower and higher in Control than EMS, respectively.

These results suggest that, under the conditions of the present study, the morning and afternoon grass and maize silage supplementation can improve nitrogen excretion without having an effect on milk production.

How does stage of lactation and breeding worth affect dry matter intake, milksolids production, and feed conversion efficiency of grazing dairy cows

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This study investigated the effect of stage of lactation and Breeding Worth (BW) index on dry matter intake (DMI), milksolids production (MSP), and feed conversion efficiency (FCE) of grazing dairy cows.

Two hundred Friesian × Jersey crossbred dairy cows with similar calving date (14 August ± 9.97 days; mean ± SD), live weight (471.5 ± 44.02) and age (7.5 ± 1.25 years) were randomly grouped into five groups (n = 40) based on New Zealand BW index: Low BW (BW = 63.1 ± 13.96); Medium Low BW (BW = 88.2 ± 6.23); Medium BW (BW = 119.1 ± 5.51); Medium High BW (BW = 128.9 ± 5.89); and High BW (BW = 146.9 ± 5.71). Milk samples were collected in early, mid and late lactation, and herbage samples were taken the day before milk sampling.

The DMI was estimated by back-calculation based on metabolisable energy requirement for maintenance and production. The MSP, DMI and FCE declined from early to late lactation. Regardless of stage of lactation, cows with higher BW had a higher DMI, MSP and FCE.

The results suggest that cows of increased genetic merit had greater FCE when measured on farm.

Structural changes in global dairy markets are resetting dairy prices

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Global dairy markets are currently undergoing structural change. This change is due to a series of political, technological and other systemic factors across the major dairy-producing nations. The magnitude of the change anticipated is now expected to result in a significant reset of dairy economics across the globe. Political changes and rising living standards have resulted in changes to global dairy markets over the past 15 years stimulating unprecedented demand growth.

Since the mid-2000s, increased demand across Asia has led to the complete depletion of intervention stores in the United States and European Union, resulting in demand growth outpacing supply growth by 50-100%. However, the recent removal of milk quotas from the world's largest collective milk producer (the EU) has created the opportunity for significant dairy expansion, especially in the non-traditional dairying regions of central and eastern Europe.

In addition, the political policies of the world's third largest producer, the United States, will influence global dairy supplies well into the future. Current dairy production in the United States is being stimulated by low feed prices (substitution of corn to biofuel has nearly collapsed), which constitute up to 80% of farm input expenses. Further production stimulus from the United States is expected with the introduction of the Dairy Margin Protection Program in 2014, whereby farmers can now insure against falling milk-to-feed price ratios.

This is further expected to encourage milk production when market signals suggest that supply growth should otherwise slow. The extent of these structural changes is not expected to spare any major economy, and an ongoing downward reset is in store for global dairy prices, especially those economies with a significant tradable component across borders.

Understanding pasture performance – the interaction between pasture yield and virus load

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In New Zealand, livestock-based agriculture is an essential component of the economy, and at the very core of virtually all livestock-based farming systems in New Zealand is a pasture comprised of perennial ryegrass (*Lolium perenne* L.).

The productivity of these particular industries is inextricably linked to and influenced by the quality and performance of the ryegrass. However, previous research indicates that ryegrass pastures can be infected with multiple viruses, and that the incidence of viruses within a ryegrass pasture can potentially increase over time.

Considering the significance of ryegrass to agricultural productivity, these findings are concerning, as multiple virus infections and increasing viral load or incidence within a pasture could potentially undermine the productivity and persistence. The extent to which this happens is yet to be fully ascertained.

The purpose of this research was to determine the impact of multiple virus infections and increasing viral load upon the yield and persistence of ryegrass. Small pasture plots consisting of ten year old and one year-old ryegrass tillers respectively were screened for multiple viruses. Viral load was quantified using rt-qPCR. Additionally, the yield of old and new ryegrass was compared over time. Preliminary results indicate that viral load was greater in the 10-year-old ryegrass and that the one year old plots yielded significantly more.

