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This Symposium could not proceed without the hard work and dedication of the staff of the Dairy Science Group in particular, Mrs. Sherry Catt.

PREFACE

The focus the 2008 Dairy Research Foundation (DRF) Symposium is on the future. The FutureDairy Feeding Module and Automatic Milking Module will be on display. We will also address some key issues such as milk prices and input cost trends in the future, carbon trading and labour management availability.

Tim Hunt (Rabobank), Fran Hernon (Nestlé) and Ron Storey (Australian Crop Forecasters) will talk about prediction and likely future trends in milk prices and input costs (in particular, fertiliser and grain). With the recent turmoil of the economic systems I am sure that this session will elicit an interesting and fruitful discussion.

As always, a great and enthusiastic group of young scientists will present their work in very brief presentations to make the industry aware of their work.

During the second day we will focus our attention on labour and labour management. Labour is likely to really restrict expansion of the dairy industry in the future and robotic milking will be one important development in this area. Other options to be looked at are share farming, overseas workers on work visas and attracting staff by simply being a good manager. We have excellent speakers on all these topics.

In the afternoon, Warren Parker from New Zealand will clarify how carbon trading will impact on dairy farming in the future. This is an extremely important issue that can offer dairy farmers the possibility of being leaders in the safeguard and preservation of our environment.

We are grateful to the major dairy industry companies (Dairy Farmers, National Foods, Weston Animal Nutrition, Bega Cheese) that are again sponsoring 15 young farmers to attend the symposium. They pay travel and accommodation and the DRF provides free registration.

During the annual dinner we will be presenting the NSW Food Authority Dairy Science Award to Tony Dowman, who has given a significant contribution to the dairy industry by providing guidance and leadership in teaching, research and extension for 40 years.

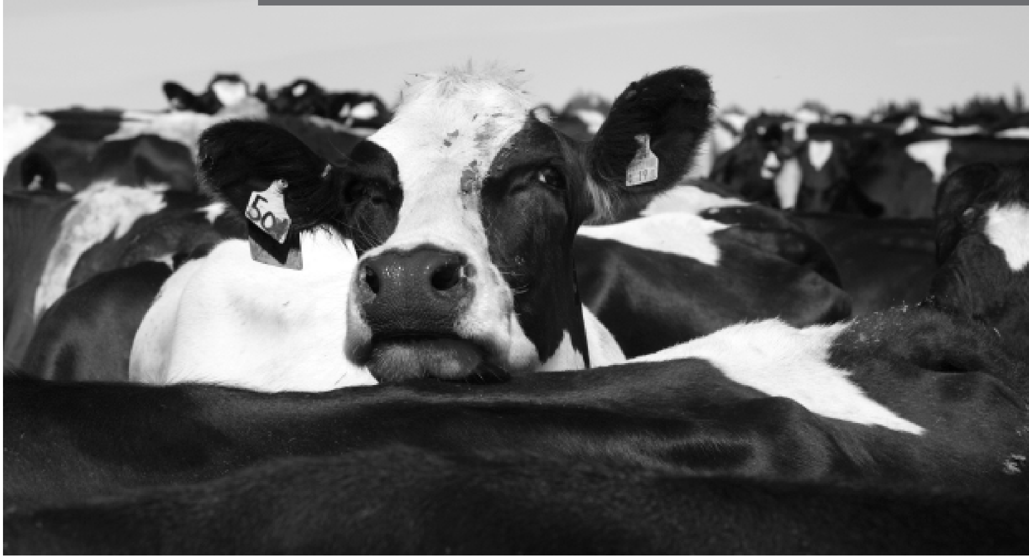
I would like to acknowledge the invaluable contribution of Prof Bill Fulkerson in the organisation of the DRF Symposium. I am also grateful to the DRF Symposium Committee and to the Dairy Science Group (Faculty of Veterinary Science) for their help and support.

I trust that you will enjoy this year DRF Symposium.

Kind regards

Dr Pietro Celi

Chairman, Dairy Research Foundation Symposium



Grains and Feed Future for Dairy Cows – Commodity Buyers or Energy Managers?

Ron Storey

Managing Director, Australian Crop Forecasters Pty Ltd

Introduction

Note: *This is an outline paper for purposes of inclusion in the symposium papers. Due to the dynamic nature of seasons and grain and feed markets, more detailed and up-to-date information will be provided at time of delivery of the paper at the symposium.*

The Australian dairy industry is consuming more grain and concentrates per cow. It has risen by about 25% over the past five years (graph to be provided showing national annual grain consumption at around two tonnes per cow per year). Against this background, the Australian dairy industry needs to consider how its growing appetite for grain and concentrates fits into its position as a major customer of Australian grain.

This paper therefore addresses the following themes from a dairy perspective:

1. World supply and demand for grains
2. How well is the Australian grain supply chain structured to meet the rising dairy consumption?
    - from a supply and volume standpoint?
    - from a quality and delivery standpoint?
    - from an efficiency and transaction sense?

World Supply and Demand for Grain

- grain prices have risen to all-time records over 2007-8 (graph to illustrate)
- driven by combination of (1) strong and rising world demand for food, feed, fuel (2) series of poor production years from early 2000's
- consequent running down of world stocks
- stocks-to-use ratio of wheat, feedgrains, oilseeds have dropped to very low levels, causing price volatility and record price levels

- these high prices are encouraging farmers to grow more grain: in the process of rebuilding stocks (providing seasons behave!)
- reality of rising world population and declining arable land per person means food prices likely to stay strong through next decade (see graph)
- the wild cards are largely political: biofuel policies (will food crops into fuel be sustained?), climate change (will global efforts re carbon emissions impact agriculture?)

Australian Grain Supply Chain

- Australia is typically (barring serious drought disasters like 1982, 2002, 2006) a grain exporter – we produce much more than we need domestically.
- BUT, due to the rapid growth of intensive livestock industries down the east coast (especially feedlots and dairy), the domestic grain market has become highly regional. For example, based on an average crop, Victoria has become almost totally a domestic market, with little likelihood of major exports from that state into the future.
- Other regions which show high domestic shares are southern Queensland, Riverina and S-E South Australia.
- The tradition of country silos connected with long trains of export grain wagons to port terminals is becoming the exception rather than the rule in these high demand domestic regions.
- Growth of on-farm storage and direct road trucking to customer is becoming the norm – this is putting extreme pressure on rural road capacity and trucking capacity to meet this demand.
- For the east coast, the typical grain "transport unit" is shifting from a train load to a B-Double. How well is the average dairy farm equipped to handle a B-Double, or is there a more economic unit required where grain moves direct from farm to farm, as opposed from farm to feedmill?
- Are the traditional grain storage systems still pointed towards the port, rather than towards the domestic consumers?

Dairy Demand and Domestic Grain Supply and Volume

- This is essentially a regional question. Nationally, Australia is almost always in comfortable surplus for exports. But at a local regional level, it can be a very different story.
- For Victoria, S-E South Australia and southern NSW, there is now an almost constant question of whether the crop is large enough to meet local demand?
- The dairy demand in Victoria is now very large and consistent, such that it dominates the local demand (almost 2 million tones out of a total feedgrain demand of 3.3 million tones, and a total grain demand of just over 4 million tonnes for the state).
- Dairy consumers therefore compete for grains with flour millers, maltsters, feedlots, poultry, and pigs.
- For southern Queensland, the main competition is from feedlots, but now also from an ethanol plant on the Darling Downs. This region is fundamentally different to S-E Australia because of the availability of summer crops (sorghum, maize) and winter crops (wheat, barley), so the supply risk is different.
- This regional supply/demand balance brings into focus the issue of supply and price risk management for dairy consumers – we cannot just assume the supply will be adequate at our local level.

Australian Grain Supply – Quality and Delivery to Dairy?

- Australian grain quality standards have been historically drawn up around human consumption processing characteristics – for flour millers and for barley maltsters.
- A diary cow's rumen does not have the same processing requirements as a flour end product or beer! The cow's end product is milk and the primary driver of processing efficiency for milk conversion is energy, not protein or extensibility or germination levels which might be appropriate for the milling/malting processors.
- On-site testing at grain delivery points does not recognize the primary value driver for the animal industries – i.e., energy! And grain growers are paid for the characteristics which deliver value to milling/malting, but not for what delivers value to cows.

- This aspect of quality and delivery to dairy cows needs to change if dairy farmers are to pay for what delivers them more milk.

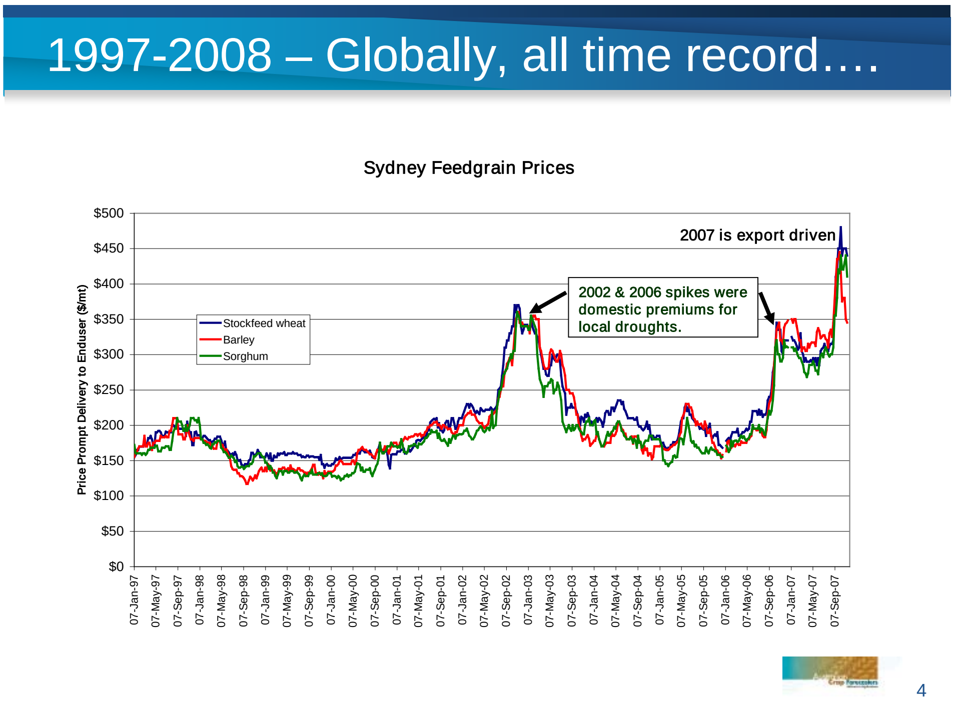
Australian Grain Supply – Delivery and Transaction Efficiency?

- Understanding what customers want is the first rule of marketing.
- It is yet to be embraced by the grain and dairy industries (with some minor exceptions).
- Grain contracts, the language used, the building of customer-supplier relationships – these are all areas which must accompany the shift required to make the grain farmer – dairy farmer relationship a win-win outcome. Each sector is now fully inter-dependent, with great growth prospects given the Asian demand on Australia's doorstep.
- Grain farmer to grain trader to major domestic/export customer contracts and relationships are well established over decades of business. In contrast, the grain-dairy relationship - which is much more fragmented due to the nature of dairy demand in small, regular deliveries often to regions outside of mainstream grain growing regions – is just starting to form.
- The contracts, payment terms, storage, freight, financing of stock, etc all need to reflect the nature of that relationship. Presently, these relationships are expressed more as an afterthought to the traditional grain commodity trading business.
- "The money in a grain transaction is not in the invoice price, it is in the contract execution". The truth in this statement must be grasped by the dairy industry to ensure they can mange all facets of the contract relationship, not just the price, to turn more of the grain into milk, which is what adds to their bottom line.

Summary Messages for Efficient Grain to Milk (Profit) Conversion

- Understand the macro position of dairy as a grain consumer in the world
- Manage your exposure to supply risk if you are in a finely balanced domestic supply/demand region
- Recognise the delivery path most relevant to your feed supply (transport modes)

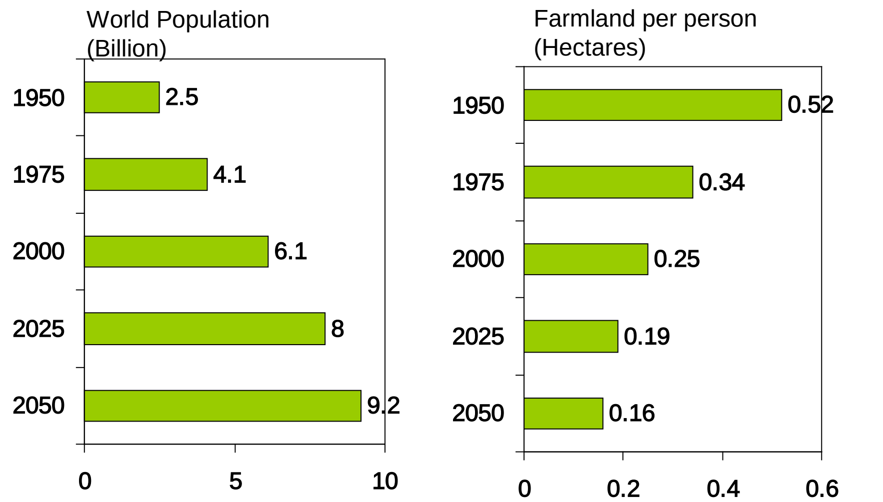
- Change the quality descriptions to what cows want for more milk, not what millers/maltsters want for processing
- Design the contracts and rules to govern the grain-dairy relationship for future mutual growth.
- This will not be easy, but the prize is worth it!



US Stocks to Use/Prices 2004-2009

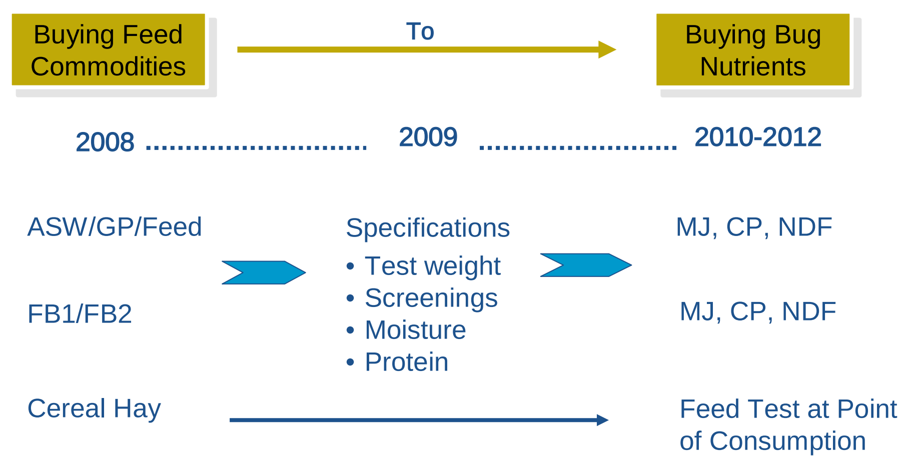
	04/5	05/6	06/7	07/8	08/9	09/0
Wheat	21% $3.40	25% $3.42	20% $4.26	11% $7.25	24% $6.25	?? ??
Corn	20% $2.06	17% $2.00	12% $3.04	12% $5.00	7% $6.00	7% $6.00
Soybean	9% $5.91	16% $5.66	19% $6.43	4% $11.00	4% $12.00	5% $14.50

Food Supply: A Global Challenge



Limited arable land and continuously growing world population, the available farmland per capita is expected to further decrease dramatically

Start with the basics - A Shift From…



Dairy Farmers Whole Milk
Australia's Best Tasting Milk
At Dairy Farmers, we pride ourselves on quality and are dedicated to bringing you the best tasting milk there is. That's why we're proud to announce that our Dairy Farmers Whole Milk won the 2007 GRAND CHAMPION DAIRY PRODUCT award.
At Dairy Farmers, the milk comes first.
OPEN
USE BY
Dairy Farmers
Milk
Australia's Best Tasting
GRAND CHAMPION 2007
AUSTRALIAN GRAND DAIRY AWARDS

The Emerging Consumer

Fran Hernon

Corporate Affairs Manager, Nestlé Australia Ltd

Background

In the food chain, from farm to fork, the consumer is the powerful end stakeholder. Today, the consumer as we've known them is beginning to change. A new consumer is emerging, with new concerns about their world. For Nestlé, as the world's leading nutrition, health and wellness company and its largest food and beverage manufacturer, it is integral to our ongoing business success that we understand this new consumer and how their needs and values may begin to drive change in our industry.

Introduction

A myriad of consumer research papers from Australia and abroad tell us consumer habits are changing. In their recent study, *Trust Through Traceability*[1], IBM christened this emerging consumer the *Omni Consumer.*

The *Omni Consumer* is well informed and concerned about all aspects of the product – from where it is sourced through to how it is disposed. As IBM says, they are more concerned, connected and empowered than ever.

At Nestlé, our own studies show that concern over environmental sustainability emerging from the rise in ethical consumerism over the past decade. Ethical consumerism covers social, environmental and economic areas and although the dominant area has been social (life balance, time for me etc), there is now a discernible swing towards the environment, driven by increased attention from media and government.

So how is this consumer affecting businesses like yours and ours? And what are the implications down the track for all stakeholders in the food supply chain?

This paper will cover five key areas –

1. Who is this new consumer
2. The new consumers' concerns
3. The retailers' role
4. What this means for the supply chain
5. Nestlé & Dairy

1. Who is this New Consumer?

In general terms the new consumer is curious about packaging, looks for environmentally friendly products and wants to know how and where products are sourced, where they are grown and how they are disposed.

They want products that deliver incremental Health and Wellness, coupled with an understanding of the impact these products have on individuals, society and the environment. Traditionally, marketers talk about the Four Ps – Price, Product, Place and Promotion. We are now witnessing the rise of the fifth P – Planet. The challenge is to deliver products that meet consumers' needs as well as their desire to help the earth.

2. Their concerns

This emerging consumer is focused on six key concerns:

- Healthy
- Local
- Social responsibility
- Environment
- Simple Living
- Control

These values encompass a myriad of other issues such as water shortage, transport, energy efficiency, rising sea levels, recycling, animal extinctions, deforestation, organics, local food sourcing and pesticides. These issues are all interlinked and pretty much undifferentiated in these consumers' minds (Hartman Report on Sustainability[2]) and they manifest across all levels of the supply chain.

Of product and packaging they ask: "*Does it contain trans fats, whole grains, etc*." or *"Is this packaging recyclable?"*

For consumer product companies they ask: *"Is it environmentally sensitive?*", *"What do NGOs say about them?"* or *"Is management responsible?"*

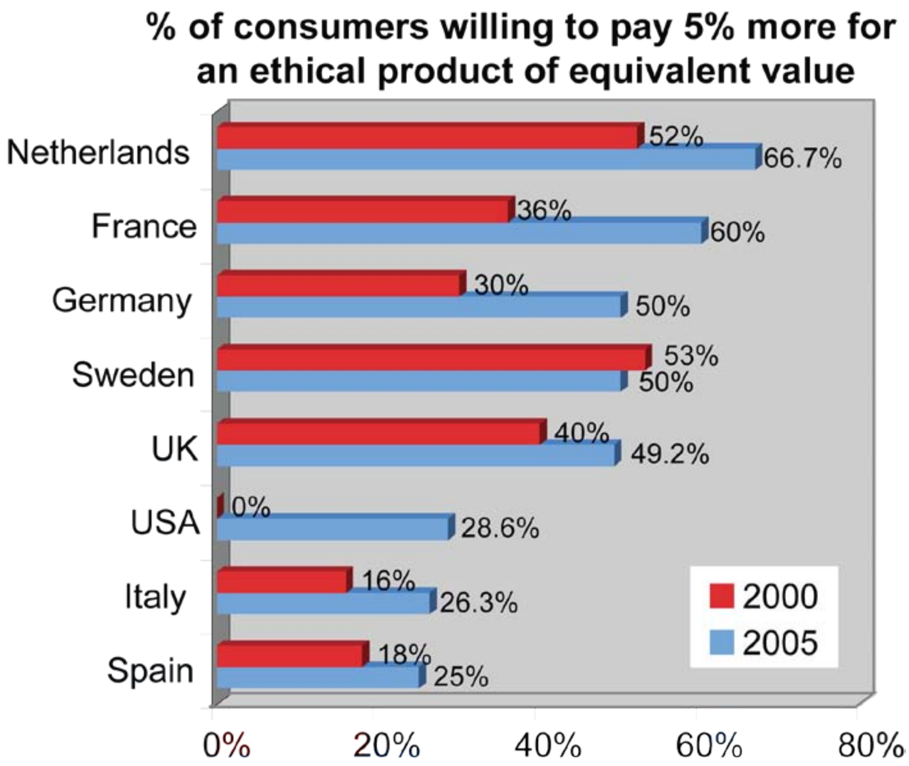
Of the retailer they ask: "*Does it stock healthy and organic?"*, *"Are employees paid fairly?"* or *"Do I feel good shopping there?"*

Of suppliers they ask: *"How are animals treated?"*, "*Is harvesting sustainable?"* or "*Who certifies operations?"*

An AC Nielsen and Oxford University study conducted across 47 countries including Australia in mid-2007 found that concern over climate change had more than doubled in six months to become the fourth major concern for consumers globally, not just in developed nations.[3]

Climate change is a very real concern for this consumer. Equally, so is trust. A range of studies show that they are sceptical of the product claims we are making, driven in large part by the plethora of confusing claim and counter claim about health benefits of various ingredients and spurious environmental claims – known as "Greenwash".
For Nestlé, we recognise that our business is built on trust, so in order to maintain this we insist that our product claims are both credible and transparent.

Ethical product also rates high on the consumers' scale of concern. As the table below indicates, European consumers are willing to pay 5% more for an ethical product of equivalent quality. Increasingly consumers are thinking about product conditions and country of origin and they are demanding ethical credentials to be transparent and independently verified.



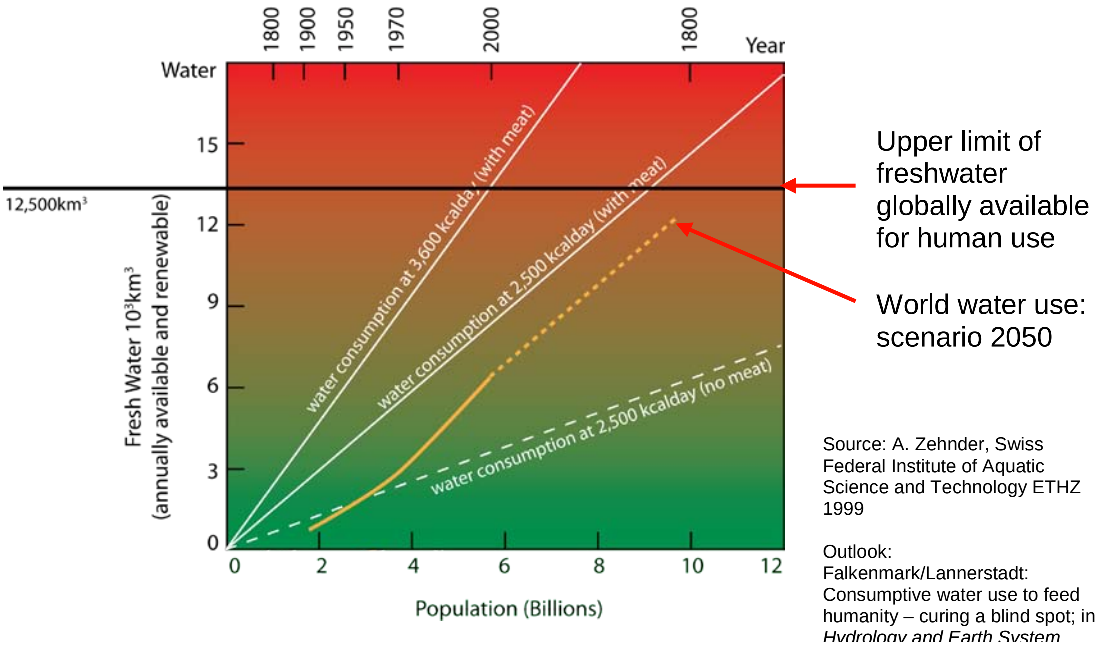
Source: Datamonitor Acknowledgement: IBM Corporation 2007

Nestlé's experience in the United Kingdom, where we launched our Partners' Blend Fair Trade coffee, shows that there is still a disconnect between consumer idealism in surveys and their behaviour at the checkout. Price still rules. However, it is clear that the green undercurrent has the power to change behaviour over time.

Water, its sourcing and consumption is also a major issue for the emerging consumer, and for us at Nestlé. The risk of water shortage, particularly water for agriculture is a key concern. Water is overused throughout the world and most consumption is not driven by households but rather by agriculture. Up to 70% of fresh water withdrawal is in agriculture with a total of 93% of water usage consumed by agriculture. The agricultural industry and its practices, especially water use, will increasingly become a focus for the New Consumer and retailers alike.

The graph below estimates by 2025 that one third of the world's population will be affected by water scarcity. According to Frank Rijsberman, Director General, International Water Management Institute: "If current trends continue and water shortage gets severe, we could be facing annual losses in farm production equivalent to 30% of global grain crops."

We need to fully understand the role that various factors - including diet, pricing and politics - play in the consumption of water. Nestlé believes that if the world continues with its current usage we will run out of water long before we run out of oil.



3. Retailers' Role

In response to the new consumers' concerns over the traceability and reliability of products, retailers are turning to suppliers for answers and accountability on how and where products are sourced. One result is carbon footprint labelling.

In June this year, Tesco, the large supermarket chain in the United Kingdom started putting the first carbon counts on what will eventually be 70,000 products. It has been working with the Carbon Trust to find accurate methods of labelling. Retailers such as Tesco and Marks and Spencer in the United Kingdom are taking the lead on these types of issues and, in turn, are applying pressure on their suppliers to comply. Suppliers are having to figure out methods of accurate tracking and monitoring of how and where they source their products and whether this is best practice.

In Australia, although the consumer's voice is growing louder, pressure is currently greater from retailers in this regard. From the retailers' viewpoint, Westpac and McDonalds have asked if we can supply them with Fair Trade coffee, Corporate Express has asked us to sign their supplier code of behaviour, and Woolworths enquired if our cocoa is sourced from farms that are free of child slave labour.

Nestlé already has these processes in place with our own suppliers and most large companies make similar requests of theirs. This is an interesting area which is leading to some onerous supply chain checks and balances.

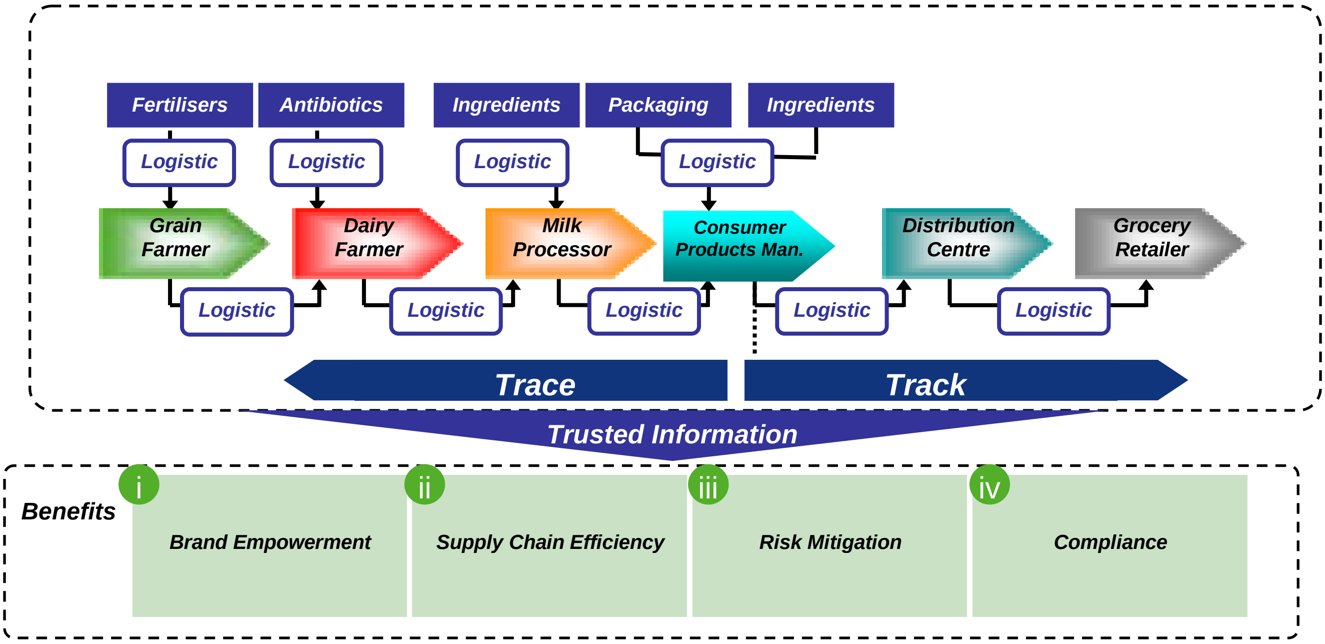
4. What this means for the supply chain

Expect increased pressure down the line from the retailers and consumers onto the suppliers who in turn will put pressure on the growers/producers. This will be seen across a range of issues including labour, water supply, use of recycling, carbon footprint, packaging, animal husbandry, treatment of animals, transport and the like. The key will be transparency and traceability from farm to fork. These two "T" factors equal trust from the retailer and ultimately, the consumer.

It may not yet be mass market but the pressure is building to understand traceability across the supply chain, from the grain farmer, to the dairy farmer, from the milk processor to the grocery retailer. Increasingly, consumers want to know how the product they are consuming has come to market.

Traceability is about the ability for each member of a supply chain to back trace the ownership and characteristics of ingredients, packaging and products. Tracking is about the ability for each member of a supply chain to track the future movement of ingredients, packaging and products through the supply chain.

Track and trace will impact every level of the supply chain, and if we can get this right, it will be very powerful. The recent experience in China where milk was criminally adulterated with melamine points up the dramatic consequences of not truly understanding the supply chain and ensuring its transparency.



Source: Economic Research Service, United States Department of Agriculture

Acknowledgement: IBM Corporation 2007

Organic and Fair Trade are two trends that immediately come to mind and the potential market for these is growing. The global market for organic foods already totals US$36.7 billion and is expected to reach US$67 billion by 2010. In terms of Fair Trade, its recognition currently lags behind "organic" and its market is estimated at US$3.5 billion.

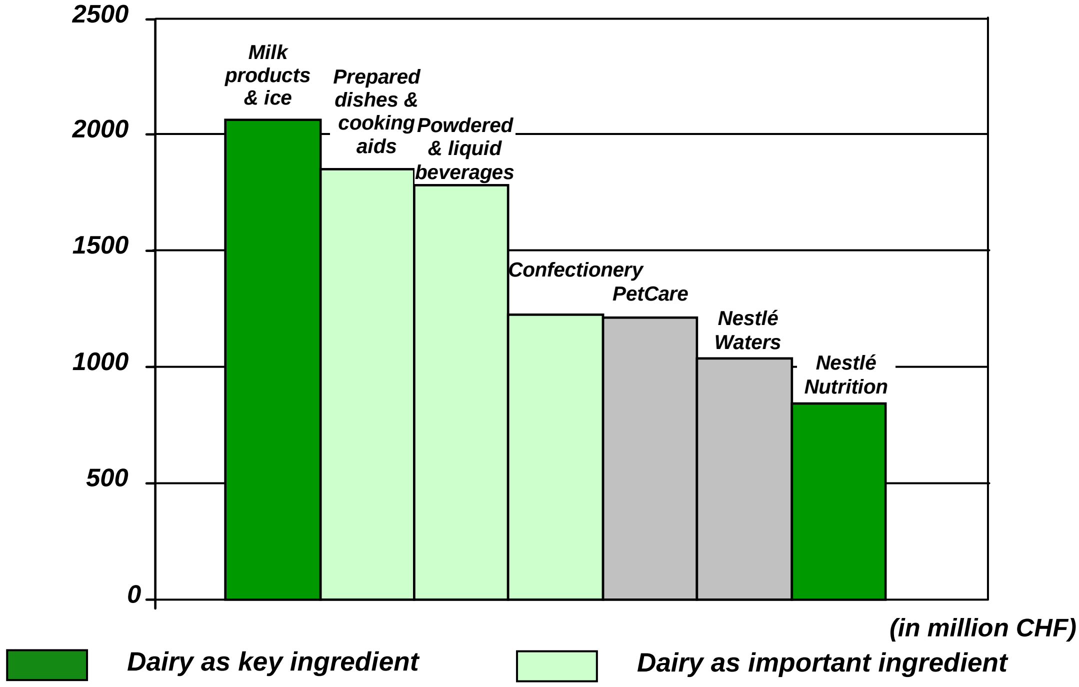
5. Nestlé & Dairy

To Nestlé, the dairy industry is crucial. It is a key ingredient for many of our products and as the world's largest food and beverages company and its leading nutrition health and wellness company, we are keenly interested in the viability and the future of the dairy industry both here and abroad. We are the world's largest milk company, sourcing 11.8 million tonnes of milk from more than 30 countries.

In South America and Asia, we are highly regarded by consumers for our nutrition credentials because in these regions we are predominantly a dairy company.

A part of our global approach to sustainability, we work primarily with developing countries where technical assistance, farming practices, raw materials and financial means are in short supply. By helping farmers and suppliers in these countries we increase the quality of the product and help educate, create employment and sustainability opportunities. We call this approach Creating Shared Value – value for the farmers (improved income levels, better developed farms) and value for Nestlé (a reliable supply of fresh, high quality milk).

Nestlé is also a founding member of the global Sustainable Agriculture Initiative and recently participated in the launch of the local Australian chapter of this organisation, which aims to bring the latest thinking and developments in agriculture to farmers around the world.



In Australia, we source from local dairies for our liquid milk production at our factory at Tongala in Victoria. We have a global dairy partnership with Fonterra and in Australia this company supplies us with our powdered milk products and which also produces our yoghurts and dairy desserts under licence.

Conclusion

We are in a time of unprecedented change, driven by an increasingly aware consumer with extraordinary access to information – not all of it accurate, but certainly easily sourced. The marketplace is evolving and responding to the demands of the key stakeholders, namely consumers and retailers.

The probability is that the issues discussed here will gather momentum. How we work to embrace and adapt to these changes will be key to the ongoing success of our Australian food industry.

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Modelling the effect of stocking rate on the lactation profiles of grazing Holstein - Friesian dairy cows using cubic splines

S.A. Adediran[1], D. Ratkowsky[1], D.J. Donaghy[2] and A.E.O. Malau-Aduli[1]

[1]School of Agricultural Science, University of Tasmania, Private Bag 54 Hobart, TAS 7001 Australia.

[2]Dairy Research Centre, Tasmanian Institute of Agricultural Research, P.O. Box 3532 Burnie, TAS 7320

Introduction

The comparative cost of producing one kg of milk is lower in grazing than in high-energy grain systems due to cheaper production of pastures which account for 70% of the feed base in grazing systems (Kellaway and Porta 1993). However, pasture quality varies greatly between seasons and utilisation still lags behind potential production per hectare (Donaghy, 2004). Whilst increased stocking density enhances better pasture utilisation and improves feed efficiency, stocking rate is a key determinant of pasture utilisation, profitability and productivity per hectare. It has been estimated that every 1tonne increase in DM/ha of pasture utilised will improve return on assets and deliver an extra $75 M to the State of Tasmania. (Chapman *et al.,* 2004). This is regardless of the level of pasture utilised because the opportunity costs associated with the capital value of land used to grow pasture are constant (Urie, 1995).

Many studies on stocking rate (Bargo *et al.,* 2002; Grainger and Matthews 1989; Holmes, 1996; Penno and Carruthers 1995; Stockdale, 1997), and grain supplementation (McCallum et. al., 1995, Kellaway and Porta 1993) in dairy cows have reported milk yield and composition responses at various stages of lactation. On the other hand, only few published studies in pasture-based dairy systems (Horan *et al.,* 2005; Macdonald *et al.,* 2008) have investigated the effect of stocking rates on the shape of the lactation curve over the entire lactation period. This represents a knowledge gap that our present study intends to fill.

The primary purpose of modeling lactation is to predict the dairy cow's average daily milk yield with minimal error, after adjusting for various environmental factors. While empirical and mechanistic models have been commonly utilised to model the lactation profile of dairy cows (extensively reviewed by Beever *et al.,* 1991), more recently, random regression procedures of legendre polynomials (Kirkpatrick *et al*., 1994) and cubic splines (White *et al*., 1999, Silvestre *et. al*, 2006.) are increasingly being used. The objectives of this study were to compare the lactation profiles and performance of dairy cows on dryland versus irrigated pastures at different stocking rates with or without grain supplementation using cubic splines model.

Materials and Methods

Animals and management

Multiparous dairy cows grazing perennial rye grass (*Lolium perenne*) and white clover under similar pasture management but varying stocking rates and supplementation at the Elliot Dairy Research and Demonstration Station, Somerset, North Western Tasmania were used in three experiments from 1996 to 2002. Thirteen stocking rates ranging from 2.0 to 4.0 cows per hectare (c/ha) were tested. Cows received supplements of hay and/or concentrate whenever there was feed shortage, except between 1996 and 1998 when some treatments were either supplemented with 500kg of grains per cow per lactation or unsupplemented.

Data size, editing and statistical models

The data consisted of 12,939 records (572) lactations of mixed parity cows. Editing criteria of the data excluded records without birthdates, calving dates, days in milk less than 5 or greater than 306 or cows with test days lesser than 4, while parities greater than 3 were pooled. Restricted maximum likelihood procedures in ASReml (Gilmour *et al*. 2002) were utilised to analyse the data using an animal model that fitted days in milk (DIM), stocking rate, year, parity and calving season as fixed effects. Random effects included cow and the splines of DIM nested in stocking rate, year, parity, calving season, while age at calving was used as a covariate. Stepwise regressions of all explanatory variables and their interactions were tested before arriving at a parsimonious model indicated below:

$$y_{ij} = b_0 + b_1 t_{ij} + b_{i0} + b_{i1} t_{ij} + \sum_{k=2}^{q-1} v_k z_k(t_{ij}) + \sum_{k=2}^{q-1} v_{ik} z_k(t_{ij}) + e_{ij}$$

Where y_{ij} is the j^{th} observation on milk yield of animal *i* on test day t_{ij} (DIM), j = (5, 305),

b_0 and b_1 are the fixed coefficient and overall linear regression of fixed terms in the model, respectively. Fixed terms in the model include days in milk

(DIM), treatment (1, 13), calving season (spring, winter), parity (1, 3) and all their second order interactions. Non-significant terms were eventually dropped from the final model,

b_{i0} and b_{i1} are coefficients of the animal and animal x linear effect, respectively, which describe the deviation from the overall regression for animal *i*

v and z are the spline and animal x spline terms, respectively, which represent the deviation from the mean spline for animal *i*, where v_k estimates the mean spline-coefficient of animal *i* at the k^{th} knot point,

q is the number of points (7 in this study),

z_k (t_{ij}) is the random spline coefficient for test day t_{ij}.,

e_{ij} is the random error with mean zero and variance σ_e^2.

Results and Discussion

Cubic splines adequately modelled the bi-weekly milk yield data with low residuals and uncorrelated coefficients which is attributed to the great flexibility of the model (Silvestre et. al., 2006). Without supplementation, mean milk yield did not differ much but was slightly higher in cows grazing at 2.5-3.5 cows/ha stocking rate (SR) compared to cows stocked below at 2.0 c/ha and above at 4.0 c/ha (Figure 1). Irrespective of SR, cows on irrigated pasture had higher peaks except those stocked at 4.0 c/ha (Figure 3). Pasture allocation significantly ($p<0.05$) increased the rise to peak milk yield in cows stocked at lower stocking rates (2.4-2.5 c/ha) compared to those on 2.8-3.5 c/ha but the later were more persistent and had higher predicted total milk yields (Figure 1).

Table 1. Summary Statistics of treatment effects on mean daily milk yield (L) of Holstein Friesian cows

Treatment	Treatment description	Mean	SD	Minim	Maxim	Count
2.0spare	Control	8.46	3.28	1.83	22.75	5869
2.4dry	Dryland	9.05	3.55	1.84	22.75	252
2.4dryplu	Dryland + grain supplement	10.10	4.04	2.47	20.91	308
2.5dry	Dryland	9.63	3.64	2.31	24.73	1918
2.5dryalt	Dryland alternative species	9.95	3.58	2.42	22.45	832
2.5dryhm	Dryland home agistment*	10.14	3.80	2.09	23.40	1059
2.8Irg30	30% irrigation	9.44	3.94	2.38	22.17	633
2.9dryway	Dryland away agistment	9.77	3.93	2.10	24.35	1160
3.2Irghm	Irrigation home agistment	8.94	3.73	2.09	24.51	1383
3.5Irgway	Irrigation away agistment	9.02	3.69	2.13	23.60	1490
3.4irgplu	Irrigat. + grain supplement	9.08	3.71	2.25	20.61	216
3.4irg	Irrigation	8.72	3.85	1.40	20.49	215
4.0Irg100	100% irrigation	9.47	3.93	2.74	21.66	569

*Agistment = off-farm grazing

The combined effect of high stocking rate with supplementation resulted in higher production per cow (Figure 1) and per hectare, clearly demonstrating the beneficial effect of boosting the high energy requirements of lactating cows through supplementation. Cows grazing on the highest stocking rate on dryland (2.9 c/ha) produced on average, 3.0 to 4.0 L more milk per day compared with those grazing on the highest stocking rate under irrigation at 4.0 c/ha (Figure 2). In addition, daily initial and peak milk yield (see Figure 3) were higher in cows grazing at 3.2 -3.5 c/ha compared to those grazing on 2.8 and 4.0 c/ha respectively (Figure 3).

Macdonald *et al.*, (2008) had reported lower production per cow as stocking rate increased. Average pasture cover (APR) declined rapidly on the irrigated treatments due to the extra feed demand associated with the higher stocking rate resulting in post-grazing residuals of only 1150 - 1250 kg DM/ha, compared to 1500 kg DM/ha on the dryland treatments, thus limiting forage intake and production in the high SR treatment (Sollenberger and Moore, 1997). High SR could potentially affect soil physical and structural properties, thereby limiting pasture regrowth.

The main positive effects of higher SR and supplementation were evident during mid-late lactation when cows on higher SR showed longer persistency (Figures 1 and 3). Pasture growth rate (kgDM/ha/d) were higher on the irrigated treatments during the summer and autumn months and enhanced longer lactation on the high SR treatments. High SR treatments also improved pasture utilisation, although the carryover effects of the additional pasture produced were minimal because the extra pasture was utilised during the same lactation season. The effect of high stocking rate could not be disentangled from irrigation.

Conclusions

The results demonstrate the accuracy of cubic splines in modelling lactation and that higher stocking rates can improve the efficiency of pasture utilisation when coupled with adequate grain supplementation. Without supplementation the 2.9 c/ha (dryland) and 3.5 c/ha (irrigation) treatments respectively were the best overall but the 3.4c/ha (irrigation) plus grain supplement was better than both. The poor performance of the 4.0 c/ha treatment highlights the potential of substitution, pasture wastage and the importance of pasture management skills in pasture-based grazing systems. The results confirmed that the key to improving profitability is optimising pasture production and then matching feed demand to feed supply with an appropriate stocking rate, to ensure that both pasture and supplements are utilised efficiently. Other potential lessons and scope for future studies are; to minimise pasture damage in wet conditions and adopting good reproductive management such as earlier calving of dryland herds to take advantage of better pasture growth in the more favourable season depending upon local growth patterns and other management practices.

Acknowledgements

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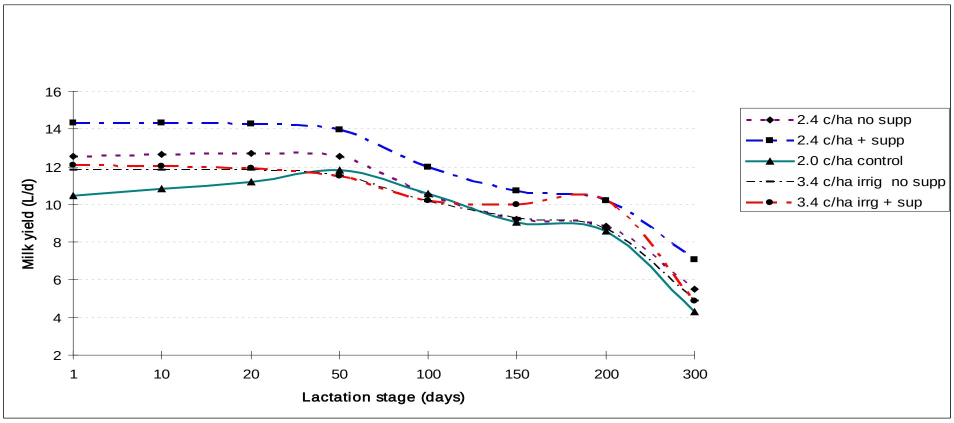

Figure 1. Comparison of Lactation profiles of Friesian dairy cows grazing ryegrass pasture at two stocking rates with or without grain supplementation and control herd.

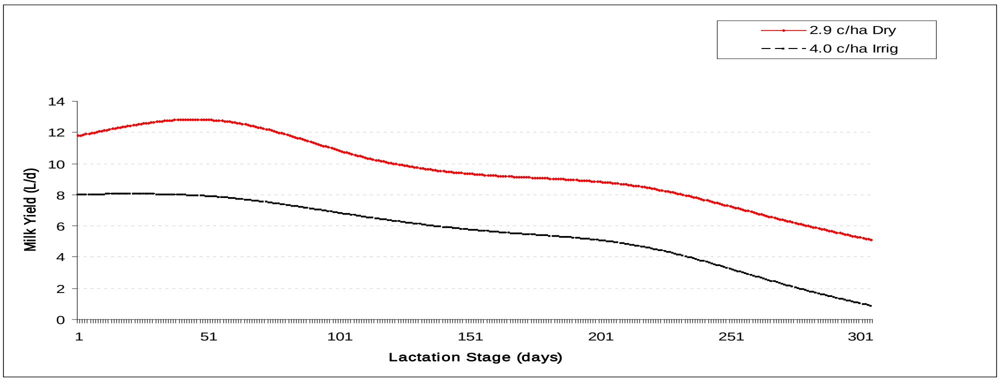

Figure 2. Comparison of the lactation profiles of Holstein-Friesian dairy cows grazing ryegrass at high stocking rates under rain-fed and irrigated conditions

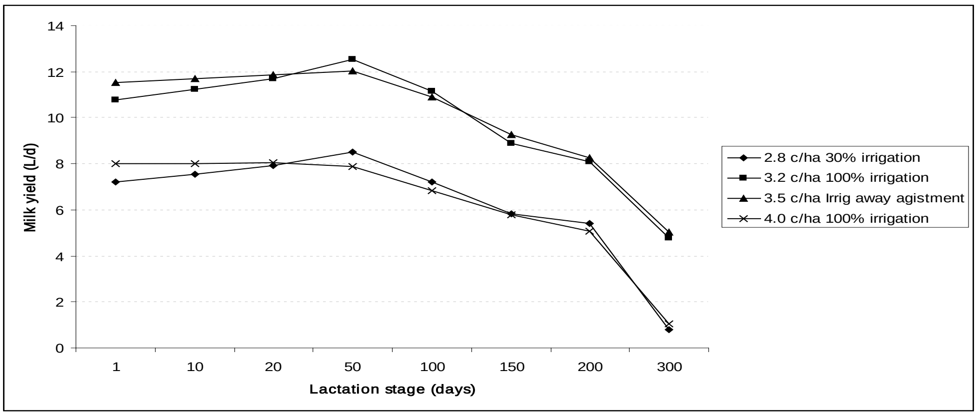

Figure 3. Comparison of Lactation profiles of Holstein Friesian dairy cows grazing at different stocking rates on irrigated pastures

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Quantification of the effects of inaccurate pasture allocation in a Pasture based Automatic Milking System

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Introduction

Automatic Milking Systems (AMS) are relatively common overseas with more than 7,000 farms worldwide now using AMS in 32 different countries (Perrotin, 2008) *pers. Comm.* DeLaval). However, the majority of farms around the world are indoor/barn style systems or with very limited grazing by the milking herd where pasture use efficiency is not considered with a high level of importance and is often little more than a "leg stretching exercise". If AMS is to have a place on typical Australian dairy farms, it is imperative that high levels of pasture utilisation can be maintained to ensure the economic viability of AMS in Australia.

In a typical conventional Australian dairy farming system animals are most commonly allocated two pasture breaks per day – one after each milking. Some farmers measure the pasture on offer and supplement daily to ensure desirable intakes are achieved. However, the majority of farmers allocate pasture based on historical knowledge, visual assessment and/or desirable grazing rotations.

Inaccurate pasture allocation to dairy cows can have negative impacts on farm productivity, largely through reduced/poor pasture utilisation, resulting in an increased proportion of milk production coming from higher cost of feedstuffs, reduced pasture regrowth (due to overgrazing when cows are under allocated), reduced pasture quality (resultant of high grazing residuals) and reduced milk production (due to reduced intakes and/or reduced pasture quality) (Fulkerson *et al.*, 2005).

These effects will similarly exist in an Automated Milking System. However, it is believed that there is likely to be much greater impacts in a system using AMS. Anecdotal evidence suggests that getting pasture allocation wrong in an AMS has additional impacts on cow traffic and milking frequency as well as pasture utilisation and milk production (Davis, 2008). However, it is possible that the overgrazing seen on conventional farms (resulting from under allocation of pasture) may not occur to the same extent due to the fact that cows can voluntarily walk out of the paddock in search of more feed.

The objective of this research is to investigate the effect of accurate pasture allocation in an automated milking system where visitation to the dairy is both voluntary and distributed (throughout a 24-hour period) on cow traffic (voluntary visitation to the dairy) and resultant milking frequency, daily herd feed intakes (average kg DM consumed/day) and post grazing residuals

Materials and methods

The project is carried out at the AMS research farm at Elizabeth Macarthur Agricultural Institute (EMAI) with the first grazing run occurring in August 2008. The study involves the milking herd of around 160 pre-trained, mixed aged lactating Friesian (88.6%) and Illawarra (11.4%) cows milked through two DeLaval Voluntary Milking systems (VMS).

The trial grazing area consists of around 16ha of kikuyu and ryegrass based pasture. Paddock blocks are divided with a two directional laneway for voluntary movement to and from the dairy via 'smart gates' where cows are drafted for milking based on whether or not milking permission is granted. The criteria on which permission is granted or denied is that cows in early lactation (<101 days in milk; DIM) must have exceeded 4 hours since their last milking session before they will be granted permission, cows in mid and late lactation (>100 DIM) must have a minimum milking interval of 6 hours.

During each grazing run cows are exposed to both accurate and inaccurate pasture allocation. The herd is allocated two pasture breaks a day (day and night breaks) in which pasture mass is measured using the C-DAX rapid pasture meter for the accurate and simulated inaccurate pasture allocation methods. Each pasture allocation method is mapped out according to size (hectares) needed to obtain daily pasture intake.

Accurate pasture allocation method

Cows are allocated 50% of their pasture allocation in the day paddock and 50% in the night paddock (current best management for AMS pasture-based farm using 2-way grazing). For the accurate pasture allocation treatment the C-DAX Rapid Pasture Meter ((RPM) as seen in figure 1.) is used on Day 0 or Day 1 of the grazing run (Day 1 is first day of grazing) to determine pre-grazing pasture masses (kg DM/ha). From this information a grazing plan is generated for the following seven days based on pre-grazing covers and an anticipated daily pasture growth rate.

Area (ha) = (# cows x Required kg)/(pre (+ growth) – post)

Once required area (ha) is calculated the grazing breaks can be mapped out in farmworks P-Plus software program.

Figure 1. The C-DAX Rapid Pasture Measurement system is the pasture measurement tool used for all pasture mass measurements recorded

Inaccurate pasture allocation method

A similar method will be used to simulate inaccurate pasture allocation. It is important that this is simulated rather than randomly allocated pasture as we need to ensure that total pasture intakes are similar across the two treatments for each grazing cycle. As with the accurate allocation treatment, cows will also be given approximately 50% (range of 25%-75%) of their daily allocation in each of the day and night paddocks. Over a 48 hours period the sum of the each inaccurate allocation (two allocations/day = four in total) will equal the total 48 hours requirement/cow (Table 1). A new randomly simulated inaccurate pasture allocation table will be generated for each inaccurate grazing treatment based on the targeted intake levels as shown in Table 1.

Table 1. Inaccurate allocation table for day and night

Inaccurate allocations	date	Day	DAY Allocation	NIGHT Allocation	Total	Total (48 hr)
	11/08/2008	1	2	7	9	
	12/08/2008	2	2	5	7	16
	13/08/2008	3	4	5	9	
	14/08/2008	4	4	3	7	16
	15/08/2008	5	2	5	7	

Animals in both allocation methods are given the same time allowance to graze each individual grazing strip. Although there is a day and night side, the allocation treatment is switched for every second trial grazing run. At the end of each grazing time allowance cows that are left in the paddock (i.e. haven't voluntarily trafficked out of the paddock) are fetched (Fig 2.) and recorded.

Parameters recorded

1. Pre and post-grazing pasture covers for every day and night pasture strip
2. Pre-grazing pasture samples will be collected daily and bulked after drying and grinding to give one representative sample for each grazing run. These samples will be analysed for feed quality characteristics including protein, energy, digestibility and acid detergent fibre. The purpose of this is to demonstrate that there is no difference between pre-graze pasture qualities for the two treatments.
3. Weekly pasture covers using the C-DAX rapid pasture meter
4. Through out the research period daily weather data including temperature, rain and wind will be recorded as this may affect cow traffic (e.g. hot days and heavy rain).
5. Daily intake of any supplements including post milking ration and pellets in machine (kg DM/cow/day)
6. Milk yield/24 h (kg milk/cow/day) and milk bulk composition every 48 hours
7. Milking frequency (milkings/c/d)
8. Cow queue indicator (average time from automatic drafting gates to milking station
9. All 'STOP' alarms are recorded using VMS Client 2006. Stop alarms may affect cow queuing, cow milking frequency and also cow production (for extreme lengthy delays).

Expectations

Whilst there is insufficient data to present at this stage the preliminary results tend to support the anecdotal evidence that inaccurate pasture allocation is detrimental to the frequency and regularity of cow traffic within a pasture based AMS. The purpose of this work is to quantify the true effect on system performance as an illustration to farmers of the importance and potential system impacts of accurate pasture allocation within an AMS. It is believed that without this knowledge new installations of AMS will likely underperform with the AMS technology unfairly receiving the blame.

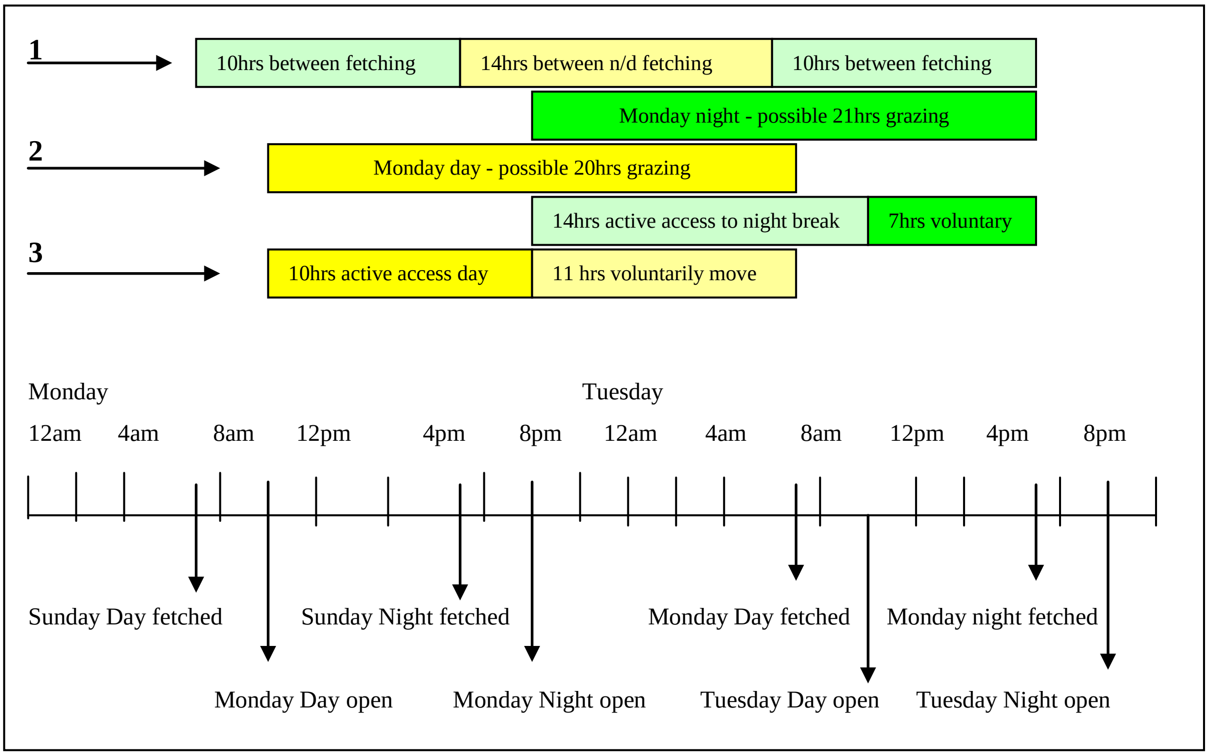

Figure 2. 48 hour time line of day and night paddock openings and fetching's. Showing the time between night and day fetching's (1). Possible total grazing time in both day and night grazing breaks (2) and total cow active access and voluntary movement times in both day and night grazing breaks (3).

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- New bioactives identified
- Portfolio of genetic intellectual property for commercial use and technology partnering

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The importance of learning networks in precision dairy farming

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Introduction

Farmers invest in precision dairying technologies to enhance control over variability and risk. Precision farming uses information technology based devices to provide data on fine scale changes in aspects of the farm business. Common examples are the use of in-line milk meters to monitor individual cow milk yield in real time, or quad-bike trailed pasture sensors to measure spatial and temporal changes in pasture cover.

The precision dairy farming concept represents a change to farm management systems, often involving moving from intuitive practice to practice based on data and computers. Successful change is not just dependant on the device, or individual farmer characteristics. Important in practice change is the network of people interacting with a farmer and the transfer of knowledge within the network.

Significant learning costs have been associated with precision farming in the arable and viticulture sectors, where adequate establishment of learning networks have not been addressed (Cowan 2000; Harsh 2005). Researchers and retailers of PDF-ICT tools have taken a techno-centric approach to precision dairying where concerted effort is placed into development of devices without sufficient consideration of issues around farmer adaptation and learning.

The aim of this study was to examine key features of the network within which Australian precision dairy systems develop.

Method

Six precision dairy farming case studies, where farmers were implementing new dairy shed automation technology, were analysed over an 18 month period. Semi-structured interviews were used to explore the themes of learning and adaptation in precision dairy systems. Interviews were conducted every four to five months during the study period, with the primary technology user interviewed.

All interviews were recorded and transcribed, then thematically analysed using NVivo™ qualitative research software. The results were analysed using the community of practice concept as described by Wenger (1998).

Results and Discussion

Learning to adapt to the new technology and techniques of precision dairying is not something that farmers achieve alone. Their learning is supported by people, both on farm and off farm, who represent members of a precision dairy farming community of practice.

In Fig. 1 the network around farmers in this study is illustrated, along with members absent from the network (denoted by dashed lines). The arrows represent relationships between members, and paths of knowledge transfer.

Key existing linkages

The relationship between farmer and precision technology retailer can be broken into three parts: local, national, and global retailer. While the relationship between a farmer and the local agent can be the strongest, it is with the national retailer that most knowledge on precision systems is transferred. This is due to most knowledge on the devices and software being centred with national retail staff, rather than the local agents.

Filling an important role in the community are people termed 'translators' in Fig.1. These people are non-retailer precision dairy experts who also have a practical understanding of farming systems. They are therefore able to translate between the two forms of knowledge.

Key potential linkages

In Fig. 1 the potential members and linkages are indicated by dashed lines. Herd improvement (HI) centres already play a role in the precision farming community, but the ability to transfer data between on-farm herd management software and HI centres needs improvement. Also missing currently is a capacity in research and extension focused on practical methods of making the most of precision dairy devices and data. Consultants (agronomists, nutritionists) were also identified as underrepresented in the precision dairy community and they offer an important ability to transfer knowledge between farmers.

Viewing the precision dairying community of practice at an industry level highlighted a need for greater emphasis on networks that facilitate the flow of data and information. Improved precision dairy practice depends upon the development of social capital, the nurturing of new knowledge, and the ability to transfer this knowledge (particularly tacit knowledge) within the community of practice.

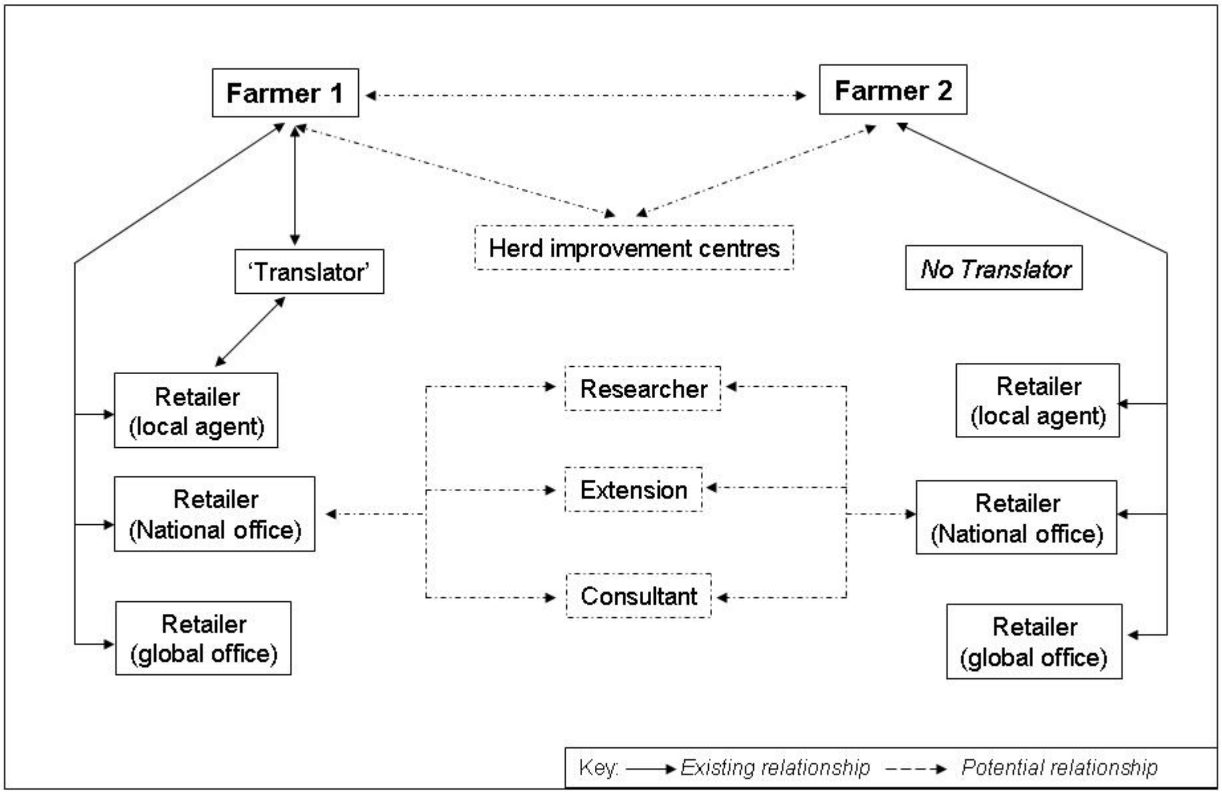

Figure 1. Relationships (existing and potential) between members of a precision dairy farming community of practice

Implications for the dairy industry

Precision farming will be an essential concept in the future of Australian dairying. Uptake and integration in real world farming systems relies on the support network around the farmer.

There is a role for industry level organisations to ensure the existence of pathways which enable transfer of not just data, but also practical knowledge on how to 'do' precision farming. Herd improvement centres are well positioned for a role in improved data transfer. Specific development of research and extension capability is needed to collect and distribute knowledge on precision farming best practice.

Acknowledgements

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Could improved ovulation prediction methods increase the AI submission rates and pregnancy rates in Australian dairy herds?

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Introduction

The "InCalf" project found submission rates and subsequent conception rates to be two critical drivers of reproductive performance in dairy cattle (Morton, 2003).

Maximising submission rates requires accurate and efficient methods of detecting cows that are about to ovulate. The subsequent conception rate from these inseminations relies on a complex number of factors, one of which is the ability to closely co-ordinate the timing of insemination with ovulation *(Dransfield, et al.*, 1998, Roelofs, *et al*., 2006).

With a trend towards larger herd sizes and the reduction of oestrus expression in the modern high yielding dairy cow, the ability to correctly select animals for AI using the traditional method of visual observation of standing heat is becoming increasingly more difficult and less practical (Borsberry, 2003, Kerbrat and Disenhaus, 2004, Yoshida and Nakao, 2005). This has resulted in a greater need for alternative AI selection methods which can predict ovulation rather than just detect oestrus, and an increase in the viability of using automated technology.

A neck pedometer that monitors cow activity in two hour lots has recently become commercially available in Australia (Rescounter II®, Westfalia-Surge). A previous study of a similar pedometer system (leg mounted) in the Netherlands has shown the ability to detect a high proportion of cows in oestrus and predict the time of ovulation. However, the position of the pedometer (neck or leg) and the husbandry and reproductive management of the herd (pasture or lot fed, and year round or seasonal calving) are known to make a considerable difference to the performance of pedometer systems (Kiddy, 1977, Koelsch, *et al*., 1994, Lopez-Gatius, *et al*., 2005, Sakaguchi, *et al.*, 2007). Thus it is important to asses a pedometer system within the environment in which it will be used.

An understanding of the variation in AI to ovulation interval that results from current AI selection practices and the ability of pedometer systems to predict ovulation across a number of different Australian dairy herd environments could lead to improved reproductive performance in many Australian dairy herds.

This study was designed to determine the potential for improving pregnancy results to AI if the time of ovulation could be predicted with more certainty and to asses the ability of the Rescounter II® neck pedometer to detect animals in oestrus and predict the time of ovulation.

Materials and methods

Data was collected from 3 Australian dairy herds. Herd 1 had 400 cows, in a pasture based, seasonal calving system in Colac, Victoria; Herd 2, had 900 cows; and herd 3 had 150 cows. Both herds 2 and 3 were fed total mixed rations, were year round calving and located near Gatton in South East QLD. The time of ovulation was assessed for animals in herds 1 and 2 by twice daily ultrasound examination of cows submitted for AI during the trial. Pedometer activity was collected from all animals in herds 1 and 3. Milk progesterone samples at the time of AI and 7 to 10 days later were used to confirm oestrus in animals submitted for AI in herds 1 and 2. In addition all of Herd 3, and a subset of Herd 1, had serial milk progesterone samples taken to monitor individual animal oestrus cycles over time. The pregnancy status of animals from herds 1 and 2, that were submitted for AI during the trial were assessed within 6-8 weeks following insemination by rectal palpation from an experienced veterinarian.

Activity alerts were calculated by 5 different algorithms using pedometer activity data recorded from herds 1 and 3. Activity alerts were compared against milk progesterone records to determine the sensitivity, specificity and positive predictive value for oestrus detection. The pedometer activity data from herd 1 was assessed against the time of ovulation to determine the distribution in interval from onset of increased pedometer activity to time of ovulation. The distribution in the interval from AI to ovulation was determined for herd 1 and 2. The proportion of inseminations resulting in pregnancy was compared for various intervals of AI to ovulation (herd 1 and 2), and intervals from onset of increased pedometer activity to AI (herd 1).

Results

Cow pedometer activity was able to detect between 87 to 95% of all ovulations in herd 1 and between 79 to 91% in herd 3, depending on the algorithm used to create an activity alert (Table 1.). The specificity ranged from 90 to 98% and was highest for both herds when using the Dairy Plan activity alert algorithm. The onset of increased pedometer activity was predictive of the time of ovulation. The mean time from start and end of activity to ovulation was 33.40 ± 12.37 and 17.27 ± 12.79 hours respectively (Figure 1.). Just under half of the animals ovulated within an 8 hour period between 30 to 38 hours after the onset of increased activity, while over 85% of the animals ovulated within a 24 hour period between 18 and 42 hours after the onset of increased activity. The combined distributions for various intervals from AI to ovulation and their subsequent pregnancy rates for Herd 1 and 2 is shown in Figure 2 (a). The distribution and pregnancy rate for various intervals from onset of pedometer activity to AI is shown for herd 1 in Figure 2 (b).

Herd	***1***					***3***				
Activity alert algorithm	DP	2SD	2.5SD	3SD	3.5SD	DP	2SD	2.5SD	3SD	3.5SD
Sensitivity (%)	90.60	95.30	93.96	88.59	87.25	79.56	90.61	87.29	82.32	79.01
Specificity (%)	98.23	90.94	94.10	96.10	97.47	97.82	90.14	92.68	94.39	95.36
Positive predictive value (%)	71.81	34.3	44.16	53.01	63.11	70.24	37.27	43.53	48.69	52.38
True-positive alerts	135	142	140	132	130	144	164	158	149	143
False-positive alerts	53	272	177	117	76	61	276	205	157	130
Animals with ≥1 false-positive alert	44	127	101	87	65	36	66	64	59	56
Range	1 to 2	1 to 6	1 to 5	1 to 3	1 to 2	1 to 5	1 to 10	1 to 8	1 to 7	1 to 6
Mean	1.20	2.14	1.75	1.34	1.17	1.69	4.18	3.20	2.66	2.32

Table 1. Oestrus detection performance of Rescounter II® neck mounted activity pedometers in two Australian dairy herds (Herd 1 and 3)

Herd 1 data; number of animals=150; number of ovulations=149; number of non-ovulatory days=3001. Herd 3 data; number of animals=69; number of ovulations=181; number of non-ovulatory days=2800. DP (Dairy Plan activity alert algorithm, Westfalia-Surge) **=** *the mean and standard deviation of the preceding 10 days was calculated for each 2 hour period. If the activity in three consecutive 2 hour periods was greater than or equal to two standard deviations from the mean of the preceding 10 days, and the mean number of standard deviations for the three periods was greater than or equal to three, than an alert was given.; 2SD, 2.5SD, 3SD, 3.5SD = an activity alert was recorded if two consecutive 2 hour periods were each greater than or equal to the mean activity for the same period over the preceding 10 days plus 2(2SD), 2.5(2.5SD), 3(3SD), or 3.5(3.5SD) times the standard deviation of that mean.*

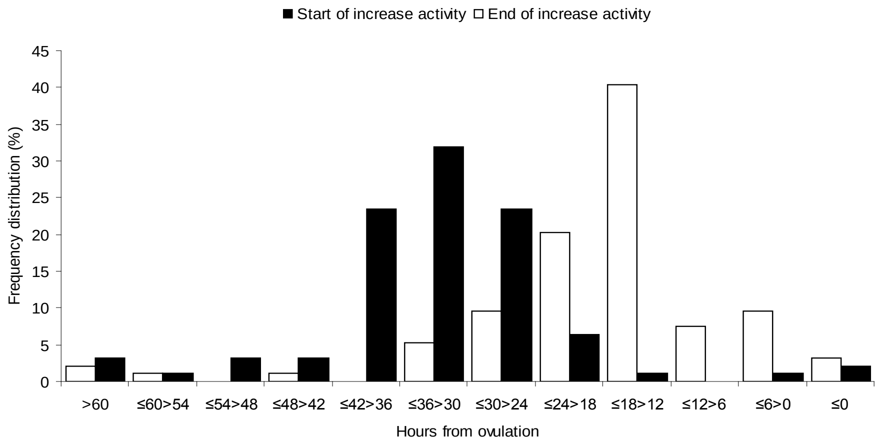

Figure 1. Distribution of interval from onset and end of increased pedometer activity to time of ovulation (Herd 1, Rescounter II® neck pedometers, n=94).

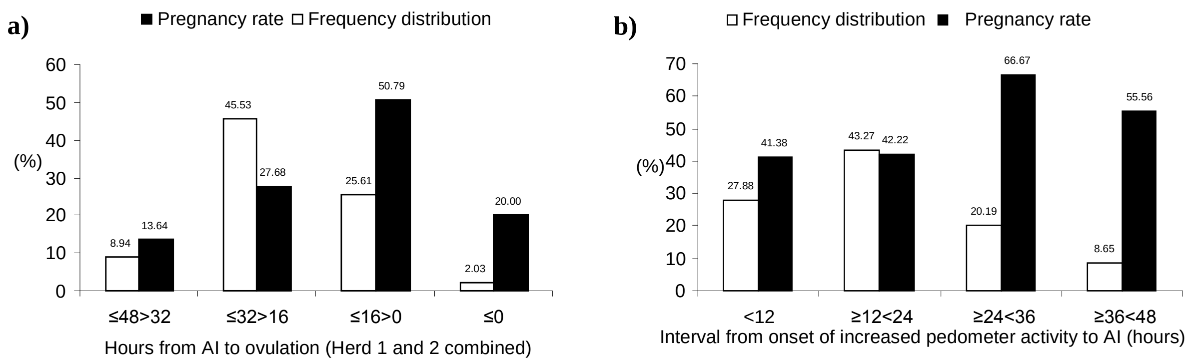

Figure 2. Distribution and pregnancy rate for different intervals of; a) time from AI to ovulation (herd 1 and 2 combined, n=202); b) time from onset of increased pedometer activity to AI (herd 1, n=104).

Conclusion

There is a large variation in the interval from AI to ovulation within and between herds and this interval has an important effect on pregnancy rate. Improving the timing of AI by better predicting the time of ovulation may provide opportunity for improving pregnancy results to AI in Australian dairy herds. Cow pedometer activity has the ability to detect a high proportion oestrus periods with moderate accuracy. The onset of increased pedometer activity has the ability to practically and accurately predict the time of ovulation and may provide a useful method of timing insemination.

Acknowledgements

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Embryonic mortality and plasma advanced oxidation protein products (AOPP) increase in dairy cows

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Introduction

In dairy cattle, failure to conceive represents a major limitation to fertility. Although fertilization rate is estimated around 90%, embryonic (EM) mortality within day 19 post mating bring this figure to 60-65%, and a further 5-10% loss occurs within day 42 (Mann and Lamming, 1999).

The causes of embryonic mortality are still poorly understood. Several papers indicate reactive oxygen species (ROS) and oxidative stress (OS) having a role in pathophysiology of mammal reproduction during fertilization and early embryo development (Fujii *et al*, 2005).

Dairy cows are exposed to metabolic stress to face high milk yield and adverse environmental conditions (heat stress). In such conditions, accumulation of free radicals may result and, if ROS generation exceeds body's antioxidant production capacity, OS may develop (Castillo *et al,* 2005). In dairy cows, OS has been associated with several pathological conditions, such as retained placenta, udder oedema, and mastitis, which in turn may lead to a decline in reproductive performances. Also, antioxidants deficiency may contribute to impaired muscle tone and thus uterine contractibility resulting in decreased transport of gametes or retained placenta (Miller *et al*, 1993).

Excessive production of ROS can cause damages to macromolecules (Fujii *et al,* 2005). In particular, ROS-mediated protein oxidation is complex and it may generate multiple products. Oxidized proteins are often functionally inactive, can be more or, on the opposite, less susceptible to proteases leading to accumulation. Moreover, they may activate the immune reaction and be the target of auto-antibodies (Dean *et al*, 1997).

Advanced oxidation protein products (AOPP) are proteins damaged by OS and they are formed mainly by chlorinated oxidants resulting from myeloperoxidase activity. In humans, they are responsible of induction of pro-inflammatory activities and cytokines, and increase in the circulation in some pathological situations. Moreover, they are referred to as markers of OS and neutrophil activation (Kalusova *et al*., 2005).

The aim of this work was to detect possible relationships between the artificial insemination (AI) outcome and AOPP as an indicator of protein oxidation to study of the implication of protein oxidation in EM.

Material and Methods

This study was carried out in northern Italy over a ten months period. A total of 157 AI's were studied in 69 dairy cows. Blood samples were collected on the day of AI (d 0) and on days 15, 28, 35, 45, and 60 after AI.

Plasma concentrations of AOPP, glutathione (GSH), pregnancy-associated glycoprotein (PAG), malonyldehaldide (MDA), total proteins (TP), albumins (A), globulins (G) and urea were measured. Whey progesterone was analysed by RIA in samples taken every 3-4 days from day 15 post-partum to day 45 after each positive AI. PAG measurement in maternal plasma was performed according to the method described by Zoli *et al*. (1992).

The AI outcome was classified *ex post* in negative (AI-), positive (AI+) and EM. The diagnosis of EM was performed by the simultaneous examination of P4 in whey and PAG in maternal plasma (fig. 1).

The beginning of the ovarian activity was assessed by whey progesterone profiles. Data were analysed using the general linear model procedures of SPSS (SPSS 15.0, 2005).

Results and Discussion

The diagnosis of EM performed by the analysis of whey P4 and maternal plasma PAG was sensitive in detecting EM occurring after day 25, but it is not useful in detecting EM before day 24 (Zoli *et al.*, 1992). Therefore, return to oestrus occurring before day 24 was classified as negative AI (AI-). In this study, 9 EM and 89 AI- were observed, while the number of AI+ was 49.

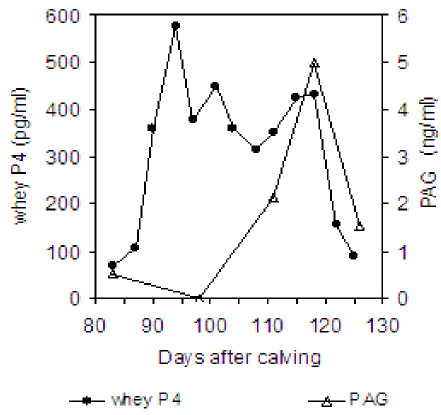

Figure 1. Variations of whey P4 and maternal plasma PAG in one cow in case of EM.

Plasma AOPP concentrations were significantly higher in EM ($P<0.01$; fig.2). On the contrary, plasma MDA and GSH were not affected by the AI outcome. However, AOPP showed weak but significant correlations with both MDA ($R=0.323$, $P<0.001$) and GSH ($R=0.096$, $P<0.05$), suggesting that AOPP may be used as a marker of OS. Although GSH is the most abundant non-protein thiol in mammalian cells and a good indicator of the blood oxidative scavenging capacity, it is also an important source of storage and transport of cysteine (Wu *et al.* 2004). Thus, total plasma GSH is likely more related to metabolic adaptations, such as sulphur amino acid sparing, rather than to oxidative stress and for this reason the relationship between AOPP and GSH is not very strong.

Plasma TP, A and G were not affected by the AI outcome, but they were significantly affected by the physiological phase ($P<0.01$), and increased significantly during the post partum. Plasma urea was significantly affected by the AI outcome ($P<0.01$; figure 2), and it increased steadily throughout the post partum ($P<0.05$).

TP and A were significantly higher in cows beginning the ovarian activity before day 42 post partum (respectively $P<0.05$ and $P<0.001$).

In this study, we report for the first time the variations of AOPP in parallel with those of circulating proteins in the cow plasma. Plasma AOPP variations are independent from those of TP, A and G, suggesting a greater degree of protein oxidation in case of EM.

Since AOPP are considered marker of both OS and inflammation (Kalusova *et al*., 2005), it is possible that higher levels of AOPP observed in EM may reflect inflammatory events at uterine levels that can compromise the correct embryonic development.

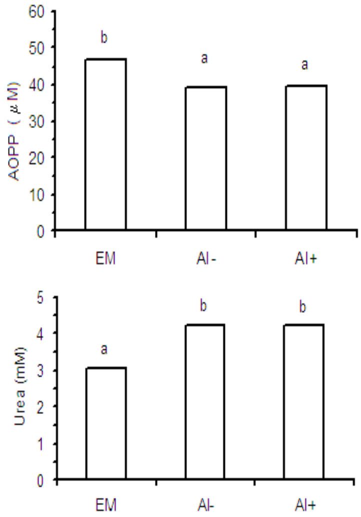

Figure 2. Concentrations of plasma AOPP and urea (different superscripts indicate significantly different means; P<0.05).

In conclusion, the data gathered in this study seem to indicate that the occurrence of EM is associated to protein oxidation. Because we were able to observe only 9 cases of EM the relationship between OS, AOPP and EM warrant further investigation.

Acknowledgements

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Effects of forage rape (Brassica napus) and persian clover (Trifolium resupinatum) on rumen parameters in sheep

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Forage rape (*Brassica napus*) and Persian clover (*Trifolium resupinatum*) are key components of new forage systems being developed to improve productivity and reduce pressure on Australian dairy farms (Garcia *et al*., 2005). Both these forages have high nutritive value with high metabolisable energy (ME) and crude protein (CP) content, but lower fibre content than common pastures. In addition forage rape has high nitrate content which can be toxic when fed in high proportion to dairy cows. However, its affect on rumen function needs to be determined. Supplementation of forage rape with high fibre feeds such as maize silage can balance the low fibre levels and reduce the excessive excretion of nitrogen into the environment.

The key question in this study is whether increasing the proportion of these forages in diet may result in better rumen function and increased efficiency of feed utilisation by the animal. To answer this question, two experiments were conducted simultaneously in which sheep were fed increased proportions (10 to 40% of total dry matter intake) of either forage rape or Persian clover to evaluate their effect on digestibility and rumen parameters.

Materials and Methods

Experiment 1: Three rumen-fistulated Border Leicester castrate male sheep (average body weight of 46 ± 0.7 kg) were fed three diet treatments in a 3×3 Latin square design: Diet FR 10 (10% forage rape + 25% concentrate + 25% maize silage + 40% short rotation ryegrass); Diet FR 25 (25% forage rape + 10% concentrate + 35% maize silage + 30% short rotation ryegrass); and Diet FR 40 (40% forage rape + 0% concentrate + 40% maize silage + 20% short rotation ryegrass).

Similarly Experiment 2 was also 3×3 Latin square design with three rumen-fistulated Border Leicester castrate male sheep (average body weight of 62 ± 2.7 kg) and the three diet treatments were: Diet PC 10 (10% Persian clover + 25% concentrate + 20% maize silage + 45% short rotation ryegrass); Diet PC 25 (25% Persian clover + 15% concentrate + 25% maize silage + 35% short rotation ryegrass); and Diet PC 40 (40% Persian clover + 5% concentrate + 30% maize silage + 25% short rotation ryegrass). All the eight diets were formulated to have similar ME, CP and neutral detergent fibre (NDF) content.

Each group of sheep were adapted to forage rape and Persian clover diets, respectively, for 15 days followed by a 5-day sampling period in the respective experiments, which were run simultaneously. Daily feed and faeces were collected and analysed for dry matter (DM), organic matter (OM), N, neutral detergent fibre (NDF), acid detergent fibre (ADF). Urine samples were analysed for N and purine derivatives to estimate microbial protein synthesis (MPS). Rumen fluid was collected at 3h interval for 24h at the end of each sampling period and analysed for pH and ammonia concentration.

In vivo digestibility data obtained in Experiment 1 and 2 were statistically analysed using analysis of variance in a Latin square design while rumen pH and ammonia-N concentration were analysed using mixed models based on REML procedure, to examine the interaction between time of sampling and diet.

Results and Discussion

Dry matter intake was similar within forage rape group in Experiment 1 and within Persian clover group ($p>0.05$) in Experiment 2, respectively. Persian clover diets had 16% higher intake (when expressed as g/kg LW/d) than forage rape diets (Table 1). This higher intake was likely due to higher palatability of Persian clover (Stockdale, 1993). The *in vivo* digestibility of DM (mean=75%), NDF (mean=65%), and ADF (mean=60%) were similar ($p>0.05$) within and between Experiment 1 and Experiment 2. The diurnal variation in rumen pH (mean = 6.17 ± 0.14) and ammonia-N concentration (mean = 22.6 ± 1.4 mg/dL) was also similar with forage rape diet treatments. However, the daily rumen pH was significantly different ($p<0.001$) among the Persian clover diet treatments, although no interaction between the treatments and time of feeding was found ($p>0.05$). Rumen pH was lower with Persian clover treatments compared to forage rape treatments. This is related to higher organic matter intake with Persian clover diets. Mean (± se) daily ammonia-N concentration (25.2 ± 2.6 mg/dl) was similar ($p>0.05$) among treatments in Experiment 1 and Experiment 2, respectively.

The efficiency of microbial N supply (EMNS) expressed as microbial N (g/d) per kg of digestible organic matter fermented in the rumen (DOMR) was also similar ($p>0.05$) within and between forage rape and Persian clover

treatments (mean = 23.2 g MN/d per kg of DOMR). However, total estimated microbial N (g/d) flowing into the duodenum was higher for Persian clover diets than forage rape diets due to the increased DOMR in the rumen for the former diets (Experiment 2).

Table 1. Mean daily dry matter intake (DMI), rumen pH, microbial N (g/d) and efficiency of microbial N supply (EMNS) in Experiment 1 and 2, respectively.

	Experiment 1			Experiment 2		
	Forage rape	sed	p value	Persian clover	sed	p value
DMI (g/d)	1125	94.6	0.19	1783	172.4	0.58
DMI (g/kg LW per day)	25	1.5	0.11	29	4.0	0.76
Rumen pH	6.17	0.1	0.29	5.70	0.1	<0.001
Microbial N (g/d)	12.8	2.0	0.57	18.4	1.0	0.21
EMNS (MN g/d per kg DOMR)	24	3.9	0.69	23	1.8	0.80

Implications

Our results indicate a high nutritive value of both forage rape and Persian clover. However, increasing the amount of either forage from 10 to 40% of total DMI did not result in improved efficiency of rumen function and MPS. The higher voluntary DMI of Persian clover needs further investigation.

Acknowledgement

This project is part of FutureDairy, an industry driven project primarily sponsored by Dairy Australia, DPI NSW, The University of Sydney and DeLaval.

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More milk from home grown feed: more profits?

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Introduction

The dairy industry productivity has increased by only 1.2% per year in the last decade (ABARE 2008).

In a context of raising inputs prices and reducing availability of land and water, farmers will have to substantially improve productivity if they want to be profitable (Malcolm and Sinnett 2003).

Considering the limitations of production/ha from pasture alone to achieve this, Future Dairy Project has developed a Complementary Forage Rotation (CFR) that, combining three crops in one year (namely maize, forage rape and Persian clover), averaged 42.3 t DM/ha/year of utilised forage (Garcia *et al.* 2007).

The feasibility of the CFR at the farm scale and its potential for milk production is now being evaluated in a whole farm study which comprises 35% CFR and 65% intensively managed pasture. This innovative concept, called Complementary Forage System (CFS), is attempting to produce 30,000 L/ha from home grown feed (four times the industry average).

Materials and methods

A whole farm system study is being conducted at University of Sydney Corstorphine Farm since April 2007. The study farm comprises 21.5 ha, with 65% of the area kikuyu based pasture (*Pennisetum clandestinum)* oversown with short rotation ryegrass (*Lolium multiflorum L.*) in autumn, and 35% CFR. The CFR is based on maize (*Zea mays* L.) as the bulk crop, followed by forage rape (*Brassica napus*) and Persian clover (*Trifolium resupinatum*) as described in Table 1.

The herd comprises 100 Holstein-Friesian cows calving in 2 batches (autumn and spring).

Table 1. CFR area forage crops

<table>
<tr><th>Oct</th><th>Nov</th><th>Dec</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th></tr>
<tr><td colspan="4" rowspan="3">Maize</td><td colspan="5" rowspan="2">Forage rape</td><td colspan="3">Persian Clover</td></tr>
<tr><td colspan="3">Maple peas</td></tr>
<tr><td colspan="8">Persian Clover</td></tr>
</table>

Pasture grazing management is based on both number of live leaves/tiller (ryegrass: 2.5; kikuyu: 4) and biomass (target pre- and post-grazing pasture cover = 2600 and 1400 kg DM/ha, respectively). Forage rape is grazed with at least 4,500 kg DM/ha on offer, and Persian clover with ~2.000 kg DM/ha on offer.

Utilised forage was calculated as the difference between pre- and post-grazing using a Rising Plate Meter (RPM) for pasture, and forage cuts to ground level for forage rape and legumes. In addition, DM on each pasture paddock was assessed weekly using an Ellinbank Sound Meter, in order to calculate growth rate and estimate the feed allocation for that week accordingly.

Preliminary results

Over 32,000 L/ha and 8,700 L/cow (rolling average) were achieved in Year 1 from a diet based on 82% home grown feed.

Figure 1 shows the daily milk production per cow and the composition of the diet through the year. Concentrates were the only bought- in feed (1.26 t/cow).

The grazed forage component includes pasture and winter forage crops (forage rape and Persian clover), while the conserved forage is mainly silage made form the maize grown on the CFR area. Forage yields (t DM/ha) are shown in Table 2.

Table 2. Utilised forage yields (t DM/ha) vs. target.

Forage	**Actual yield** (t DM/ha)	**Target yield** (t DM/ha)	Dif. (%)
Pasture	20.4	18.0	113%
Winter forage crops	8.6	15.0	57%
Maize	24.2	25.0	97%

Utilised forage yields of maize and pasture were on and above target, respectively. However, utilised forage yield of winter forages was 0.6 of target (15 t DM/ha).

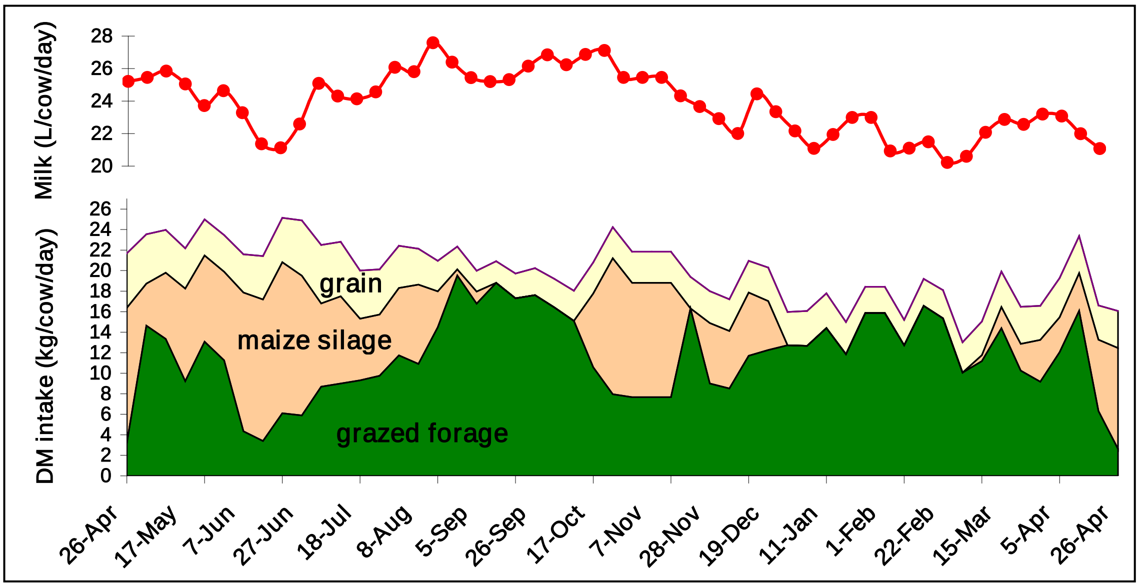

Figure 1. Diet composition (kgDM/cow/day) and milk production (L/cow/day).

Despite the lower production of winter forages due to delayed sowing, the overall forage production was on target, allowing a high stocking rate and per cow production to be maintained with relatively low dependence on imported feed.

Economic analysis

A modeling study was undertaken to assess the economic performance of the CFS system in comparison to alternative options or "scenarios" to increase production/ha.

The ***Base*** scenario was a well managed dairy farm, with an irrigated milking platform of 140 ha, stocked at 2.4 cows/ha, utilising 12 t DM/ha/year and producing more than 16,000 L/ha/year from ~7,000 L/cow. From that situation three different scenarios were established (Table 3) to increase production through: more pasture utilised (***+Pasture*** scenario), more pasture and grain supplementation (***+Pasture +Grain*** scenario) and replacing pasture area by CFR crops (***CFS*** scenario).

A whole-farm modeling approach was used for the economic evaluation, using a representative farm approach (Anderson and Hardaker, 1979). Data was obtained from ABARE, NSW DPI MilkBiz Whole-Farm Budgeting Program combined with physical data from the Corstorphine Dairy trial (year1), in order to determine the resources available for a typical dairy farm. In all three scenarios additional expenditure was considered to increase dairy farm capacity is in terms of dairy shed, vat, effluent systems and laneways (see Alford *et. al.* 2008 for details). Significant improvements in operating profit were achieved in the ***+Pasture*** scenario as a higher use of pasture allowed for an increase in stocking rate (Fig. 2).

Table 3. Scenarios tested for increased production

		Base	***+Pasture***	***+Pasture +Grain***	***CFS***
Stocking rate	Cows/ha	2.4	4	3.7	3.7
Production per cow	L/cow	6900	6900	9000	8773
Concentrates fed	tDM/cow	1.2	1.2	2.3	1.26
Pasture utilised	tDM/ha	12	18	18	20,4
CFR yield	tDM/ha	-	-	-	32800
Milk production	L/ha	16600	27600	34000	32644
Milk from home grown f.	L/ha	14200	23600	26900	26768

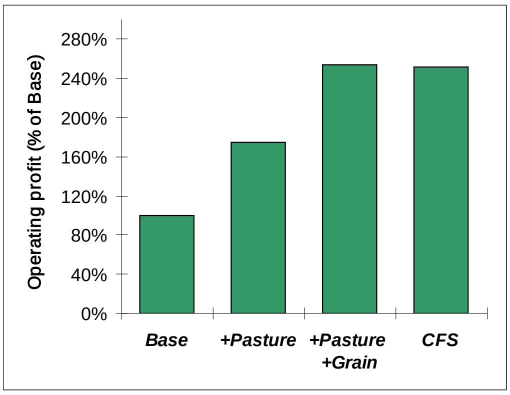

Figure 2. Operating Profit of each scenario as % of Base scenario.

Furthermore, the additional use of supplements in ***+Pasture +Grain*** scenario continued to increase profit, and so did the ***CFS*** scenario both achieving higher per cow production also.

Nevertheless, it is important to note that this exercise was done using a milk price of 0.45 $/L and a grain price of 330 $/ton. Since feed is the item with highest impact on variable costs, the sensitivity of these systems to variation in grain prices was evaluated.

As shown in Figure 3, even though all systems are drastically affected by increased grain price, ***+Pasture +Grain*** seem to be the most vulnerable to rising grain price scenarios.

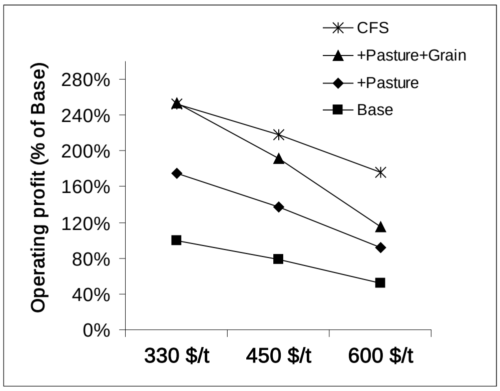

Figure 3. Sensitivity to grain price (as % of Base scenario Operating Profit)

Conclusions

This ongoing study has demonstrated at the farm scale that CFS is a feasible option to increase milk production from home grown feed beyond the potential of pasture alone. Preliminary economic analysis showed comparative advantages of CFS to intensification through increased use of supplements, particularly at higher price of grain.

The potential impact of CFS on commercial farms, and its sustainability implications are yet to be evaluated.

Acknowledgement

This project is part of FutureDairy, an industry driven project primarily sponsored by Dairy Australia, DPI NSW, The University of Sydney and DeLaval.

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The development of Lactococcus lactis as an antimicrobial agent against Staphylococcus aureus

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Introduction

Lactococcus lactis is widely used as starter cultures in the manufacture of cheese. Due to it's generally regarded as safe status; it is also regarded as a promising candidate for the production of proteins of therapeutic interest.

One such protein is lysostaphin, an endopeptidase that is naturally produced by *Staphylococcus simulans* biovar *staphylolyticus* ATCC1362 (Schindler and Schuhart, 1964). Lysostaphin specifically attacks the cell wall of *Staphylococcus aureus* resulting in cell death.

S. aureus is an important pathogen in human and animal (Barkema *et al.*, 2006; Boucher and Corey, 2008). It is the primary causative agent of wound infections, bacteraemia, and sepsis culminating in high mortality rates. *S. aureus* infections are of particular relevance to the dairy industry as the primary cause of contagious bovine mastitis (Monecke *et al.*, 2007).

S. aureus initiates infection by adhering to host extracellular matrix (ECM) proteins, such as fibronectin and keratin.

With the decrease in the efficacy of antibiotics to treat *S. aureus*, the use of lysostaphin as an alternative has attracted significant interest in recent years.

Recent work by Turner *et al.* (2007) demonstrated the expression and secretion of active lysostaphin in several lactic acid bacteria, including *L. lactis*.

Therefore, it was the aim of this study to investigate the potential of lysostaphin expressed by *L. lactis* to inhibit *S. aureus* adherence to fibronectin and keratin.

Materials and Methods

Preparation of L. lactis cell extracts for adherence assay

Previously, a *L. lactis* strain was constructed that expressed and secreted the mature lysostaphin protein using the Sep promoter and secretion signal (Turner *et al.*, 2007). This strain (*L. lactis Lss*) and a plasmid-only control strain (*L. lactis* pG9) were inoculated in GM17 media, supplemented with erythromycin, and incubated at 30°C for 2 days.

The cells were centrifuged, washed with phosphate buffered saline (PBS), and then resuspended in PBS at 100 times concentration. The cells were homogenised with a Mini-Beadbeater-8 cell disruptor using 0.1mm zirconia/silicone beads. Cell debris and beads were removed by centrifugation. The supernatant was removed and used immediately in the adherence assays.

Adherence of S. aureus to immobilised proteins and L. lactis cell extracts

Adherence experiments were performed in 96-wells flat-bottomed tissue culture plates. The protocol was as described by Walsh *et al.* (2004) with some modifications. Each well was coated overnight with ECM proteins (either fibronectin or keratin) in the coating buffer (0.02M sodium carbonate buffer, pH 9.6). Coating buffer alone was used as a Blank control. Any unbound ECM proteins were discarded and the wells were washed with PBS. The wells were then blocked with bovine serum albumin (BSA). After blocking, cell extracts from *L. lactis* pGhost9:IS*S1* or *L. lactis Lss* were dispensed into each well and incubated overnight. PBS was used as a negative control. The cell extracts (or PBS) were discarded and the wells washed with PBS.

Concentrated *S. aureus* cells were added to each well and allowed to attach for 2 hours. Unattached *S. aureus* cells were discarded and the wells washed with PBS. Cells that remained attached were fixed with formaldehyde, and stained with crystal violet solution. The stain was solubilised with acetic acid and the absorbance was measured at 570nm in a microplate spectrophotometer.

Results

Cell extracts of L. lactis strains block the adherence of S. aureus to fibronectin.

S. aureus is able to adhere to fibronectin as shown in Figure 1, lane PBS. The cell extracts of both *L. lactis* pG9 and *L. lactis Lss* strains were able to prevent the adherence of *S. aureus* to fibronectin (Figure 1, lanes pG9 and Lss).

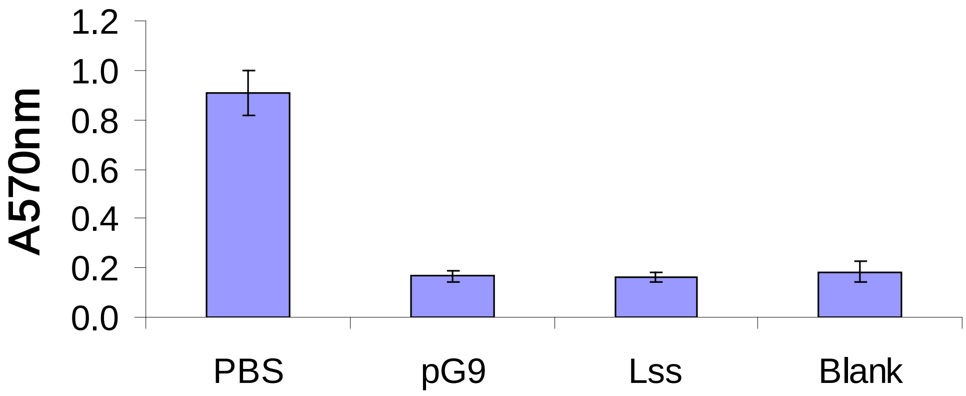

Figure 1. *L. lactis* pG9 and *L. lactis Lss* prevent the adherence of S*. aureus* to fibronectin. Blank refers to wells not coated with fibronectin. The columns represent the mean of n=9 in PBS and pG9, and n=3 in Lss. Error bars represent ±standard deviation.

Adherence of S. aureus to keratin is blocked by cell extracts from L. lactis Lss.

S. aureus is able to adhere to keratin as shown in Figure 2, lane PBS. Keratin-coated wells treated with cell extract from *L. lactis Lss* were able to completely block the adherence of *S. aureus* to keratin (Figure 2, lane Lss).

Conclusions

These results demonstrate that the cell extract of wild-type *L. lactis* was able to block the adherence of *S. aureus* to fibronectin. In addition, the cell extract of *L. lactis* expressing lysostaphin (*L. lactis Lss*) was able to block the adherence of *L. lactis* to keratin. The adherence of *S. aureus* to fibronectin and keratin are the initial steps in the subsequent development of infection. The implication of these results is that *L. lactis* cell extracts could be used in the treatment of *S. aureus* infections, or used prophylactically to prevent infections, both in human and animals.

Acknowledgements

The Authors would like to thank Dairy Australia and Queensland University of Technology for providing funding for this research. The first author would like to thank C. Eastwood for his invaluable comments.

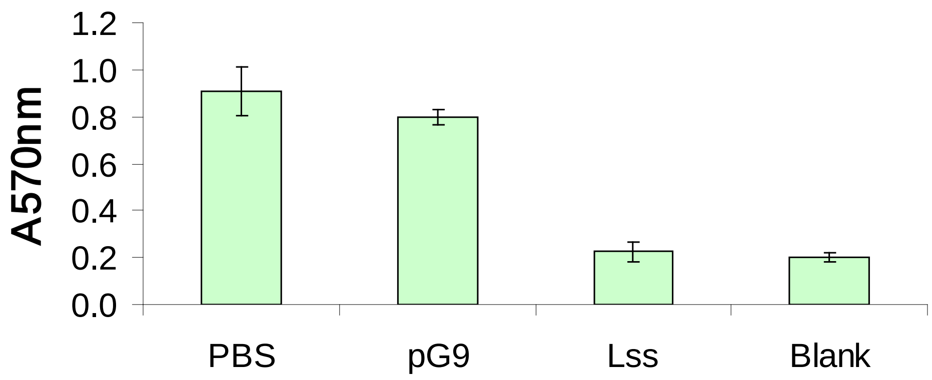

Figure 2. Cell extract from *L. lactis Lss* was able to block *S. aureus* adherence to keratin. Blank refers to wells not coated with keratin. The columns represent the mean of n=12 in PBS and pG9, and n=6 in Lss. Error bars represent ±standard deviation.

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Milk acetone may be influenced by follicular activity

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Introduction

Poor reproductive performance in modern dairy cows is believed to be in part due to the mismatching of the current genotype, feeding system and management, resulting in significant *post-partum* negative energy balance (NEB) (MacMillan *et al.* 1996).

A 12-month calving interval is required to match cow requirements with seasonal pasture growth. Prolonged *post-partum* anoestrus is a significant problem in achieving this (Rhodes *et al.* 2003). Ultrasounding studies have consistently shown that the first dominant follicle emerges around day 17 *post-partum*, but in pasture-based cows this remains smaller than 10mm and does not ovulate (Savio *et al.* 1990; McDougall *et al.* 1995).

Milk acetone concentration has been shown to be a useful indicator of NEB (Clark *et al.* 2005) and ketosis (Cook *et al.* 2001).

A pattern of change in milk acetone concentration in early *post-partum* dairy cows was found in a continuous

calving system, consisting of milk acetone 'peaks' every 21 to 28 days (Clark *et al.* 2006). Similar peaks had been reported in cows in South Africa (Winterbach *et al.* 1993), but these occurred at a seven to ten day interval. Both of these authors suggested that ovarian activity may have an influence on milk acetone concentrations. We hypothesised that the relationship between acetone peaks and ovarian activity would be more marked in seasonal and split calving systems, where the majority of cows in the herd are in similar physiological stage.

The aim of this study was to investigate changes in milk acetone concentration in seasonal and split-calving herds, and to examine these in relation to luteal activity.

Materials and methods

Twelve early *post-partum* dairy cows were studied on each of two pasture-based dairy farms in Gippsland, Victoria, were milk sampled daily for 6 to 7 weeks. Samples were analysed for milk acetone (flow injection analysis) and progesterone (radio-immuno assay). Luteal activity was inferred from milk progesterone (>3nmol/L for three consecutive sampling days).

Farm 1 seasonally calved 210 cows during July. Farm 2 calved 130 cows, and had 50 cows from the preceding autumn calving. Both herds grazed perennial? Ryegrass-based pasture, supplemented with triticale fed at milking (4 and 6kg per cow per day for Farm 1 and 2, respectively).

Results

'Peaks' in milk acetone concentration were defined as days when the mean acetone concentration was significantly higher than the mean (or 'baseline') for the whole study. On Farm 1, two peaks of similar magnitude appeared around 21 and 28 days *post-partum* (Figure 1). On farm, 2 a peak occurred around 16 days *post-partum* (Figure 2).

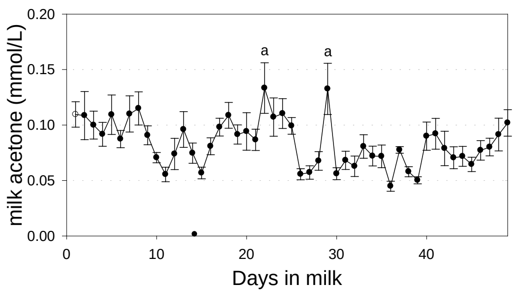

Figure 1: Mean ±se milk acetone concentration (mmol/L) for Herd 1 over the study period. a= significantly higher than 'baseline'.

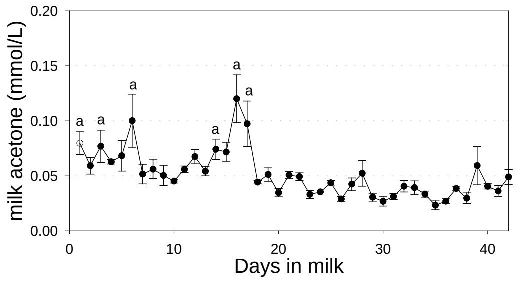

Figure 2: Mean±se milk acetone concentration (mmol/L) for Herd 2 over the study period. a= significantly higher than 'baseline'.

The period from *partum* to resumption of luteal activity was longer and more variable on Farm 1 (median 30 days in milk, ranging from 17 to50+ days, compared to 25 days in milk, ranging from 10 to 36 days on Farm 2).

Individual cows milk acetone concentrations (data not shown) appeared to vary in 'wave'-like patterns, rising and falling at 5-10 day intervals.

An interesting feature of these acetone peaks is that they are synchronised between animals. In this study some of these peaks could be attributed to 'extreme' winter weather conditions, consisting of strong wind and rain.

Discussion

It is possible that milk acetone concentrations may be influenced by the formation of an ovulatory follicle preceding luteal activity.

The Farm 2 cows had shorter and more compact resumption of luteal activity, and would have experienced less waves of dominant follicle growth before ovulation and luteal formation. The two milk acetone peaks, which occurred later, on Farm 1, may be related to the delayed and spread luteal resumption. These cows would have experienced more waves of dominant follicle emergence before ovulation, and these would be more variable between cows.

Wet and cold conditions have been shown to alter dry matter intake and increase lipolysis (Tucker *et al.* 2007). These could be associated with some of the peaks seen but not all of them.

Monitoring milk acetone concentrations may indicate how NEB, weather and oestrus cycles are influencing fat mobilisation. In this way the production-reproduction interaction may be understood.

Acknowledgement

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What does water use efficiency mean?

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Introduction

Irrigation water is becoming increasingly scarce in Australia, with environmental concerns, climate change and demands from other water-using sectors of the community placing pressure on governments to legislate to reduce the supply of irrigation water and/or increase its cost. Water is the primary constraint to forage production for the Australian dairy industry, where irrigation, if used, supplements rainfall to boost pasture productivity. In fact, 56% of all Australian dairy farms use at least some irrigation (Watson 2006). However, there are important dairy regions which rely almost entirely on irrigation between September and April, such as northern Victoria, where 96% of dairy farmers irrigate an average of 78% of their farm (Watson 2006). The dairy industry is the second largest user of irrigation water in Australia, using some 19% of all irrigation water. In doing so, irrigated dairy production contributes some $1.63 billion to the Australian economy (ABS 2006). The recent droughts have highlighted the scarcity of water, not only to farmers, but also water restrictions in the major capital cities. In some irrigation districts with water allocations down to 5% of water right at the start of the season, and were associated with water prices for temporary transfer of up to $1000 ML, normally around $50 ML (Goulburn - Murray Water 2008). These water shortages have placed increased pressure on farmers to use irrigation water and rainfall as efficiently as possible. As a result, forage WUE has recently become an important performance indicator for sustainable dairy production.

Table 1. Mean yield, water used and water use efficiency of different forages under optimum irrigation over three years.

Forage/Location	Yield (t DM/ha)	Water used[A] (mm)	WUE (kg DM/ ha.mm)	ME (MJ/kg DM)
	C_3 perennials			
Perennial ryegrass	20	1073	19	10.7
Fescue	24	1116	22	9.9
Prairie grass	24	1140	22	10.6
Lucerne	20	1197	18	9.2
Red clover	18	1099	16	10.0
White clover	16	980	17	10.2
	C_4 perennials			
Kikuyu	24	818	30	9.6
	C_3 winter annuals			
Short rotation ryegrass	14	725	21	10.4
Persian clover	12	690	18	10.0
Wheat	20	749	26	9.1
	C_4 summer annuals			
Maize	29	694	43	9.7
Sorghum	18	645	28	8.8

[A]*Irrigation + rainfall + change in soil water content – runoff – drainage*

Material & Methods

A field experiment was conducted on a brown dermosol at the University of Sydney, Camden, over three years to evaluate the dry matter yield (DMY), water use efficiency (WUE) and nutrient content, of 30 forages under optimum and two levels of deficit irrigation. A neutron probe was used to determine irrigation scheduling requirements, as well as water extraction down the soil profile. At a 30mm soil water deficit, the optimum treatment was refilled to field capacity (100%), while the two water deficit treatments received 33% and 66%, respectively, of the water applied to the optimum treatment. Each forage was harvested at the optimum stage of growth for determination of DMY and quality. Fertilizer was applied to replace nutrients removed at each harvest, except for legumes where no nitrogen was applied. WUE was calculated by dividing dry matter produced, by the sum of rainfall, irrigation and change in soil moisture content, less any runoff and drainage.

Results

Optimum Irrigation

There were significant (P>0.001) differences between forages, not only in WUE, but also yield, when considered on both an annual and seasonal basis (Table 1, Figures 1 and 2). There were many species of forage that were more WUE than perennial ryegrass under optimum irrigation (I1), with maize being the most WUE on both a seasonal and annual basis. In fact, maize was four times more WUE than perennial ryegrass during summer (Figure 1), although it was reduced to only twice the WUE on an annual basis (Table 1). During summer, the other C_4 forages including sorghum, paspalum and kikuyu also had higher WUE than the C_3 forages lucerne, perennial ryegrass and white clover (Figure 1). However, the advantage of the C_4 forages over C_3 forages in WUE was also reduced on an annual basis. During winter, when the C_4 forages were inactive, there were still relatively large differences in WUE between other forages with short rotation ryegrass and wheat having the highest WUE of 38 and 35 kg DM/ha.mm respectively.

The C_4 perennial grasses kikuyu and paspalum, and the C_3 perennial grasses prairie grass and phalaris were able to maintain high groundcovers and plant densities over time, while the ground covers and plant densities declined over time for all the other C_3 perennial forages. This led to a significant decline in yield, and consequently WUE was reduced by up to 65% in the summer/autumn and 36% in the winter / spring, between years 1 and 3 (Table 2) for the perennial forages, such as perennial ryegrass and white clover. For those persistent forages, such as kikuyu and prairie grass, there was no significant difference in WUE between years 1 and 3 (Table 2). In contrast to the significant decline in WUE over time for some of the perennials, the WUE of the annual forage species were relatively stable and not significantly different between seasons and years for most forages, except maize.

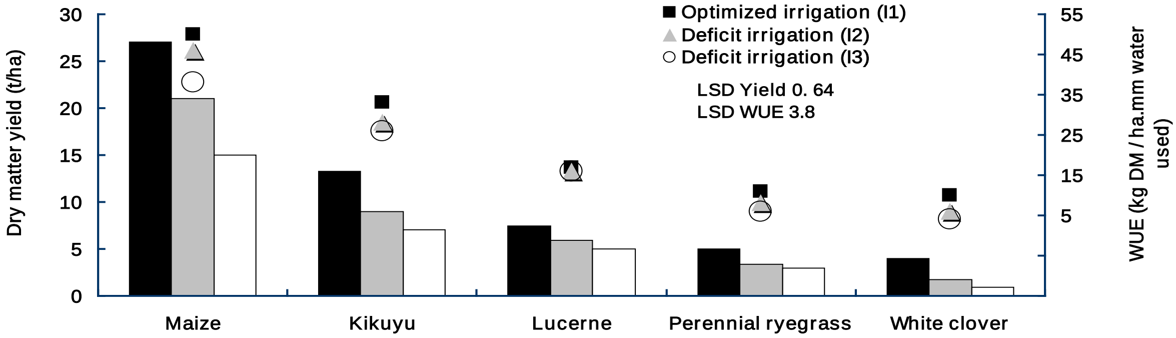

Figure 1. Mean dry matter yield (t DM/ha) (columns) and water use efficiency (kg DM/ha.mm water used) (symbols) of forages for three irrigation regimes during summer averaged over 3 years.

Deficit irrigation

Impact of the deficit irrigation treatment on WUE differed significantly between forages and seasons. During periods of high temperatures and evapotranspiration in summer, some of C_3 forages, such as perennial ryegrass and white clover and the C_4 forages maize and kikuyu showed significant declines in WUE under the deficit irrigation treatments, while the C_3 forage lucerne did not (Figure 1). During winter under lower evaporative demand, there was no significant difference in yield or WUE between the deficit irrigation treatments for the winter annuals, such as short rotation ryegrass and Persian clover (Figure 2), when starting with full soil water profile. In contrast, for the perennial forages, the soil water profile was generally low at the start of winter, which led to significant declines in yield and WUE between deficit irrigation treatments, for perennial ryegrass and white clover, but not for lucerne. On an annual basis, all the perennial and summer annual forage species except for lucerne, showed a significant decline in WUE. This contrasts to most winter annuals, except long season growing species such as long rotation ryegrass and Persian clover, where there was no significant difference in annual WUE.

Table 2. Comparison of forage WUE over time over different seasons.

	Kikuyu[A]		Perennial ryegrass[A]		Prairie grass[A]		White clover[A]	
	Sum–Aut	Win -Spr	Sum–Aut	Win–Spr	Sum–Aut	Win–Spr	Sum–Aut	Win–Spr
Year 1	3							
Year 2	35	25	17	27	18	28	18	23
Year 3	33	23	7	23	15	24	9	14
LSD (0.05)				4.1				

[A]Irrigation + rainfall + decrease in soil water content – runoff – drainage

Yield vs. water use

When yield is plotted against water use for C_3 perennial forages across all irrigation regimes there is strong positive relationship (R^2 = 0.62) is demonstrated in WUE (Figure 3). Interestingly, while annual yields of C_3 perennial forages under optimum irrigation (I1) varied from 13 t DM/ha to 27 t DM/ha, water use varied between only 1040 and 1250 mm. Similarly under deficit irrigation treatment (I3) in years two and three (excluding the establishment year), yield also was much more variable, ranging from 4 t DM/ha to 12 t DM/ha, while water use varied between only 650 and 820 mm.

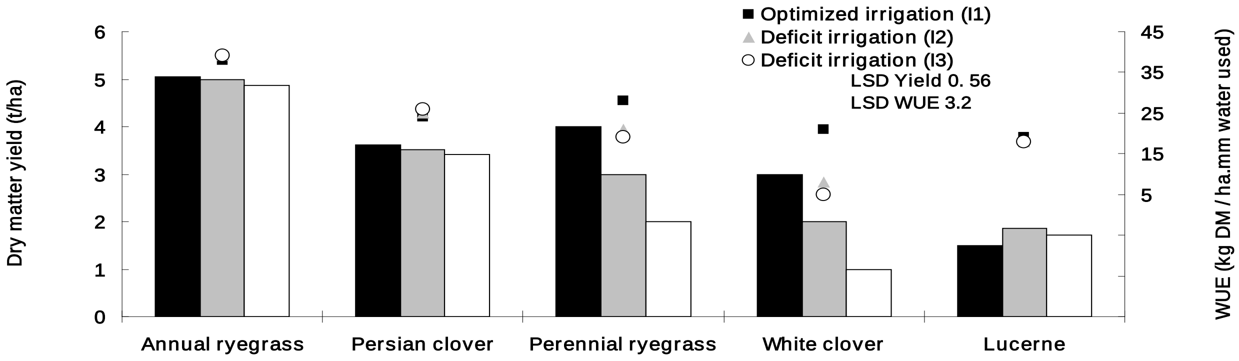

Figure 2. Mean dry matter yield (t DM/ha) (columns) and water use efficiency (kg DM/ha.mm water used) (symbols) of forages for three irrigation regimes during winter averaged over 3 years.

Discussion

Optimum irrigation

These results demonstrate that there is large variation in WUE between forages which could be exploited on farm. Maize was by far the most WUE forage and highest yielding with a WUE of 43 kg DM/ha.mm under the optimum irrigation, fertility and management in the Camden environment. This high WUE of maize was even achieved during the period of the highest evaporative demand and was also achieved in only four months In contrast, mean WUE of perennial ryegrass, the dominant dairy forage in Australia, was much lower at only 19 kg DM/ha.mm. The temperatures during summer, were well above those for optimal growth of perennial ryegrass (Blaikie and Martin 1987), presumably leading to the decline in WUE over time. In fact, maize was 1.5 times as WUE as perennial ryegrass in year 1, but increased to 3 times as WUE by year 3. While the C_4 forages have substantial advantage in WUE in summer, this was reduced on an annual basis, with the C_4 forages WUE ranging from 22-41 kg DM/ha.mm. While C_4 forages were still generally higher than C_3 forages, there was some overlapping in WUE with C_3 forages ranging from 13-26 kg DM/ha.mm. The C_3 forages with higher WUE tended to be winter annuals, as they grew during period of lower evaporative demand and optimum growing temperatures for these species, and in doing so, maximised WUE.

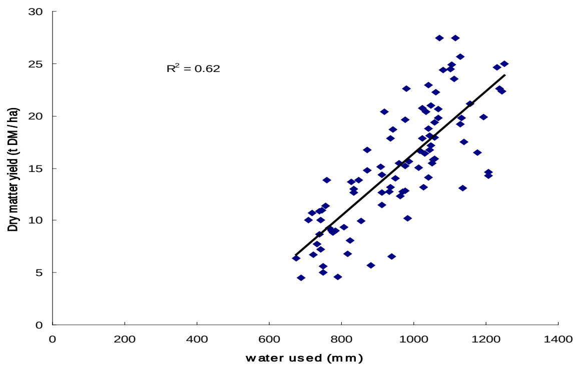

Figure 3. The relationship between annual yield (t DM/ha) and annual water used (mm) for the C_3 perennial forages.

The strong relationship between yield and water use, with greater rate of change in yield than water use, highlights that in order maximise WUE it is necessary to maximise yield. Furthermore, under optimum irrigation in particular, the small difference in water use in contrast to yield, is because evapotranspiration is determined mainly by atmospheric conditions (Allen *et al.* 1998), not the growth rate of the plant. With water use almost independent of yield, this further highlights the need to target strategies that focus on increasing yield. By ensuring adoption of best management practices greater yields and higher WUE will be achieved.

Comparing the results of this study to on-farm WUE data is difficult, as data does not exist or is incomplete, as up until the recent droughts water was relatively plentiful and cheap, as result little money had been invested into research in forage WUE. On farm WUE surveys in Northern Victoria, calculated using the similar parameters have been shown WUE to be in the order of 28-34 kg DM/ha.mm for maize (3 farms) (Greenwood *et al.* 2008), while for dairy pastures predominantly perennial ryegrass where in range of 5-10 kg DM/ha.mm and with a mean of 9 kg DM/ha.mm (170 farms) (Armstrong *et al.* 2000). The mean yields of the forages ranged from 18–20 t DM/ha for maize (Greenwood *et al.* 2008) and only 6-12 t DM/ha for the predominantly perennial ryegrass pastures (Armstrong *et al.* 2000). In the current study maize yielded 27 t DM/ha, while the higher yielding perennial pastures fescue, prairie grass and kikuyu had mean annual yields of between 24 and 25 t DM/ha. Under similar conditions, perennial pastures yield up to 26 t DM/ha have also been reported in northern Victoria (Greenwood *et al.* 2006) and up to 28 t DM/ha in south east Queensland (Lowe and Bowdler 1995). While these yields were achieved under cutting and not grazing, if the mean yields on farm are only increased by 50%, then this is going to have huge implications on WUE and food production. Even doubling mean yields of perennial grass production is not out of the question as there are already farmers who are achieving yields of 18–20 t

DM/ha of perennial pasture (Spain 2005; Melsen *et al.* 2006).

While utilising a forage like maize will provide the greatest potential to improve WUE, particularly when on farm efficiency of maize is 50% higher, than the maximum achieved from perennial ryegrass under experimental conditions. Furthermore, while not increasing WUE, maize can be combined with a WUE winter annual, to increase the yield per hectare. Combining maize with wheat will lead to high yields in excess of 40 t DM/ha, way in excess of that achievable form perennial pastures. However, whole farm economic analysis where the entire farm is allocated to maize singularly, or maize and wheat in combination, resulted in loss of $489,000 and $202,000 respectively (Neal *et al.* 2007). In contrast, allocating the lower WUE and yielding forage perennial ryegrass, over entire farm led to profits of $287,000 (Neal *et al.* 2007). The reason for dramatic differences in profits is due differences in incomes and expenses for the different forage options. Maize and wheat are crops which need to sown each season, but also cannot be grazed, thus these forages must be harvested and ensiled and feed out throughout the year. In contrast, perennial ryegrass needs only to be resown every 3-4 years, reducing planting costs and can be grazed reducing harvesting and feeding expenses, also it has a higher energy density leading to higher potential milk production than either maize or wheat. This economic analysis highlights the complexity of choosing forages, as there important tradeoffs in WUE, yield and nutritive value that need to be taken into account. In converting forage to milk, dairying is one of the most complex agricultural enterprises in agriculture. Dairy farms rely on the efficient use of many resources, amongst which, ***water*** is but one, in determining overall farm sustainability and profitability.

Deficit irrigation

For all the other perennial species, except lucerne, deficit irrigation leads to a decrease in WUE. Clearly, there is an advantage for the winter annuals, in starting with full profile and growing during a period of lower evaporative demand for reducing water use. In this study, the winter growing annual forages were are able avoid water stress from the decreased irrigation inputs, by increased extraction of water from soil water profile, and received enough water from rainfall, particularly in the spring to match reference ET till end of October. In contrast, the high evaporative demand during summer, resulted in water stress and growth being limited, as the forages could not compensate for decreased water availability by soil water extraction, even with rainfall, as the reference evaporation was always much higher. Thus a deficit irrigation strategy may be successfully used in winter with no decrease in WUE, depending on season, rainfall pattern, starting soil moisture, and forage water requirements. Although growing forages after October due to higher evaporative demand and soil water profile being exhausted can lead to forages such as Persian clover and long rotation ryegrass with a decrease in WUE. In contrast, for those forages growing through the summer, apart from lucerne, a deficit irrigation will not lead to maximise WUE.

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Automatic Milking System Performance Update

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Introduction

Changing labour demands in the Australian dairy industry have the potential to impact on the sustainability of dairying. Automatic milking has the potential to address some of these issues by reducing the required labour to operate the dairy business (in particular with respect to milk harvesting), improving the hours of work and therefore the ability to attract and retain staff in the industry and to improve the lifestyle aspect of dairy farming. All of these benefits should result in an increase in the sustainability of dairying as we move into the future.

There are now more than 7,000 commercial farms around the world that have incorporated automatic milking systems (AMS) in 32 countries. In some European countries, 50-60% of new dairy installations are now AMS indicating that it is a widely accepted technology in that part of the world. Whilst the majority of installations around the world are still small to medium scale and within indoor systems there are increasing larger scale operations within a variety of farm system types. In Australasia there are now 4 commercial farms in operation (total 14 milking stations) with at least another two farms signed up awaiting installation. All the commercial installations in Australasia are pasture-based operations with varying levels of inputs.

Surveys carried out in 2001/02 across 4 European countries (107 farmers surveyed, in countries with a relatively high labour cost) indicated that 67% of adopters had reasons other than profit for investing in an Automatic Milking System (AMS) – typically stating labour flexibility, improved social life and health concerns as key reasons impacting the investment decision (EU Project Automatic Milking). In Australia there is increasing interest in this technology for similar reasons. The attractiveness of the dairy industry, and efficiency of, to labour could improve if staff had the opportunity to work ‘normal’ working hours, spend less time doing activities related to milking cows and be more involved in farm management. Thus, this technology would improve dairy farm sustainability through attracting and retaining staff on farm and creating a system which will allow for later retirement of the owners from dairy farming.

The Camden AMS research farm was established 2 years ago. Phase 1 of the project has been an establishment phase. It takes 12 months to develop an established herd so that 'experienced' cows are calving into the system and going through the early lactation phase of the cycle. Year 2 allows generation of sufficient data to determine the true system performance capabilities and the areas that required refinement/improvement.

This document will outline progress of the AMS research over the 2 year period from May 2006.

Milk production

During year 2 of operation the AMS research farm produced a total of 967,991 litres milk (68,050 kg MS). Using the average number of cows in milk (125) this equated to 22,000 litres/ha, 7,744 litres/cow and 544 kg MS/cow. Production per ha (based on total farm size of 44 ha) was 1547 kg MS/ha.

Table 1.1 shows an 11% improvement in milksolids (MS) per cow and a 29% improvement in MS for the farm from year 1 to year 2. There are three main factors resulting in the improved performance:

1. Implementation of learnings throughout the 2 year period resulting in general improvements of all aspects of the farm system performance including distribution of cow traffic, improved milking frequencies and improved daily dry matter intakes.
2. Increased herd size over the two year period as a result of having captured an improvement in milking station utilisation.
3. Year 1 data is largely generated by an inexperienced herd of cows that were learning the system, whereas year 2 data is largely generated by a herd of experienced cows that understand the system and the incentives in place and have confidence with moving around the system.

Already the year-to-date performance figures for 2008 are around 13% higher (with regard to milksolids per cow) than performance to date for 2008 (table 1.1)

Table 1. Annual milk production performance for year 1 and year 2 of operation for Camden AMS research farm and year to date performance for 2007 and 2008.

	12 month performance		
	Year 1 1 May 2006 – 30 April 2007	Year 2 1 May 2007 – 30 April 2008	1 July 2007 – 30 June 2008
Total kg milk	752,653	967,991	971,760
Total kg MS	52,685	68,050	68,606
Ave cows in milk	108	125	124
Ave kg milk/cow	6969	7744	7836
Ave kg MS/cow	488	544	553
Ave kg MS/ha	1197	1547	1559

Utilisation of pasture

During 2007 we showed that very high levels of pasture utilisation (14 t DM/ha) can be achieved on irrigated paddocks. This is much higher than the district average (6-7 t DM/ha) and in line with pasture utilisation levels achieved in the farmlets on the conventional research dairy (No. 9 dairy) during the same year. During the period July 2007 to June 2008 this level was increased to 15 t DM/ha on 61% of the farm that was irrigated. The average pasture utilised across the entire AMS research farm averaged 12.8 t DM/ha from July 2007 to June 2008.

These results are extremely encouraging. We are no longer of the belief that automatic milking could be associated with a decrease in pasture utilisation as a result of the voluntary trafficking system. Provided the conditions exist for high levels of pasture production there is no reason why high levels of utilisation should not be achieved within an AMS.

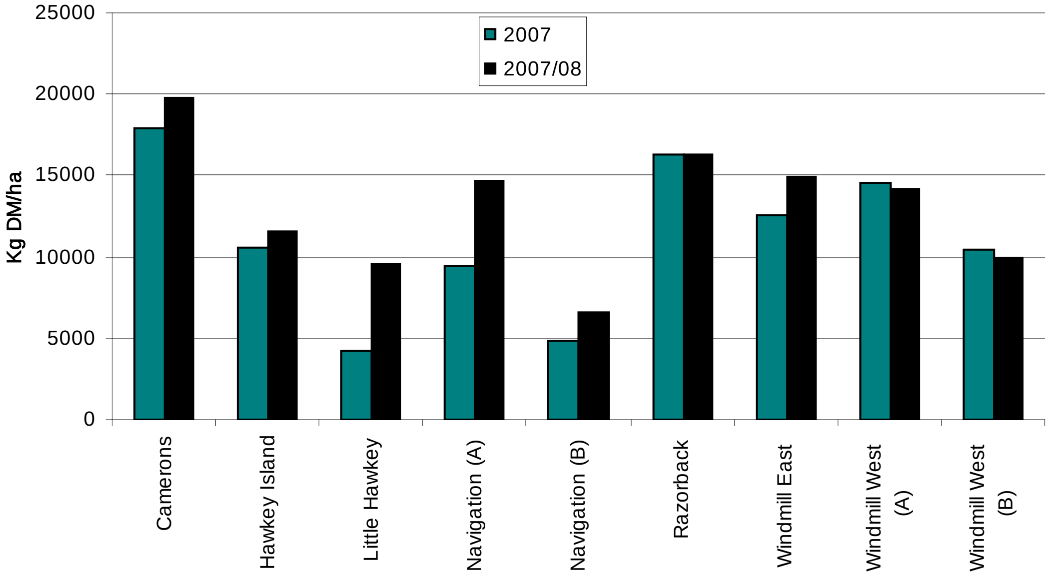

Figure 1. Annual dry matter production per paddock through 2007.

Visitation frequency

The figure 1.2 shows the monthly average milking frequency for the herd and for the early lactation cows. The herd average milking frequency is largely affected by the proportion of cows in early, mid and late lactation. Although great progress has been made with regard to the early lactation milking frequency of the most recent 16 months there is still some room for improvement with the target milking frequency for the early lactation cows being 2.0 - 2.5 milkings/cow/day.

Learnings from year 1 which were implemented throughout the past 2 years have resulted in higher and more predictable and manageable milking frequencies. This is mostly through manipulations of the incentives used to create voluntary cow traffic. The much improved milking frequencies seen through year 2 will be a large contributor to the improved milk production seen in table 1.1.

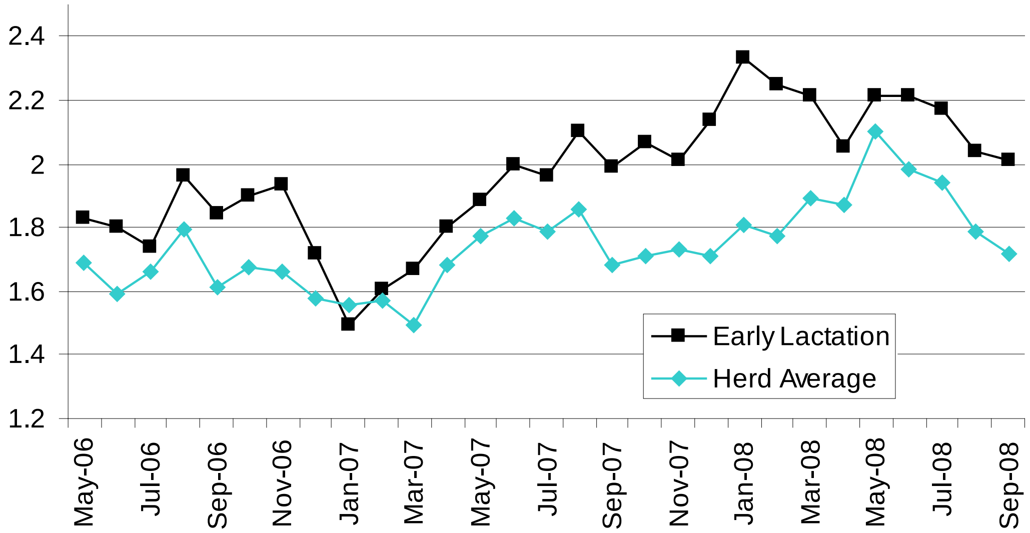

Figure 2. Monthly average milking frequency of the AMS herd (all cows in milk) and early lactation cows.

Milking Distribution and Machine Utilisation

Indoor European AMS farms achieve high levels of machine utilisation with machines idle for only 2-3 hours/24 hour period. Similar levels of utilisation would ensure a high potential for economic viability in the Australian industry. However, cows that are outdoors are subject to diurnal patterns resulting in sleep times when the majority of cows sleep for a number of hours. In addition cows that are pastured tend to have bouts of activity compared to cows fed a TMR (total mixed ration). Pastured cows need to have grazing bouts and rumination bouts rather than feeding right throughout the 24-hour period. These behaviours result in a reduced utilisation of the machines and some challenges to try and lift utilisation whilst maintaining the typical Australian pasture-based system.

The AMS efficiency would be maximized if milkings were evenly distributed throughout the 24-hour period. This would allow for maximum machine utilisation (through optimisation of the number of cows in milk and the milking frequency of those cows), thereby maximizing the amount of milk harvest per machine. Machine utilisation is a key contributor to economic viability because it affects the ratio of cows to machine and therefore has a big impact on financial outlay for the system. Typically in European systems the average amount of milk harvested per machine per day ranges from 1500-2500 litres. In contrast, the Camden farm has had monthly average harvest levels ranging from 987 litres to 1772 litres/machine/day (mean 1382 litres) over the past 12 months.

The average European farm has machines idle (not milking or washing) for only about 10% of each 24-hour period. In contrast the Camden research farm has ranged from 20-49% idle time over the past 12 months (depending on the number of cows in milk and the average milking frequency (figure 1.3).

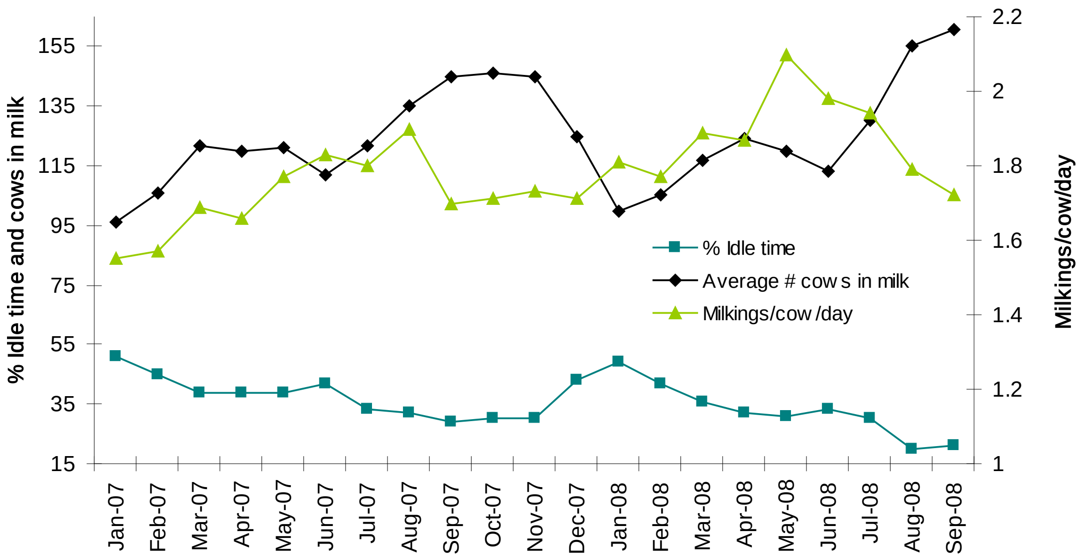

Figure 3. Monthly average milking frequency, herd size and idle time (proportion of each 24 hour period when milking stations are not milking, cleaning or self testing)

Figure 1.3 indicates the average idle time per month (idle time has a direct relationship with number of cows in milk and milking frequency, among other factors). Idle time alone does not paint the full picture, the most under-utilised periods of time is during the early hours of the morning (figure 1.4) and this period will be targeted to allow an increase in machine utilisation. However, increased utilisation across the whole day may also be targeted through under-utilised periods and through more milkings/day (either by milking more cows or milking the existing cows more often, or a combination of both).

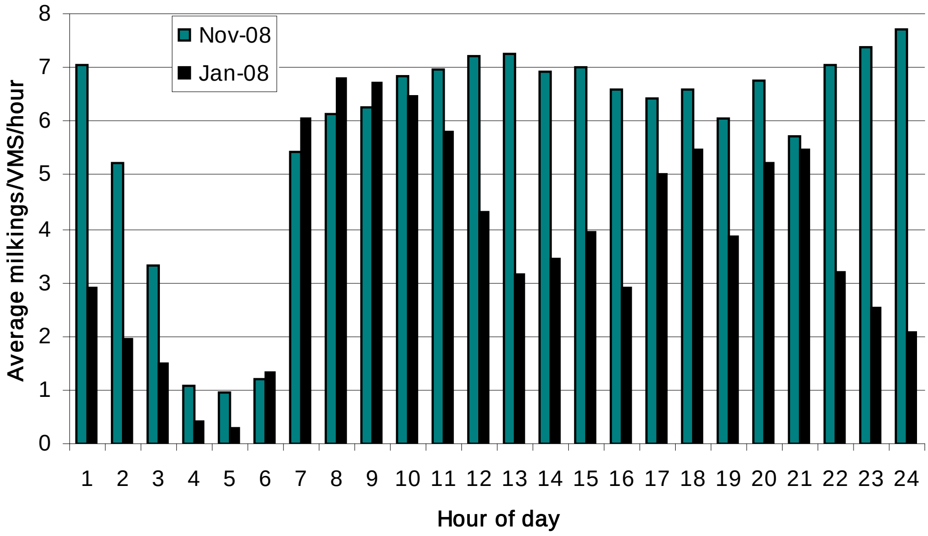

Figure 4. Average number of milkings per milking station for each hour of the day during a period of low utilisation – January 2008 (100 cows at 1.81 milkings/cow/day, 49% idle time) and higher utilisation – September (161 cows at 1.72 milkings/cow/day, 21% idle time)

Daily intakes and cow traffic

An automatic milking system (regardless of the intensity of the system) is reliant on voluntary cow traffic. However, it must be accepted that not all cows will volunteer for milking at the regularity that is expected of them. As a result there are some cows that require to be fetched for milking. In an indoor system these cows are in amongst all other cows in the barn and must be firstly found and then fetched as individuals by the stock person. In a pasture-based system these cows are typically the cows that remain in the "old" pasture break and are therefore easily identified / targeted. In a pasture-based system these cows are encouraged out of the pasture break and they then tend to walk to the dairy whilst the stock person is setting up temporary fences for the fresh pasture break (generally opened or made available to cows a few hours later). The cows that require fetching tend to be cows that fall into one of the following categories:

- late lactation
- inexperienced
- oestrus
- ill or of poor health

However, in addition to these cows the incentives used to generate cow traffic have a large impact on the number of cows requiring fetching. A strong correlation can be seen between the proportion of pasture in the diet and the proportion of milkings resulting from fetching (figure 1.5).

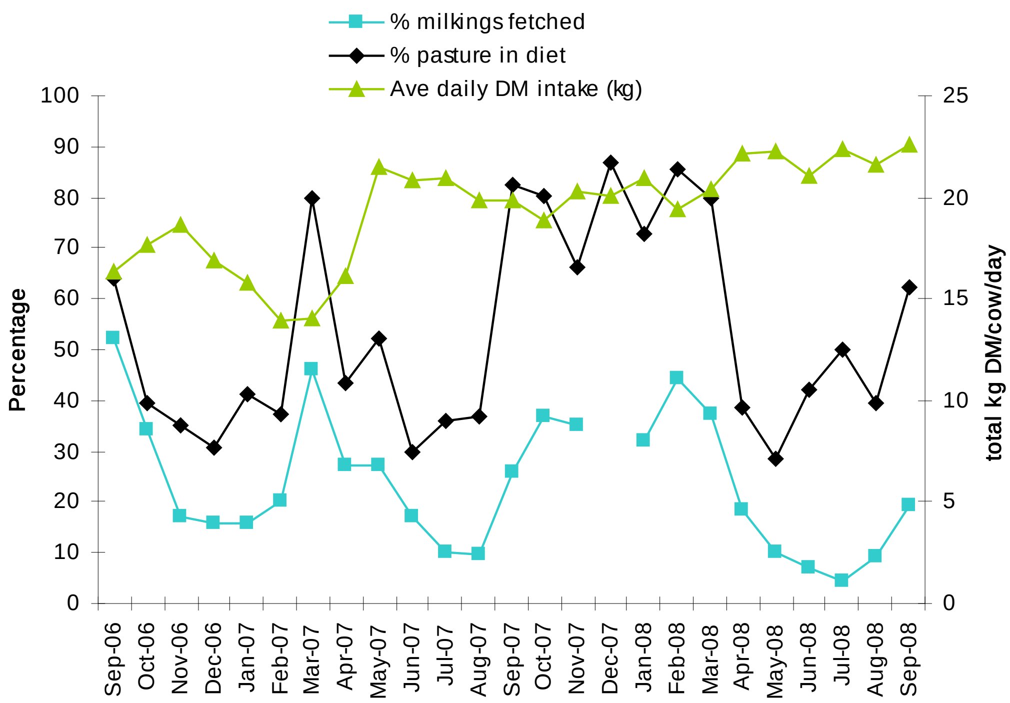

Figure 5. Monthly averages for daily DM intake (kg/cow), proportion of the daily diet coming from pasture and the proportion of milkings resulting from cows that have been fetched (calculated as average number of cows fetched per day divided by total number of cow milkings occurring on that day).

A target daily intake of 20-23 kg DM/cow/day was not achieved until May 2007. Since that time target intakes have been met (or have been very close to being met) each month. During late 2006 and early 2007 the incentives in place for the cows were inadequate to generate consistent milking frequencies, which in turn resulted in many cows not accessing fresh breaks of pasture. By improving the accuracy of feed allocation and manipulating the timing of access of pasture allocation, more consistent cow traffic, milking frequencies and daily intake levels have been achieved.

It is important that the level of fetching is managed during periods of high pasture intakes as the incentives for generation of cow traffic are reduced during these periods. It could be imagined that provision of 3 pasture breaks/day during these periods could be beneficial (smaller allocations of feed – resulting in more cow traffic). However, large numbers of cows requiring fetching really only impacts negatively if it is creating large (long-lasting) queues of cows at the dairy and if it requiring additional labour or impacting on cow intakes.

Conclusions

As time progresses and our application of learning are implemented on farm we continually see the performance of the system improving. This is a low intensity system with the majority of feed being sourced form pasture and cows being fed with about 1.2 tonne concentrate/cow/year. Given the current cow and pasture performance levels it is our belief that the system around the AMS is now well developed. Research work will continue but industry interest is increasing rapidly and it is expected that uptake on farm will begin to increase over the next 12-24 months. We now have a plentiful supply of knowledge and understanding to ensure that farmers that do embark on this new way of farming have every opportunity to be successful.

Acknowledgement

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For further information, progress updates and recent research results please refer to www.futuredairy.com.au.

Lifting on-farm productivity by increasing stocking rate, milk yield per cow, or both: The Feeding Module of FutureDairy

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Introduction

The rationale of the Feeding Module of FutureDairy is on the increasing pressures on Australian dairy farmers to sustainably improve productivity (Garcia and Fulkerson 2005). This can be achieved by increasing either home-grown feed (the Forage module), or the utilisation efficiency of feed brought into the farm (the Feeding module). In any case, an increase in either the amount of milk produced by each cow or the number of cows/ha, or both, would be necessary to achieve the desired level of productivity gain.

However, Australian dairy farmers have questioned whether this productivity gain should be achieved by prioritising an increase in either milk yield/cow, stocking rate, or both. Quantifying these different paths to increase productivity was the overall goal of the Feeding Module.

To enable a proper evaluation of the systems that differ in stocking rate and level of milk production per cow, systems were first modelled (stage I of the Feeding Module); two herds of contrasting milk yield/cow were developed (stage II); and a Whole System Farmlet was set up at No9 Dairy Farm, EMAI, DPI NSW in 2006 to compare the physical and economic performance of modelled treatments over 2 consecutive years (Stage III). Preliminary results from the first year of the experiment were presented at 2007 Symposium. This paper reports on key results of the farmlet comparison after its completion in 2008.

Treatments (Farmlets)

The treatments were (Table 1):

Control

Cows grazed pasture for most of the day and were fed concentrate at milking and silage/hay as required. Target proportion of pasture in the total diet of cows is 60-70%.

High Stocking Rate

This system was designed to achieve a higher milk yield/ha through higher stocking rate (3.4 cows/ha) but similar level of milk yield/cow in comparison with the control system (Farmlet Green).

High Milk Yield per cow

This system was designed to achieve a higher milk yield/ha through higher milk yield/cow and same stocking rate as the control system. Cows grazed on available pasture and were supplemented with concentrates and fodders using 'partial mixed ration' (PMR) strategy as required.

High Stocking Rate and High Milk Yield per cow

This system was designed to achieve a 'quantum leap' in milk yield/ha through increasing both stocking rate and milk production/cow. Cows grazed on available pasture and were supplemented with concentrates and fodders using 'partial mixed ration' (PMR) strategy as required

Table 1. Feeding module Farmlets

	FARMLETS			
Milk yield (L/cow)	6000		9000	
Stocking rate (cows/ha) Initial planned Actual	 2.3 2.5	 3.4 3.8	 2.3 2.5	 3.4 3.8
Stocking rate (kg LW/t pasture DM produced, based on 10 t DM/ha)	144	204	144	204
Farmlet code	A	B	C	D
Farmlet ID	Control	High Stocking Rate	High Milk Yield/cow	High Stocking Rate AND High Milk Yield/cow
Farmlet Colour ID	***Green***	***Grey***	***Yellow***	***Blue***
Target Milk yield (L/ha)	14400	20400	20700	31050

All Farmlets comprised a maximum of 30 lactating cows of average genetic merit for production (average ABV milk fat + milk protein at the beginning of the experimental period= +4kg).

Management rules

All blocks (paddocks) were matched between farmlets based on previous pasture growth, soil fertility and soil nutrient status from data collected as part of the Phosphorus study (E. Havilah, pers. comm.). There were a total of 11 paddocks on each farmlet, with a total area of 9.5 and 6.5 ha for the farmlets stocked at a higher and lower stocking rate, respectively.

To ensure an unbiased comparison, all farmlets were managed according to previously agreed upon guidelines in terms of grazing management, reasons for drying-off cows, etc. (Garcia 2000, MacDonald and Penno 1998).

Nitrogen (N) fertiliser was applied on all farmlets at a rate varying from 100 to 150 kg Urea/ha every second grazing. This resulted in total N input being similar across all farmlets and ranging between 350 and 450 kg N /ha/year for individual paddocks.

Due to infrastructure, water availability (local water restrictions) and labour cost problems; irrigation water could not be applied as per originally planned (i.e. refilling soil profile in accordance to soil moisture condition). Instead, irrigation was limited particularly during the dry summer of 2006-2007 (year 1). Total irrigation water input was similar across all farmlets (6.2 ML/ha in year 1 and ~3ML/ha in year 2) but ranged from ~4 ML/ha (paddocks ‘dropped’ from the rotation during the drought of 2006-2007) to ~7.5 ML/ha in those paddocks which received better irrigation.

Grazing and feeding management

The same management decision rules were applied to all 4 farmlets during the 2 years and were based on maintaining:

- A whole farmlet pasture cover target of ~1,700 kg DM/ha (± 200 kg); and
- Pre- and post-grazing pasture cover target of ~ 2400 and 1600 (±200 kg), respectively.

The step-process to allocate pasture and supplements to each herd (farmlet) was as follows:

1. Weekly, pasture cover was monitored on each paddock using a calibrated rising plate (RPM) meter in year 1 and the C-DAX Rapid Pasture Meter in year 2.

2. Pasture cover and pasture growth rate (PGR) were calculated using the program P-Plus.

3. Pasture was then allocated based on PGR and the actual pasture cover (e.g. if pasture cover for a given farmlet was below target, then ‘available’ pasture was lower than indicated by PGR, to allow pasture cover to recover to target level)

4. Supplements were allocated according to each system target (see farmlet description above).

Overall, the whole process involved the following steps:

1. Total energy, protein and fibre requirements were determined using a computer model (CNCPS) weekly.

2. Pasture was allocated first; and

3. Supplements were used to cover any deficit between cows’ requirements and pasture availability.

Measurements

Individual milk yields were automatically recorded using automatic flow meters (DeLaval).

Milk samples were taken at AM and PM milkings fortnightly and analysed for milk fat, milk protein, and somatic cell count.

Pasture DM intake was estimated for each farmlet by measuring the pre- and post-grazing herbage mass on Mondays, Wednesdays and Fridays of each week, using a rising plate meter in year 1 and a the NZ Rapid Pasture Meter (C-DAX) in year 2. Concentrates and fodder fed out were measured daily.

Cows were weighed weekly and condition scored fortnightly. All animal events were recorded in order to allow a statistical comparison between farmlets.

Pre-grazing pasture samples were taken by hand-plucking to simulate grazing height from each paddock. Samples of all supplements used were taken on a weekly basis.

Samples were pooled on a monthly basis, oven dried at 60 °C for 48 h and ground on 1 mm screen miller to be later analysed for metabolisable energy (ME), crude protein (CP), water soluble carbohydrates (WSC), neutral and acid detergent fibre (NDF and ADF, respectively) and lignin content.

Results

Milk production

Farm areas, average cow numbers and milk production per cow and per ha for the 2 years are given in Table 2.

Based on 'rolling average' figures, cows in the high milk yield per cow farmlets produced ~9,400 L/cow/year (5% more than target) while cows in the lower milk yield per cow farmlets produced only 1,000 L less/cow (~8,400 L/cow/year or 25% more than target). It is noted that these figures are for the whole lactation (i.e. not corrected to 305 days in milk); milk production per cow corrected to 305 days would be in the range of ~8,000 and ~7,000 L/cow for the two high milk per cow and lower milk yield per cow farmlets, respectively. Individual cow data are yet to be analysed as part of a PhD study (S. Farina, unpub. data).

Milk production per ha increased from ~21,000 L/ha in the Control farmlet to 24,000 (+11%); 31,000 (+45%) and 36,000 (+67%) L/ha in the high Milk Yield/cow; high Stocking Rate; and High Milk Yield-high Stocking Rate farmlets, respectively (Table 2).

Table 2. Farmlet characteristics and milk production (L/cow and L/ha) (average of two years) of the four farmlets study.

	Control	***High Stocking rate***	***High milk yield/cow***	***High SR High MY***
Farmlet area (ha)	9.5	6.4	9.5	6.5
Cows number (average of milking cows only)	23.7	24.2	23.7	24.5
Stocking rate (cows/ha)	2.5	3.8	2.5	3.8
Milk production/cow				
L/year	8521	8338	9516	9353
Kg Milk fat/year	350	343	396	379
Kg Prot/year	277	267	309	299
Milk production/ha				
L/year	21526	31300	23904	35988
Kg Prot/year	879	1287	985	1439
Kg Milk fat/year	695	1004	768	1137

The mean monthly milk yield/cow (L/day) for each farmlet is shown in Figure 1. Cows from the two High Milk Yield per-cow farmlets produced more milk per cow than cows from the two Lower Milk Yield -per-cow farmlets from January to August but the latter cows (control and high stocking rate farmlets) produced nearly as much as the other two herds from August to December Figure 1).

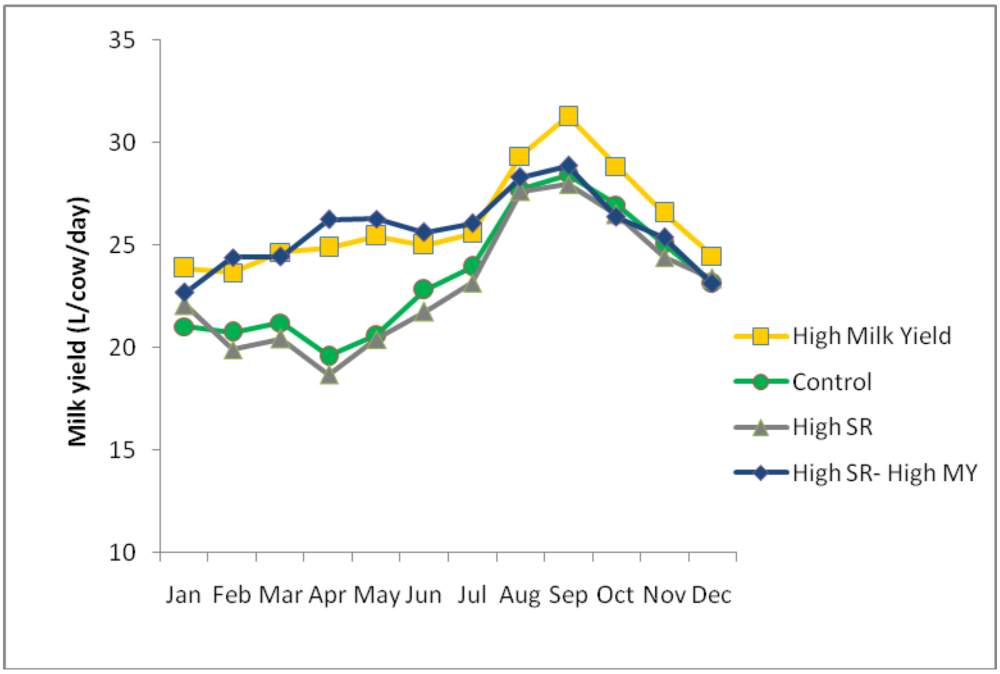

Figure 1. Mean monthly milk yield (L/cow/day) for the 4 farmlets of the Feeding Module study. Data are averages of Years 1 and 2.

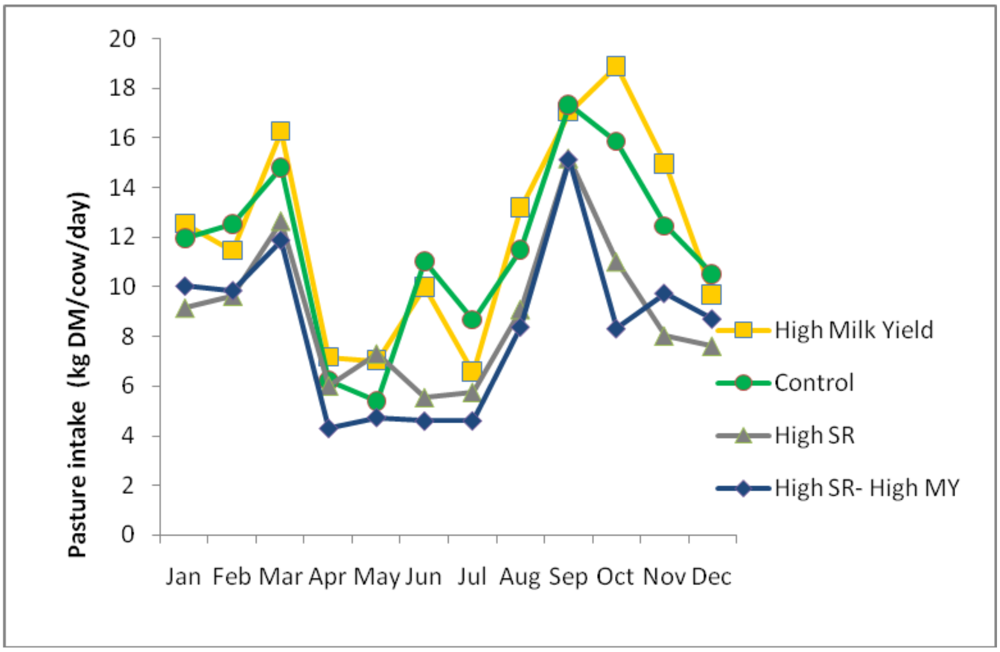

Figure 2. Mean monthly pasture intake (Kg DM/cow/day) for the 4 farmlets of the Feeding Module study. Data are averages of Years 1 and 2.

The relatively higher milk yield per cow achieved by the Control and High SR herds during the late winter-spring-early summer period was correlated to the amount of quality pasture consumed by the cows (Figure 2).

In addition to the increased pasture consumption, pasture quality was highest during winter early spring, as indicated by the higher metabolisable energy (ME), crude protein (CP) and water soluble carbohydrate (WSCH) content, and lower fibre (neutral detergent fibre, NDF) content (data not shown).

Milk composition

Annual milk fat and milk protein content (%) and yields (kg/cow/day) of milk fat, milk protein and milksolids are shown in Table 3.

Table 3. Milk fat and milk protein content (%) and yields (kg/cow/day) of milk fat, milk protein and milksolids in Years 1 and 2 of the farmlets study.

Farmlet	***Year***	***Milk fat (%)***	***Milk protein (%)***	***Milk fat (kg/cow/ day)***	***Milk protein (kg/cow/day)***	***Milksolids (kg/cow/day)***
Control	1	4.10	3.32	0.95	0.77	1.71
	2	4.11	3.20	0.98	0.76	1.74
	Mean	***4.10***	***3.26***	***0.96***	***0.76***	***1.73***
High SR	1	4.12	3.24	0.97	0.76	1.73
	2	4.11	3.18	0.93	0.72	1.66
	Mean	***4.11***	***3.21***	***0.95***	***0.74***	***1.69***
High MY	1	4.17	3.28	1.12	0.88	2.00
	2	4.13	3.22	1.05	0.82	1.87
	Mean	***4.15***	***3.25***	***1.09***	***0.85***	***1.93***
High MY-High SR	1	4.07	3.27	1.07	0.86	1.92
	2	3.99	3.12	1.00	0.78	1.79
	Mean	***4.03***	***3.20***	***1.04***	***0.82***	***1.86***

With the exception of the relatively lower contents of milk fat for the High SR-High MY herd in late winter-early spring –which was likely related to the higher amount of concentrates fed to that herd-, there was no other important seasonal variation in milk composition between herds. This is an interesting finding as the expectation was for higher milk protein content in the two herds fed higher amount of concentrates.

Feed intake

Average feed consumption per cow and per ha are given in Table 4.

Table 4. Feed consumption (t DM) per cow and per ha of the Farmlets study (Stage III).

	Control	*High Stocking rate*	*High milk yield/cow*	*High SR High MY*
Feed intake (t DM/cow)				
Pasture	4.1	3.2	4.3	3.0
Maize silage	0.8	1.5	0.7	1.2
Concentrate	1.1	1.2	2.0	2.6
Pasture silage and hay	6.1	6.1	7.2	7.2
Total DM intake	6.1	6.1	7.2	7.2
Feed intake (t DM/ha)				
Pasture	10.4	12.0	10.6	11.3
Maize silage	2.0	5.5	1.7	4.6
Concentrate	2.7	4.3	5.0	10.0
Pasture silage and hay	0.2	1.1	0.6	1.6
Total DM intake	15.3	23.0	17.9	27.5

Pasture utilisation

Cumulative pasture utilisation is shown in Figure 3. Utilised pasture includes grazed pasture plus any surplus of pasture conserved as silage.

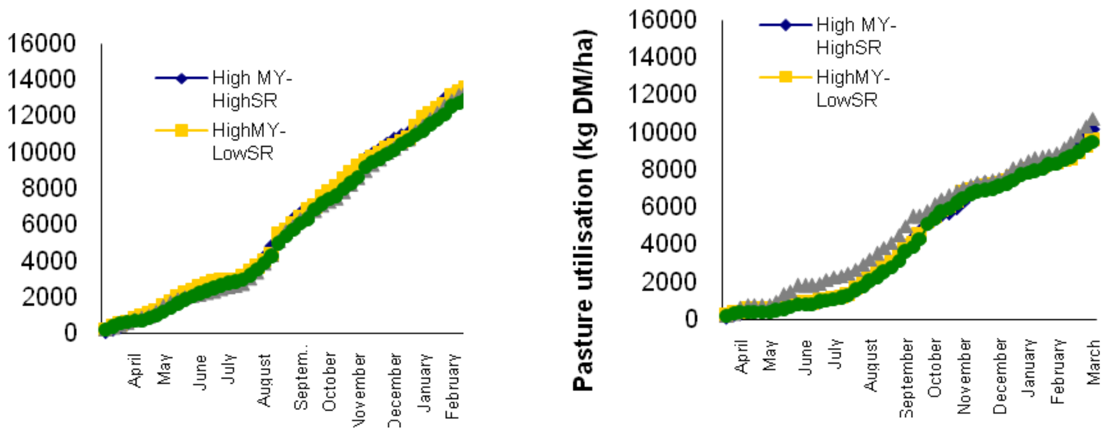

Figure 3 Cumulative pasture utilisation (kg DM/ha) for the 4 farmlets of the Feeding Module in Years 1 (left) and 2 (right). Data include any surplus forage conserved as silage.

On average, all farmelts utilised about 10 t DM/ha in Year 1 and about 14 t DM/ha in Year 2. The lower level of pasture utilisation achieved in Year 1 was the result of drought and limited irrigation. Approximatelly only 25% of the total area of each farmlet was irrigated during the dry period of late spring-summer in 2006-2007.

Concentrate intake

Cumulative concentrate intake (kg DM/cow) for the 2 years is given in Figure 4. The differences in concentrate intake was consequence of the management principle applied, which was basically to feed concentrate (and supplements in general) only when a true deficit of pasture was apparent. As a result, total concentrate intake varied from ~1.0-1.2 t DM/cow for the two herds with 'lower' production per cow (Control and High SR) to about 2.0 t DM/cow on average for the High MY group and 2.5 t DM/cow for the High SR-High MY group (Figure 4). The total concentrate intake for these latter herds was lower in Year 2 than in Year 1 due to increased availability of pasture in the second year.

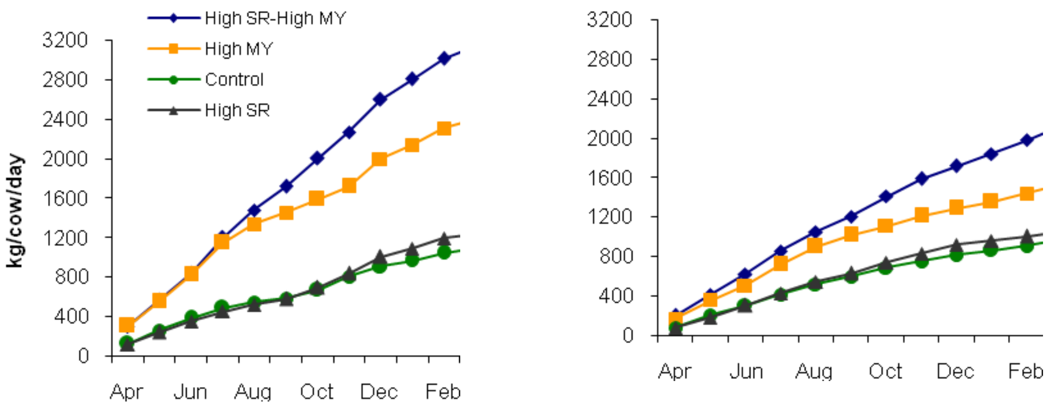

Figure 4. Cumulative total concentrate intake (kg DM/cow/day) for the 4 farmlets in Years 1 left) and 2 (right).

Liveweight and body condition score

Both liveweight and body condition score were higher for the two groups with higher production per cow (High MY and High SR-High MY herds) than for the other two groups (Table 5).

Table 5. Mean annual liveweight (kg) and body condition score (1 to 8 scale) for the four farmlets in Years 1 and 2.

Farmlet	***Year***	***Liveweight***	***Body condition score***
Control	1	594	4.10
	2	576	4.12
	Mean	***585***	***4.11***
High SR	1	585	4.08
	2	579	4.05
	Mean	***582***	***4.06***
High MY	1	597	4.20
	2	582	4.22
	Mean	***589***	***4.21***
High MY-High SR	1	610	4.46
	2	590	4.31
	Mean	***600***	***4.39***

Economic insight: preliminary results

An preliminary economic analysis was conducted taken into account that these four different businesses require different levels of investment in terms of herd size, milking shed and associated yards, effluent and laneway capacity and feed related infrastructure.

Prices and costs are taken from the 2005/06 year (milk price =$0.35/L). Results are expressed as percentage change relative to the Control system.

Key feed related costs including grain, and pasture costs were obtained from real data used in the trials and prices obtained from local suppliers. Similarly associated contractor rates were taken from published commercial contractor rates. Other farm costs such as herd and shed costs could not be taken from the trial and were taken from ABARE (2006-2008) farm survey data.

A milk price of 35 cents per litre was used in this modelling exercise which was the typical price paid by NSW factories to producers in 2005/06. Throughout Australia in 2005/06 the average typical price paid for a litre of standard milk was 33.1 c/L, varying between 29.0 c/L in Western Australia to 36.6 c/L in Queensland (Dairy Australia, 2006/7).

Herd and shed costs used were 3.0 and 2.0 c/L, respectively (ABARE 2006).
Feed costs were obtained from average commercial prices paid for bought-in feeds to the University of Sydney, Camden for the finical year 2005/06 and expressed in price per tonne of dry matter equivalent. For home grown feed costs for pasture ($91/t DM), maize silage ($154/t DM) and other home grown fodder (~$180/t DM) were derived from gross margins for these fodder or pasture activities and expressed in terms of price per ton of dry matter utilised.

A value of 5 per cent of total dairy income was used as common fixed costs in the model.

All labour was considered as paid labour. A conservative ratio of 80 cows per labour unit and labour costs of $60,000 per annum including on-costs were used.

Key results

Relative to the Control system, the High SR scenario achieved the highest increases in net profit (+32%) and returns on assets (18%) (See Table 6). The High SR-High MY scenario obtained the next highest increase in net profit (9%), although return on assets was 4% lower than the Control due to the extra capital invested in the former system.

Table 6. Comparison of key economic outcomes for the various whole farm scenarios assuming “steady state” production and average capital values, 35c/L net milk price received

	Dairy Income	***Total Variable Costs***	***Feed costs***	***Dairy Gross Margin***	***Net Profit***	***Return on Assets***
Control	100%	100%	100%	100%	100%	100%
High SR	145%	157%	109%	136%	132%	118%

High MY	111%	125%	128%	100%	94%	92%
High SR-High MY	167%	211%	149%	132%	109%	96%

At a hypothetical high input cost scenario (e.g. concentrate at $600/ t), the High SR system still outperforms the other systems at current milk price ($0.5/L; data not shown), but the difference with the Control system may be too small to justify any investment.

Key messages

Several messages arise from this preliminary physical and economic analysis of the farmlet study.

First, the flexibility of the Australian pasture-based systems is enormous. This is demonstrated by the achievement of:

a) Milk production per ha ranging from 20,000 L/ha to more than 36,000 L/ha. This range of production was achieved with the same cows' genetics (originally producing <6,000 L/cow), soil type and management.

b) Milk production per cow ranging from >8,000 to ~ 10,000 L/cow/lactation. This was achieved with the existing cow type and genetics, with cows going from an original average production <6,000L/cow in 2003 to ~10,000L/cow in some herds in 2007-2008. It is noted that these figures are not corrected to 305 days in milk; milk production per cow corrected to 305 days would be in the range of ~8,000 and ~7,000 L/cow for the two high milk per cow and lower milk yield per cow farmlets, respectively.

Second, the importance of forage quality is paramount. This is clearly demonstrated by the strong correlation between pasture intake and milk yield/cow, particularly over the winter-spring period, when pasture quality was highest. The key to achieve this was the applied management based on good pasture management and the use of supplements to cover true pasture deficits.

Third, pasture utilisation was consistently high (relative to irrigation availability) and, more importantly, very similar for all farmlets over two consecutive years. This was as expected and a consequence of the applied pasture management (the pasture 'dictates when is to be grazed').

Fourth, the study showed an increased efficiency of concentrate use. This was demonstrated by the relatively high milk yield/cow achieved by the Control and High SR herds with relatively low levels of concentrates fed per cow (~1 t/cow/year). This effect is also a consequence of the applied management.

Fifth, the preliminary economic analysis showed that increasing stocking rate appears to be the most profitable way to increase productivity, although any advantages over the more resilient Control system can be easily eroded when input costs increase or milk price decreases.

Acknowledgement

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The People in Dairy

Chris Hibburt

Veterinarian & Consultant, Timboon Vic

The typical dairy farm in Australia has progressed significantly from its status as family run business, with few non-family staff. Today with an average herd size over 300 cows and two thirds of farms employing non-family members, it has provided the challenge of managing not just cows and pastures, but also people.

It is evident that many farm businesses struggle with this challenge.

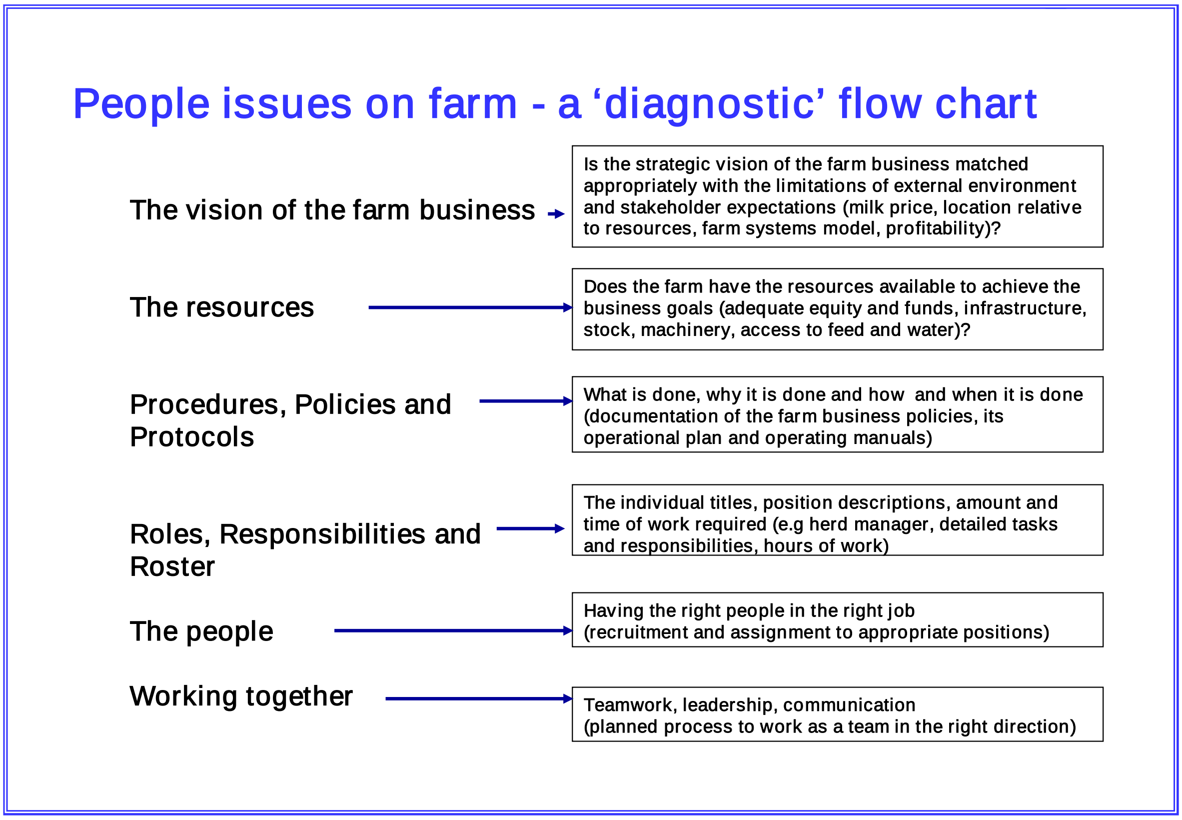
The People in Dairy program has been developed to assist farm owners and managers to address people so that they can attract & retain people they need, comply with legal requirements and increase farm profitability through a more efficient and productive workforce

There are a number of symptoms of a farm with people problems. Amongst those, tired owners and operators, good staff leaving, no time to pursue interests off farm, inability to do everything on time, lower profitability, disinclination to expand the business, early exit from industry.

The three key principles of The People in Dairy program are:

1. designing the farm around people rather than trying to get people to fit the farm;
2. finding the right people to put into clearly defined roles and responsibilities;
3. building effective working relations among the team.

A farm that successfully manages its people will have a well planned and implemented strategic hierarchy that provides a sound business model as a basis for building an effective team. Until this is addressed adequately many farm businesses will continue to suffer from the 'revolving door' syndrome with their employees and will be compromising their own work life balance.



The People in Dairy, as part of its program have developed a web site available to the dairy industry that provides a number of resources at www.thepeopleindairy.org.au.

It comprises two sections:

1 ***The People analysis***. This section is designed to assist farms in analysing their people performance and identifying the areas where they can improve. It provides sum subjective and objective measures such as

a. Measure of work-life balance
b. The risk that the farm is under due to non-compliance especially in such areas as OH & S and industrial relations
c. The ability to attract retain and develop people
d. How well the business has planned for the future of its people
e. A measure of its people productivity
f. An in depth analysis of the efficiency of farm practices from a people perspective
g. Tools to assess and modify roles and responsibilities and working conditions

2 ***The live library***. This section has most of the resources and is divided into 7 modules

a. *The People Approach.* This module provides a background to people issues on farm, some statistics and an introduction and path way to address people issues
b. *Farm policies and procedures*. This module covers safety and standard operating procedures. It provides a list of over 700 procedures on a farm that can be downloaded and modified to suit individual farms
c. *Recruitment*. This section provides many tools to assist farmers through this process from designing a position description through to an induction program for new staff
d. *Engagement and Reward*. This section has details of federal and state industrial relations laws including a number of templates of contracts of employment and collective agreements. It also has details of minimum and market rates of pay.
e. *Individual performance management*. Being able to develop people to their potential has benefits in both increased effectiveness and retention. This module includes tips on performance appraisals and training programs
f. *Working together*. The ability to have a team work effectively towards a common goal is the ultimate in people performance. This requires leadership skills, a culture that is amenable to the business and people within it, an understanding of the individuality of people that make up a team and good communication. This module provides many tips on these topics and templates for team meetings, rosters and time management
g. *Planning for the future*. The final module addresses the farm business as a cycle where up to three generations may be involved at once. Having appropriate business structures, business and personal goals that align transfer of assets and responsibilities all contribute to a healthy succession plan for a farm business. This module provides great background information and resources to do this.

The website has a list of over 200 templates and a number of links to websites with additional support.

National Foods owns some of Australasia's favourite food brands, brands that you will find in homes right around Australia and New Zealand. Some of these brands, which cover milk, fresh dairy, juice, specialty cheese and gourmet foods, have been a part of Australian life for over 100 years.

National Foods was created in 1991 with the merger of several dairy and food businesses. We pride ourselves on producing great tasting and nutritious foods and sourcing quality ingredients to create products that consumers will love. By continuing to invest in our brands, people and product innovation, National Foods builds on a strong heritage to develop and grow each category we operate in.

Share-farming / Equity Partnerships - The way around labour problems

Rob Cooper
Dairy Farmer, Upper Manilla, NSW

Background

I started my dairy farming career working for three cents per gallon of milk, on a weekend relief milking basis for Associated Dairies at their Clydesdale Dairy, whilst studying at Hawkesbury Agricultural College. It was a large herd and a difficult milking shed and conditions. After seeing many workers and contract milkers come and go, I quickly realised that production and results were based on the financial incentives and rewards received. Observing this over several years, the performance and results varied up to double with some operators compared to others. The success of each farming operation was determined around the labour and workers' performance, and the farm workers' performance was determined by the rewards and conditions under which they worked. Things ran more smoothly, production was higher, there was less wastage and lower costs when the right remuneration and incentive package was in place.

For me, my next main dairy experience was in North West Tasmania working on a large grazing dairy under a management salary plus incentive system. This arrangement worked well, but it was limiting profit and expansion. A 50/50 share-farming agreement was looked at to take this farm to the next level of production and profit.

I didn't take up this option at this time, but decided to travel and work in the USA. First I worked on a family farm in Wisconsin. It was, I feel, typical of a family operation where there were plenty of family members ready or forced to help. Jobs got done to a high standard because of the personal commitment and the family was very aware of the bottom line and the main factors that influenced it.

From Wisconsin I shifted to Arizona, where I worked for a family that was expanding and building their dairy business by equity partnerships. An established family member would supply the capital to purchase another dairy or build one for a younger person. The profits were then usually shared 50/50. This process would be duplicated and it allowed for very successful expansion at a fast pace, but all along there was a strong personal involvement and commitment.

I have since then worked in both 50/50 and 60/40 share-farming agreements in the Hunter Valley. Often these types of share-farming agreements were set up more as a way of providing labour than having an attitude like I have seen in New Zealand. Their attitude is one of the farm owner believing that if the share farmer is successful, the owner will also be successful. Both parties can grow and profit together. It requires looking beyond that of just being a way of getting the job done, providing labour. On both these dairies in the Hunter Valley we expanded rapidly, tripling total production. But all along, I really felt I was dragging the farm owners along to get things done. Expansion and future planning were a very low priority for the owners. This made it hard work and not a long term relationship.

Present Shared Equity

At present I am in a shared equity company, where the farm owners and I realised that the best way forward was to share:

- the capital invested
- any future capital investment
- time input
- and profit received

For example, it was identified that for the long term future of the dairy farm, the eight travelling irrigators needed to be upgraded. With much planning, it was decided that centre pivot irrigators were the way to go. There was therefore a major capital investment needed to upgrade the irrigation system. In a share-farming or lease agreement both parties would find it difficult to justify the capital cost for such a project by themselves, whilst the other party benefited in either less labour, improved profit or improving the farm without bearing any of the capital cost. Under a shared equity agreement both parties can contribute at an agreed amount and benefit through shared profit and conditions. As with the irrigation project, you look at the overall investment, what each party will contribute and how that aims to translate into profit or reduced labour input. Then a tailor-made agreement can be drawn up. This agreement has worked for us for other capital costs and developments.

Lessons to be Learned

What can we learn from all this?

First, all situations are unique, some are very similar but you cannot make blanket recommendations. Each needs to be looked at separately for the situation, future plans and the people involved.

Second, shared equity or sharefarming unlocks potential extra profits because profit is directly related to how well the dairy is managed and timeliness of operations.

Let us go back to the basics of producing milk. I think we are in a fairly unique business. A high percentage of our costs are fixed for running the operation, but also a high percentage of the costs per/cow are also fixed. I don't think people realise how much of the cost is fixed and how we can use this to our advantage. Let me list a few:

- calving cows
- replacement calf rearing
- health treatments
- breeding
- drying off
- the cows' maintenance
- portion of feed
- milk harvesting
- dairy costs and much of the labour costs are fixed (i.e. cannot be changed);

And the list goes on. These are all "fixed" costs, locked in and can only be changed a in a minor way.

Knowing this fact and using it to your advantage, we know if we can lift the per/cow milk production, the profit margin on these extra litres are very high and can ***potentially*** increase the profit margin, but of course that does not always happen. This area is what, I believe, can be tapped into and shared through the right agreement, i.e., sharing of capital development cost and profit by share-farming or shared equity.

In practice how is this worked out?

It is often about doing the little things, observation and timing that gives those extra litres per cow. These things often happen on the small family-run farm, but they are limited by size. Once you grow beyond this size, then it is time to start looking at your arrangement for management and labour.

Some of these areas that relate to observation and timing include:

- having high production per unit of dry matter fed
- monitoring the way feed is fed and offered to the cows and the amount of time cows are on- and off-feed
- minimising pugging of pasture
- keeping cows comfortable in stressed time of cold, wet or extreme heat
- keeping health problems and death rate low but in-calf rates high
- ensuring adequate access to water
- ensuring general cow and young stock comfort through the whole day
- looking at movement of cows
- being aware of staff attitude to cows.

Also important is to monitor key activities such as:

- milking thoroughness and teat dipping
- mastitis detection
- calving supervision and assistance
- calf care - health and condition of young stock
- irrigation, fertilising and sowing
- weed control and harvesting

All tasks that are done when they are required. There are still others on the list and I think most people would relate to the importance of observation, timeliness and actually getting the job done.

On a dairy farm, there are so many ways how little things like observation and timing can substantially double or triple your bottom line. Being observant and then acting on this in a timely way, leads to the higher profit margin.

This is generally impossible to achieve through a normal wage/salary plus incentive package.

There needs to be flexibility in time input and incentive to do that little extra when others have headed home or turned their back on other things needed to be done.

Conclusion

Clearly these two areas come together, future farm investment and getting the maximum performance and profit from the farm.

An employee arrangement can achieve a certain level. Shared equity or share-farming can take it to a higher level because of personal commitment related to reward.

Where to from here?

Look at:

- all options for management and labour
- a plan for the future
- capital required to be invested
- labour and management requirement
- the profit range and different cost/benefit scenarios

All these will allow you to tap into the potential profit area, make future capital investments and stay in the dairy game.

There is no set recipe, so put all your cards on the table and work out an arrangement where both parties will benefit together, where 1 plus 1 is going to be greater than 2. A certain possibility in Dairy Farming!

Challenges and benefits of overseas workers on work visas

Fiona Clarke

National Farmers Federation

Australia Needs Skills: How Immigration can help with skills shortages

As family members move off the land, farmers may find they are looking for skilled labour from a relatively small local labour market. Australia's immigration program offers a range of temporary and permanent visa options to help farmers meet skills and labour needs.

Industry Outreach

For farmers new to the idea of sponsoring overseas workers, expert guidance can be found through a dedicated immigration liaison contact. Fiona Clarke is seconded from the Department of Immigration and Citizenship (DIAC) to the National Farmers' Federation to help farmers fill positions through skilled migration.

The secondment recognises that farmers operate with specific needs and often need the right kind of labour at key times.

Fiona says agricultural producers may need help to identify suitable visas and map out future pathways for overseas workers. Visa options will vary according to the type and the duration of the work.

"I can answer questions and provide information on how to find the right forms and prepare applications," she says.

"Many farmers want to know about their obligations, the costs involved, what regional concessions exist and how they can make the process as fast as possible."

Hosted by the NSW Farmers Association, Fiona has travelled around Australia meeting individual farmers and presenting seminars free of charge to farming groups and organisations. Since July 2007, Fiona has provided phone and email support for hundreds of enquiries about visa types and requirements.

DIAC also has a number of state and territory based Regional Outreach Officers who are able to provide information and help to farmers in regional areas.

Seasonal Work

The Working Holiday visa is an important source of seasonal workers for Australian farmers. In 2006-07, more than 134 000 Working Holiday visas were granted, including second Working Holiday visas.

These visas are not skill based or tested and applicants must be between 18 and 30 years old.

This visa is currently available to passport holders from Belgium, Canada, the Republic of Cyprus, Denmark, Estonia, Finland, France, Germany, Hong Kong SAR, the Republic of Ireland, Italy, Japan, Republic of Korea, Malta, the Netherlands, Norway, Sweden, Taiwan and the United Kingdom.

In February 2008, the Minister for Immigration announced that negotiations were under way with other countries to expand the Working Holiday program.

Working Holiday visa holders who complete three months work with a primary producer in a regional area are eligible to apply for a second Working Holiday visa.

On 31 October 2007, a new agreement to allowing US nationals to visit, travel and work in Australia came into effect. Australia is the first country with which the USA has entered into a Work and Holiday agreement.

The Work and Holiday visa allows a stay of up to 12 months and work with any one employer for up to six months. It is estimated that the number of applications from US citizens for this visa will grow to 30 000 over four years.

Australia also has Work and Holiday arrangements with Chile, Thailand, Turkey, Bangladesh and, in the future, Indonesia.

International students are also entitled to work for up to 20 hours a week during term and unrestricted hours while on holidays.

Employer Sponsored

Once a farmer has found a worker with the right skills, sponsorship is often the next step. The farmer will need to be approved as a sponsor and the position will need to be approved as a skilled position. The final step is for the worker to apply for a visa.

Employer-sponsored visas include the Temporary Long Stay Business visa, available for three months to four years, and the Regional Sponsored Migration Scheme, which is a permanent visa.

Farmers may choose to sponsor on a temporary visa initially as these are generally faster to process than permanent visas. They may then consider sponsoring for permanent residence at any time, as long as the worker has at least diploma level skills.

Independent

International students may apply for permanent residence without an employer to sponsor them if they meet a points test. More information is available at http://www.immi.gov.au/skilled/general-skilled-migration/visa-options.htm.

Business Skills visas allow experienced business people from overseas to buy into or set up farming businesses in Australia. Overseas farmers are eligible once they have achieved prescribed levels of ownership, turnover, employment and investment levels.

State and territory governments may offer business people support in applying for these visas under the Business Development Sponsorship. More information at http://www.immi.gov.au/skilled/business/business-development-sponsorship.htm

VEVO and Employer Sanctions

Since August 2007, it has been an offence to knowingly or recklessly employ illegal workers. Illegal workers are people who are not Australian permanent residents or citizens and who do not have visas. This includes people who have visas but do not have work entitlements.

Individuals who are convicted of employing illegal workers may be fined up to $13 200 and two years' imprisonment while companies face fines of up to $66 000 per illegal worker.

The offences also apply to businesses that operate informal labour referral services such as backpacker hostels that organise harvest work for backpackers.

Checking work entitlements

The safest, easiest and quickest way to avoid penalties under the new offences is for farmers to check the work entitlements of all workers before employing them.

There are three ways to check:

Visa Entitlement Verification Online (VEVO): www.immi.gov.au/evo

Fax: 1800 505 550 (Contact Fiona for a form)

Phone: 1800 040 070

Farmers have 48 hours from the time employees start work to check their entitlements. If you check within this time and you do not know they are illegal, you will not face fines or prosecution.

For more information on skilled migration, please contact Fiona Clarke on 0401 713 536 or fiona.clarke@immi.gov.au. Regional Outreach Officers can be contacted through 131 881.

How to Keep Good Staff

Sam and Carol Doolan

Dairy Farmers, Ecklin, Victoria

Background

Sam and Carol Doolan are third generation farmers and run a dairy farm 20 minutes inland from the Great Ocean Road in south west Victoria, 10 kms north of the small town of Timboon. The area is well known for dairy farming and reliable rainfall. They milk about 500 cows, with a year round calving pattern. They own 280 ha and lease 2 out paddocks to run young and dry stock within 20 minutes drive from the home farm.

In April 2008 Sam and Carol won the 'Employer of the Year' award in Warrnambool for the 'Great South West Dairy Awards'.

Employer History

Over 25 years Carol and Sam have employed a range of people from various fields and backgrounds to help grow their business to where it is today. These include: apprentices and trainees, international students, agricultural students, full time staff, part time staff and casuals.

Currently they have their second son and partner share-farming, their youngest son working full time on the farm doing his 'gap year', and 2 casuals doing 6 milkings between them per week.

How to get good staff is a separate issue and it has been addressed in a separate paper of the 2008 DRF Symposium (Chris Hibburt, The People in Dairy, www.thepeopleindairy.org.au), but this is strongly related to keeping good staff, because in dairy farming, as in any other business your reputation is everything.

It's not who we are, but what we do that defines us!

Recently, Mark Buckley published the following in the Herald Sun:

Question - It is said that people leave their jobs because of their work managers, not because of the organisation they work for. Is that true?

Answer - From my experience in the private and public sectors, there is a great deal of truth in this statement.

Unfortunately, for employees and employers, poor management practices can lead to low staff morale, frustration and deterioration in work relationships resulting in some people wanting a change of manager, not a change of career.

Employers and managers can take several steps to address this problem. Amongst those are: ensuring all employees are made to feel valued; don't forget to give praise and recognition where it is due; making all employees believe they can make a positive contribution to the success of the organization; making sure that all staff have access to professional development opportunities; listening to your employees' concerns and ensuring that they are dealt with in a professional manner.

If Problems occur, make certain they are dealt with quickly before they get out of hand and become more difficult to solve. Trust employees to perform their work roles without consistently looking over their shoulders. See that all employees are treated fairly, with respect and dignity, whatever their role. Finally, plan social activities to promote good staff relations. When good staff practices exist, staff turnover is relatively low, there are major benefits for staff and organisations prosper.

We believe that the following suggestion and guidelines (Human Relations – Advice from Dairy Australia) are extremely useful and they can help you to put in place a framework to employ and maintain good staff.

The recruitment module will assist you in getting the right people doing the right things on the farm. The Analysis module will provide guidelines and information about roles and responsibilities and job descriptions. This way will assist you in clarifying employees' expectations and thus they will know what they are responsible for and what is required of them. The Employment Law section will cover issues like work cover and superannuation. In the Industrial relations section you will find several policies and procedures. We would particularly recommend looking at the

Occupational Health & Safety and the Farm health and safety policies. The Manage module will cover issues related to the working conditions and the environment in which you work. In the Remuneration section you will become familiar with issues like employee benefits, which can vary with experience and individual circumstances and pay above the award. In the Induction processes module, you will appreciate how time for orientation varies, the importance of providing a farm map, buddy up until the person is confident and competent in what they are required to do. Have a farm manual so employees know how you expect things to be done. The Training and development issues module will provide guidelines on how to enable staff to attend relevant courses to benefit them and the business while enabling the work to continue. For example, “Cows Create Careers” run through the local school, “Sustainable Farm Families” community health program, “Milk Plus Project” run through the Warrnambool Cheese and Butter Factory, Field days, Discussion groups. Finally, the Separation/termination procedures section will assist you in finish the employment relationship on good terms; please consult VFF for up to date information. In conclusion, when the store of good will run out, your reputation goes with them, so does the intellectual knowledge!

We have also drawn on valuable information from the Australian Institute of Management - Management and Leadership program for Dairy Farmers. For example:

- Be generous with people and be ruthless with time.
- Treat others as you would like to be treated yourself.
- Be honest and respectful.
- Observe peoples talents and allow them to use them as best they can.
- Be encouraging not demanding.
- Give hope and keep your goals in sight.
- Practice what you preach.
- Show daily leadership, be approachable.
- Have good time management and triage skills.
- Care personally about the people who work for you.
- Getting it wrong can mean day in, day out disappointment.

On the farm

- Have effective staff meetings weekly.
- Have monthly rosters, be flexible, and be fair.
- Year planners in the dairy office, keep a well informed diary.
- White boards for passing on information, mobiles in service range.
- Yearly work appraisals and performance reviews, opportunities to improve form – review people and the workplace.
- Rewards and bonuses – encourage team work and stimulate the need for learning, training and development.

Recognize and reward high performance.

- Keep your equipment in good repair, down time is frustrating and uneconomical, be realistic about workloads.
- Don’t expect employees to do something you would not do yourself.
- Pay wages on time.
- Make your farm environment a place where people want to be, think about what you have to offer at your place that sets you apart from the rest.

We believe that you must have ***people*** working at your farm, not labour units.

We are convinced that humour has its place in a serious work environment; it can make difficult tasks bearable. Some of the things that we have adopted in our farm are playing bingo when herd testing, having a joke of the week and running a footie picks competition in winter. We also try to employee people with a happy disposition. Finally, at your Xmas break-up, have some fun!

In conclusion, we hope that we have addressed why we need to keep good staff in agriculture. We cannot afford to loose good people from agriculture especially with the current labour skills shortage. If we don’t meet the market we go out of business as dairy farmers, we do not want to be and do not deserve to be a sunset industry. We need to promote the industry, attract and keep high quality people; we need to improve our reputation as employers. We need to beat the drum for the next generation, and make it clear that dairying is a career choice and has a positive future.

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Management and leadership development program for dairy farmers.

Climate change, carbon trading and dairy farming: A new paradigm[1]

Warren Parker

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www.landcareresearch.co.nz

Introduction

Climate change is one of the defining themes of the 21st century. Solutions to lower greenhouse gas (GHG) emissions and the concentration of CO_2 in the atmosphere to avoid unsustainable global warming will touch every economy, enterprise and household. Changing from established norms of conducting business and living using mostly hydrocarbon technologies reliant on non-renewable resources towards an economy centred on renewable sources of energy – such as from plants and hydrogen – will require political courage, the rapid development and adoption of low carbon technologies and, perhaps most challenging of all, big changes in the way people work and live. These new ways of thinking and doing – the start of a new economic paradigm – are already being ushered in through high fuel prices, a growing availability of carbon neutral products and services and eco-efficient technologies such as hybrid and electric cars, and changes in public policy to support new investment in infrastructure, such as public transport.

Dairy farmers up till now have largely been 'observers' of this transition but this will change quickly over the next 5 years through both direct and indirect drivers. In New Zealand the legislation for an emissions trading scheme (ETS) was enacted in October 2008; Australia's equivalent Carbon Pollution Reduction Scheme (CPRS) is scheduled to be introduced in 2010 (Department of Climate Change 2008). These schemes align both countries to the requirements of the Kyoto Protocol (Australia joined in December 2007) but other powerful market, environmental and technology drivers are also at play and these are moving business and communities towards a 'low carbon' future.

In this paper these drivers are considered, early estimates of the financial effects of the ETS/CPRS (which increase markets to trade carbon) are presented, and practical

[1] This paper draws directly from Parker (2008a, b).

steps farmers can take to prepare proactively for a more energy efficient and environmentally benign future are outlined.

Market trends and drivers for low carbon dairying

Climate change is only one of the factors driving change towards more low carbon, sustainable dairy production (Harris 2007; Figure 1). Food safety, animal welfare and environmental regulations have been shaping farm practice and supply chain credence for at least two decades. However, growing concern about the impacts of climate change and new Government policy to address these have added impetus to initiatives to reduce GHG emissions and widened the focus for sustainable dairy production.

The UK supermarket chain Tesco plans to label all 70,000 items it sells with data on each product's carbon footprint; Marks & Spencer is planning to go carbon neutral; Wal-Mart is aspiring to achieve zero waste and is sourcing sustainable products; and many other companies in the food sector are looking to change their business model in response to climate change. Tesco, for example, has identified reduction of its carbon footprint as a central business driver and implemented a comprehensive three-pronged plan to help its customers select and afford 'green' products, set an example in measuring and reducing its GHG emissions around the world, and, by working with others, develop new low-carbon technology throughout the supply chain (Tesco 2007).

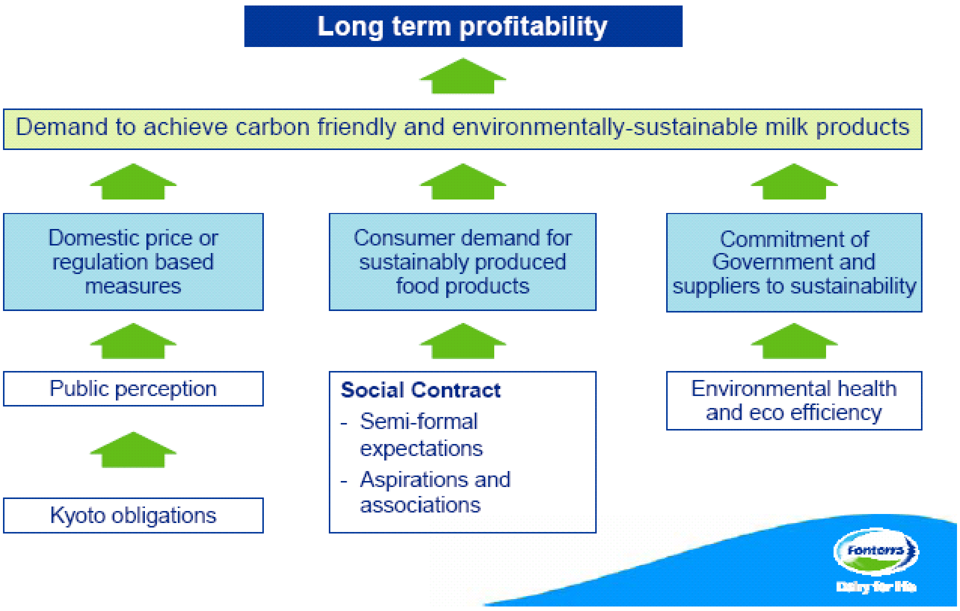

Figure 1. Drivers for the dairy industry to respond to climate change (Source: Harris 2007).

Food and beverage exporters, to the UK in particular, have already begun to respond to this market requirement. For example in a world-first, New Zealand winery Grove Mill supplied Marks and Spencer with certified-carbon-neutral wine in November 2006 (Grove Mill 2008). Through Landcare Research's carboNZero programme, the company measured its carbon footprint, identified ways to reduce this and was certified as carbon neutral through an independent audit (carboNZero 2007).

In the dairy sector Fonterra is working to measure the carbon embedded in milk products (Harris 2007). However, other than Basset-Mens *et al*. (2007) and Ledgard *et al.* (2007), who report on a comparison of life cycle analysis (LCA) for cheese production in New Zealand, the UK and EU, the scientific literature on the carbon footprint of dairying is sparse.

Energy security is another strong driver of change towards low carbon, renewable technologies. Oil consumption has been growing faster than the discovery of new stocks (Energy and Capital (2007) claim by 9 to 1 barrels) and, although strongly debated, some forecasts suggest viable fossil fuels could be exhausted by as early as 2030–40. In addition political instability in oil-producing regions, tighter supply control by OPEC, and inclement weather (e.g. hurricanes in the Caribbean) have contributed to increased prices for petrol and diesel. Most developed economies, including Australia and New Zealand, have adopted a renewable energy strategy incorporating biofuels as a mechanism to address both climate change and energy security (Parker 2008a). These circumstances have precipitated rapid growth in biofuel production – ethanol and biodiesel – and this in turn has affected prices for dairy, grains, sugar, oils and fats (IDF 2007), and stimulated higher costs for essential farm inputs such as fertiliser (FMB 2007).

A third driver of change is scarce natural resources and the non-sustainability of current practice especially with respect to water but also the health and function of natural ecosystems. Figure 2 illustrates, for various parameters, the capacity of New Zealand to cope and adapt to warmer average temperatures – water, natural ecosystems (biodiversity) and coastal communities are the most exposed. A similar situation is likely to confront Australia. Landowners, because of the effects of management practice on the environment, will be at the forefront of change to mitigate and adapt to the effects of development and climate change on natural resources.

Australian agriculture's greenhouse gas challenge

In 2005 agriculture accounted for 17% of Australia's GHG emissions (87.9 M t of CO_2 equivalent), including 60% and 84% of Australia's methane (CH_4) and nitrous oxide (N_2O), respectively (ABARE 2007, table 1). As Table 1 shows, reduced land clearing and forest planting have strongly assisted Australia to meet its first Kyoto commitment target (108% of 1990 levels; Keogh 2007) but there is now less

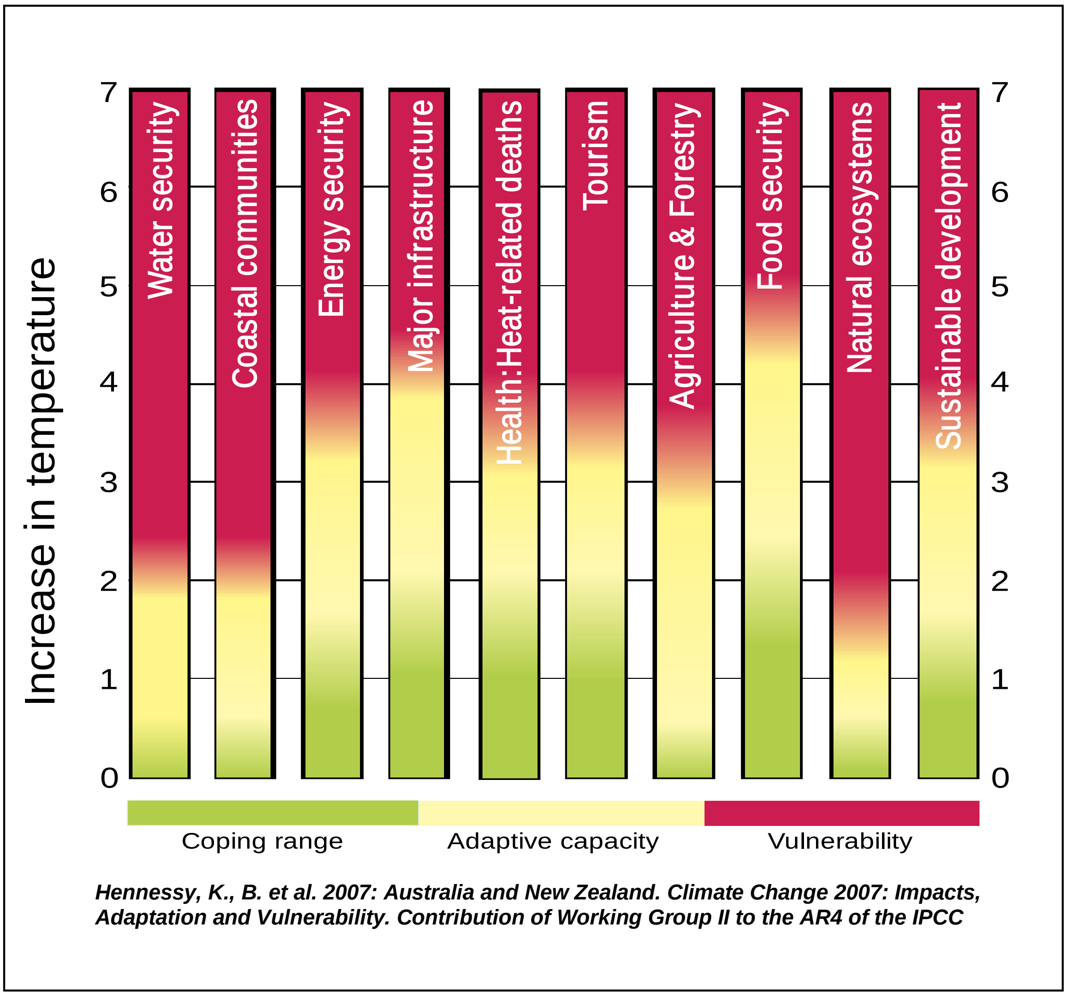

Figure 2. Ability to adapt to higher temperatures associated with climate change (Source: NZ Climate Change Centre 2008).

capacity to meet future targets through these mitigation mechanisms. Other parts of the economy – which have been increasing emissions at 3–4% per year since 1990 – will carry most of the burden in meeting Australia's aspiration to reduce GHG emissions by 60% from 2000 levels by 2050 (Department of Climate Change 2008) While agriculture will not be introduced to the Australian CPRS until 2015 (the mechanism and extent of this are not yet clear), this legislation, if adopted in 2010, will greatly accelerate the development of carbon markets, which are already in operation internationally and in NSW through the GHG Abatement Scheme and the Greenhouse Friendly programme (ABARE 2007). Agriculture enters the New Zealand ETS in 2013 although the forestry sector was aligned to this from January 2008. The ETS creates opportunities for farmers to participate in the carbon market both to provide (e.g. through land dedicated to regeneration of indigenous vegetation or exotic forest plantings) and potentially to purchase (e.g. to offset livestock emissions) credits. At this stage under the New Zealand ETS, livestock emissions will be managed at the processor-level but the mechanisms by which this can be cost-effectively achieved and provide incentives and rewards to farmers for GHG management are not yet clear (ABARE 2007, p. 506).

Table 1. Net historical and projected agricultural and forestry emissions for Australia. (Source: ABARE 2007).

	1990 $MtCO_2$-eq	***2000***	***2005***	***2010***	***2020***
Agriculture					
Enteric fermentation	63.9	60.4	58.7	63.7	68.9
Manure management	2.1	3.3	3.4	3.3	3.5
Rice cultivation	0.5	0.7	0.2	0.4	0.3
Agricultural soils	14.4	17.4	16.6	16.8	17.2
Prescribed burning of savannas	6.6	13.2	8.7	11.1	11.1
Field burning of agricultural residues	0.3	0.4	0.4	0.3	0.3
Total	87.7	95.5	87.9	95.6	101.2
Land use, land use change and forestry (LULUCF)					
Forest land	−42.8	−47.9	−51.5	−43.1	−38.8
Other land use change	124.5	60.5	48.2	44.5	44.5
Total LULUCF	81.6	12.6	−3.2	1.4	5.7
Total agriculture and LULUCF	169.3	108.1	84.7	97.0	107.0

Financial effects of the CPRS on dairy farming

Few estimates of financial impact of the proposed CPRS on agriculture have yet been published and those that have are speculative in nature because of the lack of detail on how the scheme will apply at the farm enterprise level. The Australian Farm Institute, which has perhaps conducted the most comprehensive analysis, reported in September 2008 (Keogh & Thompson 2008) on the potential effects on 10 model case farms based on three price scenarios for CO_2-e and for different policy settings related to whether agriculture is directly responsible for GHG within (i.e. ‘covered’) or outside the CPRS (‘uncovered’) (Table 2). Under the ‘covered’ options, applying from 2015, the effects of whether agriculture has Emissions Intensive Trade Exposed (EITE) status (i.e. 90% of emission permits required by the sector could be made available free of charge) and ‘EITE status from 2015 with the sector having achieved a 10% reduction in net emissions through on-farm mitigation strategies’ were explored.

The dairy model was based on a property with 242 ha of improved pasture (42 ha of which were irrigated) and 298 cattle (191 dairy cows) producing 955,521 litres of milk. Each year 56 ha is cropped and 45 t of NPK fertiliser (a total of 10.86 t N) are applied. Net annual GHG emissions were 743 t CO_2-e (or an emissions intensity of $1.967 t CO_2-e per $m revenue). Productivity was assumed to improve by 1.2% p.a. CO_2-e was priced in 2010 at three levels: $20/t increasing at 6% pa (Low (L)), $30/t increasing at 6.5% p.a. (Medium (M)) and $45/t increasing at 7% p.a. (High (H)). These price scenarios generated CO_2-e prices of $64, $106 and $174 per tonne in 2030 for the L, M and H scenarios, respectively. Results, summarised in Table 2, show the substantial effect of the carbon price and whether agriculture is issued carbon credits in 2015.

Table 2. Estimated impact of emission prices on dairy farm cash margins in 2016 under four CPRS scenarios (Source: Keogh & Thompson 2008).

Enterprise	***Business as usual***	***Emission price***	***ETS – uncovered***	***ETS – covered***	***ETS – EITE***	***ETS-EITE-M***
Dairy	$109,406	Low	−$5,331 −4.9%	−$26,410 −24.1%	−$7,439 −6.8%	−$7,228 −6.6%
		Medium	−$8,225 −7.5%	−$40,749 −37.2%	−$11,477 −10.5%	−$11,152 −10.2%
		High	−$12,689 −11.6%	−$62,866 −57.5%	−$17,707 −16.2%	−$17,205 −15.7%

Keogh and Thompson (2008) concluded for agriculture overall that: the CPRS would reduce case margins by 3 and 9% in comparison with ‘business as usual’; the effects were proportionately greater for smaller scale and less profitable businesses; it was highly preferable for agriculture to be accorded EITE status with the bulk of emissions provided free of charge; improving accounting methodologies for GHG emissions is vital; and, research is needed to accelerate the development of mitigation technologies and management practices.

While the New Zealand ETS (NZETS) has different features, estimated financial effects are presented in Table 3 for comparative purposes. The dairy case (at 2006/07 prices and costs) is based on MAF's monitoring model farm comprising a 126-ha property producing 127,176 kg milk solids (ca. 1.6 M litres of milk) from a herd of 360 milking cows and generating $566,816 of revenue (net of stock purchases) and a net profit before tax (NPBT) of $71,690.

Table 3. Estimated financial effects on output and input prices and net profit before tax if the NZETS had been applied for the 2006/07 financial year (Source: MAF 2007).

		Allocation of 90% of 2005 emissions from each species[1]			Full liability		
Carbon Price> $/t		***$15***	***$25***	***$50***	***$15***	***$25***	***$50***
Output price impacts							
Milk solids	c/kg	−5.1	−8.5	−17.1	−16.1	−26.7	-53.4
Beef	c/kg,cwe	−0.7	−1.1	−2.3	−16.6	−27.6	-55.2
Sheepmeat	c/kg,cwe	−3.0	−5.0	−10.1	−38.8	−64.6	-129.2
Input price impact (cents or $/unit)							
Petrol	148c/litre	3.7	6.1	12.2			
Diesel	100c/litre	4.0	6.7	13.3			
Electricity	20c/kwh	1.0	2.0	4.0			
Urea(46%N)	$579/t	$590.80	$598.66	$618.32			
DAP(18%N)	$670/t	$674.62	$677.70	$685.14			
Change in net profit before tax (%)							
Dairy ($4.14/kg ms)		−12.0	−20.4	−40.7	−36.8	−61.6	−123.1
Sheep & beef		−4.6	−7.9	−15.9	−48.1	−80.3	−160.5

[1] *Assumes that 90% of 2005 pastoral emissions of N_2) and CH_4 related to each species are freely allocated (e.g. through processors) in a way that benefits each pastoral species in direct proportion to its emissions of these gases. Other allocations are possible; e.g. lump sum allocations to farmers to ensure that incentives to reduce actual emissions are retained.*

Calculating a carbon footprint

An environmental footprint is calculated by preparing a 'cradle to grave' life cycle analysis (LCA) where all of the '*potential environmental impacts of a product are assessed by quantifying and evaluating the resources consumed and emissions to* *the environment at all stages of its life cycle – from extraction of the resource through the production and use of raw materials, the product itself, and the use of the product to its reuse, recycling or final disposal'* (Basset-Mens *et al*. 2007, p. 2; Guinee *et al*. 2002). A carbon footprint is a sub-set of this and incorporates the products (or depending on the unit of study, farms) GHG and energy use (Basset-Mens *et al.* 2007). The footprint is expressed as carbon dioxide (CO_2) equivalents (where nitrous oxide is 310 CO_2-e, and methane (CH_4) is 21 CO_2-e). GHG emissions from energy-used (Figure 3) is classified as being either direct (e.g. electricity, fuel) or indirect (e.g. urea fertiliser) (Ledgard *et al.* 2007). The milk production system has a marked effect on the size of the farm's footprint – as Basset-Mens *et al*. (2007) showed intensification of milk production through greater use of urea and/or maize also increased the farm's footprint relative to a low-input pasture system (Figure 4). In a New Zealand case study for cheese, Ledgard *et al*. (2007) estimated that urea contributed 41%, electricity 28% and fuel use 6% of the total energy used to put milk in the vat for the typical farm in 2004/05. Of total energy use, 87% was expended on-farm for production activities and 13% off-farm for grazing and bought-in feed. Total GHG emissions of 0.94 kg CO_2-equivalent/kg milk comprised 57% methane, 33% nitrous oxide and 10% carbon dioxide.

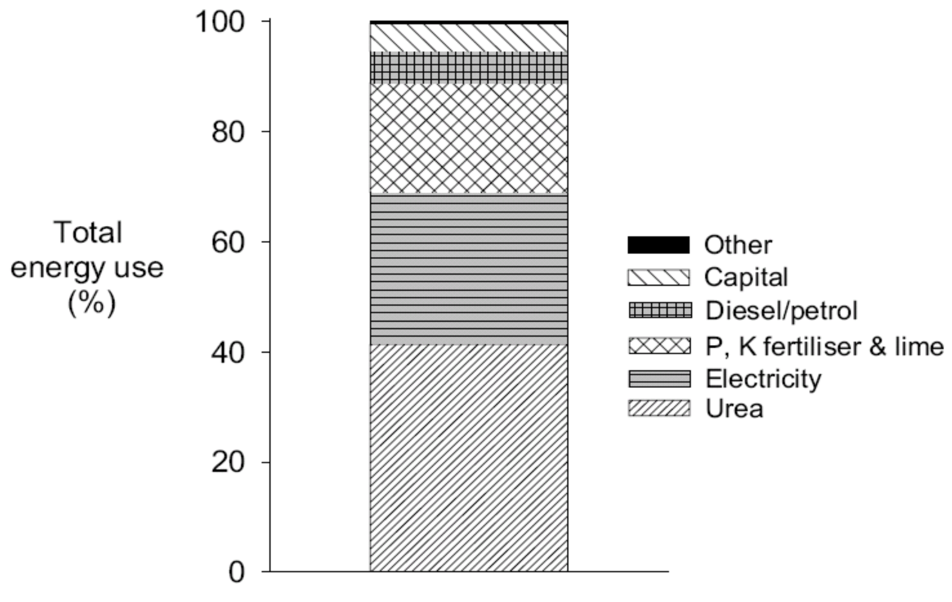

Figure 3. Sources of energy used by the average 2005 New Zealand dairy farm from production to milk-in-the-vat. (Source: Ledgard *et al*. 2007).

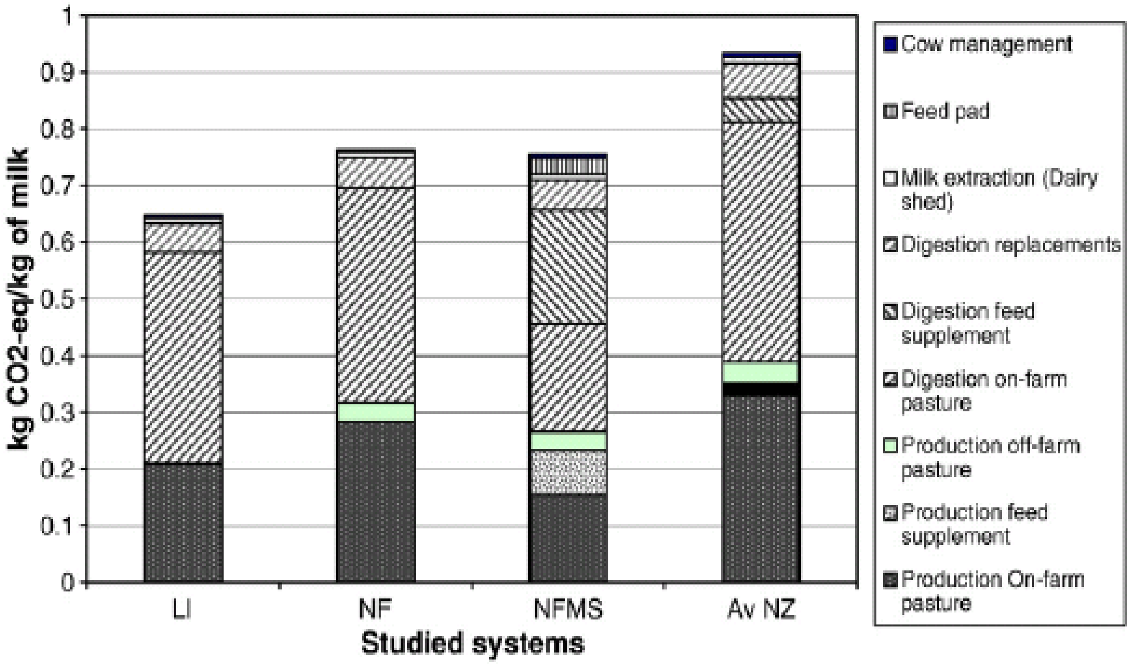

Figure 4. Sources of GHG emissions and direct energy use (kg CO2-eq/kg milk) for different pasture-based production systems (LI = Low input, NF = Nitrogen fertiliser, NFMS = N-fertiliser plus maize silage and an average (Av NZ) system). (Source: Basset-Mens *et al*. 2007).

The LCA for a dairy product, such as cheese, incorporates energy use and GHG emissions during processing, transport, distribution and consumer travel as illustrated in Figure 5 for New Zealand cheese.

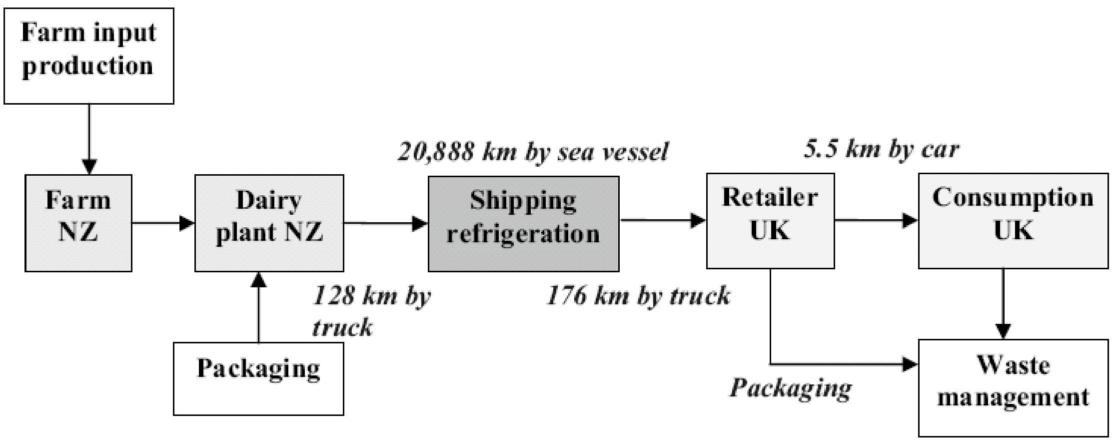

Figure 5. Components in the life cycle of New Zealand cheese with one-way distances from farm to plate (Source: Ledgard *et al*. 2007).

'Food miles', a termed coined by the SAFE Alliance in 1994 (Paxton 1994, p. 1), refers to the total energy consumed in this 'pasture to plate' chain (Mila I Canals *et al*. 2007). In its original use the term had a broader interpretation to include wider social and ecological implications of international food trade than has become common usage (McLaren 2007). McLaren (2007) provided a full review of food miles and their implication for food industries remote from the marketplace, especially for a distant exporting country such as New Zealand. She noted that food miles variously embody climate change, air quality, traffic efficiency, local economies and communities, biosecurity, animal welfare and food security. Some have labelled food miles as protectionist but as listed above this is a simplistic view and, now that more LCA reports are showing local market produce is not necessarily more eco-efficient, not credible (McLaren 2007).

Life cycle analyses for alternative dairy farm systems in New Zealand and the EU (Figure 6) have revealed that the former are relatively efficient (Basset-Mens *et al*. 2007) and that when these are integrated with modern shipping transport, the food miles of New Zealand products can be lower than those produced in-market (Ledgard *et al*. 2007, Saunders & Barber 2007).

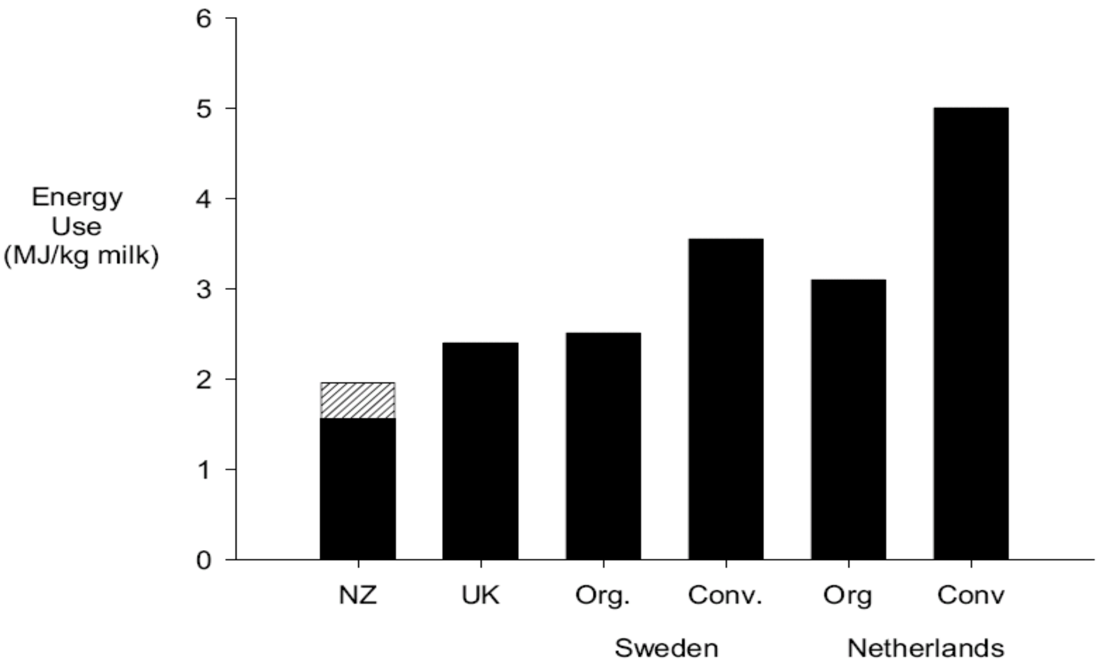

Figure 6. Comparison of GHG emissions to the milk-in-the-vat stage for dairy production systems in New Zealand, the UK, and for conventional (Conv.) and organic (Org.) farms in Sweden and The Netherlands. Food miles to the UK market are shown by the hatched section of the NZ bar. (Source: Basset-Mens *et al*. 2007).

The carboNZero programme

The carboNZero programme was developed by Landcare Research to measure, manage and mitigate GHGs and direct energy use for businesses, households and individuals (Smith *et al*. 2006, carboNZero 2007). It services users across sectors through easy-to-use Web applications, a certification process, and a suite of licensable certification marks. The programme enables verification of an organisation's emissions inventory (and reductions achieved), and a certification standard for marketable carbon neutrality. The programme has led to many firsts in carbon-neutral products and services including for wine, energy, travel, and public services.

Where mitigation is required carbon credits can be acquired through Landcare Research's EBEX21 scheme (EBEX21 2007). Under this programme landowners covenant land for 100 years to allow reversion and establishment of indigenous vegetation. The carbon inventory of the land is assessed at regular intervals and credits sold to firms and organisations that are unable to completely manage down their GHG emissions. This creates a dual benefit – the landowner is compensated for restoring indigenous biodiversity (often on lower quality, unstable hill land) and the firm achieves carbon neutrality. To avoid 'greenwash' the carboNZero programme puts a high emphasis on implementing steps to reduce energy use and GHG emissions rather than simply offsetting the present footprint. Significant cost savings and improvements in eco-efficiency have been documented by organisations completing the programme.

Research is in progress to obtain emission factors and other data to apply the carboNZero programme more widely in the pastoral, horticultural and wine sectors (Fraser *et al*. 2007). Calculators to estimate a farm household's footprint are on the carboNZero website (http://www.carbonzero.co.nz/).

Practical options for farmers to consider

This strategic outlook together with further increases in biofuel production and the growing influence of government policies to address climate change (such as the CPRS) mean dairy farmers need to proactively adapt their systems and management. Enkvirst *et al*. (2008) suggested three broad strategies: realise eco-efficiencies by optimising current assets (e.g. smarter use of energy); invest in new-generation low carbon technologies that provide for ‘drastic emission reductions’ (e.g. local distributed renewable energy); and positively influence the design of public policy and associated regulation.

Farmers can consider the following options:

Evaluate the portfolio of land use: Dairy land is a scarce asset and suitable for other uses. Improved prices for other agricultural commodities and the emergence of markets for ecosystem services (e.g. carbon storage and biodiversity protection) have generated new options for land use that may have economic, staff and environmental advantages over dairying. The financial effect of the CPRS varies by enterprise (e.g. vegetable and horticulture are lower than dairy (Keogh & Thompson 2008) due to their low emissions intensity) giving farmers scope to reassess their portfolio of land use. Further, dairy livestock are a liquid asset and their value has generally improved with the increase in milk price. Milk processors therefore confront strong competition to secure future supply and can be expected to act proactively to sustain the best possible milk prices.

Strengthen the balance sheet: Recent economic events have highlighted the volatility in global markets confirming the IDF (2007) outlook for greater milk price variability due to slower world economic growth and relatively rapid changes in government policy and petroleum prices. And, significant increases in energy, fertiliser and interest costs have already occurred. In these circumstances farmers need to work hard to control costs, increase productivity and ensure, through debt reduction if necessary, that they have sufficient balance sheet resilience to cope with greater economic uncertainty. Adopting this tactic for the near-term could lower overall farm business risk and best meet ownership goals. Nevertheless the potential for business expansion should not be discounted as opportunities arise as other landowners and stakeholders in agribusiness adjust to climate change and tighter resource constraints (e.g. less irrigation water).

Increase the use of pasture: Pasture-dominant dairy systems are less exposed to increased dairy feed costs but, other things being equal, generate higher GHG emissions than those using intensive feed inputs due to the herd’s diet. To mitigate increasing urea costs (and its GHG footprint; see Figure 3), pasture swards with a strong legume component should be encouraged. Nitrogen inhibitor products may be an option to lower nitrous oxide emissions in some situations (Kelliher *et al*. 2007).

Greater use of pasture may lower herd average yields yet still improve profitability relative to a high input system due to the milk price:feed cost ratio. With emissions trading pending, it is important to monitor the price of carbon (farm GHG inventory) and to explore its impact on the viability of alternative future production systems. However, it is important to note that systems with a larger component of bought-in feed may have associated infrastructure that can support easy adoption of GHG mitigation technologies (e.g. biofilters in areas used to house livestock, methane capture for electricity generation from effluent ponds (e.g. NSL 2008)).

Manage the farm's natural capital: Customer expectation, supported by Government regulation in many areas, is demanding dairy farms lower their environmental impact (Harris 2007; Ledgard *et al*. 2007). In addition to expectations already in place for soils and water, more attention now needs to be given to managing the farm's carbon footprint and understanding the role the farm has in supporting biodiversity (e.g. its contribution to providing habitat and landscapes) and other ecosystem services (Parker 2005; Zhang *et al.* 2007). Biological limits, as is increasingly being experienced with water in Australia and elsewhere, will more prominently influence the price of commodities due to economic growth and probably changed weather patterns. Those who sustain their natural capital will strengthen their long-run competitiveness.

Pursue energy efficiency to reduce the farm's carbon footprint: All aspects of farm energy use should be measured and ways to increase farm energy efficiency should be actively pursued. This information can be integrated into calculating the farm's carbon footprint and in developing an emission reduction plan. Fonterra suggests savings of up to 20% can be achieved (Harris 2007). Where irrigation and cropping, both high users of energy, occur savings may be even greater by changing the technology mix and crop rotation. For large dairy herds there is considerable scope to utilise effluent for energy generation and recycling of nutrients (NSL 2008).

Achieve productivity gains through operational excellence: As always the most successful farm businesses will continue to be those that pay attention to detail and exceed best practice. Achieving 'stretch' targets for genetic improvement, herd fertility, feed, nutrient and labour management, and animal health – key drivers of dairy farm productivity – will all contribute to improved farm viability and increase capacity to adapt to the CPRS.

Summary

Addressing the effects of climate change presents a substantial challenge to all sectors of the economy and dairy farming is no exception. While there is still a high degree of uncertainty about how Australia's CPRS will unfold there are sufficient indicators in policy-related documents and sound commercial reasons for farmers to start taking practical steps to lower their farm's carbon footprint. External drivers, such as customers seeking food and beverage products with low carbon footprints, higher fuel and electricity costs, and greater constraints on the use of scarce natural resources, all strengthen the case for rapid change. Over the next few years much greater knowledge about the footprint of dairy systems and products will become available and there is optimism that more effective GHG mitigation technologies than the present suite available to farmers will be commercialised. These developments will be spurred on by the introduction of the CPRS and national targets for GHG reduction.

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Lessons from Succession Planning & the Family Provisions Act.

Grant and Jane Sherborne

Dairy Farmers, Moss Vale, NSW

Succession planning, very simply is a way of ensuring that a person's estate is passed on to their beneficiaries in the most financially efficient and tax effective way possible. The aims are to try and avoid the likelihood of any next of kin suffering financially; and to minimise the family.

The Aim of the Family Provisions Act is to remedy unfair treatment of certain people who had been left without proper provision being made for them in a will–i.e. the deceased did not specify them to receive any property under the will. Simply, any eligible person can apply to the court for some property from the estate of the deceased. This is irrespective of whether they were included in the actual will of the deceased.

The Family Provisions Act. states that a person may give away his property in any way he likes. Aside from the Act, whether or not a third party agrees with how the testator gives away his property is irrelevant. In the opinion of the court, having regard to the circumstances at the time the order is made, provision ought to be made for the maintenance, education or advancement in life of the eligible person, i.e. a spouse, or defacto partner, children, former spouses (in some special circumstances), a person who was dependent upon the deceased, a person who was a member of the deceased's household, (a carer, or a homosexual partner).

Notional Estate

Any property own by the deceased, whether or not in joint tenancy, can be designated as notional estate, from which a provision can be made.

History Grant and Jane Sherborne are Dairy Farmers on the family farm "Willow Vale" in Burrawang NSW. Grant's parents operated the dairy until William's sudden death in a tractor accident in 1976.

Alma was previously married and had two children to her first husband, one of them moved away and very rarely visited. The other remained in the area, and visited from time to time. Alma remarried in 1961 to William Sherborne and In 1963 Grant was born, being the only child of this relationship. Grant and his mother Alma Sherborne have been running the farm in partnership, since Grant's father's death in 1976, when Grant was 13 years old. Alma made her first "Will".

Grant and his Mother operated the farm together with the assistance of employed labour, until Grant was able to leave school at the age of 15. When Grant turned 18, he became a sharefarmer. Alma and Grant entered into a farming partnership, and made out new "Wills"

The partnership from 1982 consisted of Grant owning "Willow Vale" the main dairying property, Alma owning an adjoining property, and Grant and Alma owning 2 smaller properties as tenants in common.

Map of properties in joint tenancy

In 1990 an off-farm investment was made in purchasing a house in Burrawang. This property was purchased in Joint tenancy.

Grant and His mother were aware that trouble may arise in the future, as they were given a hint of what might happen, by the reaction of family members after Grant's father death. Knowing this, they approached a local solicitor for advice. He agreed that there could be trouble and would think about the situation, not knowing what to do. So he did nothing! It was then placed into 'too hard' box until a much later stage.

In the mean time Grant married Jane in 1993, and both updated their "Wills", Jane decided that she could continue working at her business in town as well as help out with calf rearing before and after work. Alma broke her hip in 1994 and after that time was unable to actively participate, but remained interested in the general goings on of the farm business. Jane was made a sharefarmer in 1994. Jane then left her own business in town, to concentrate on the family dairy business. It was decided that they would build a new dairy and milk more cows, in preparation for deregulation. They also started their own family. Georgia was born in 1995, William in 1997 and Samuel in 2000.

Photo of the New Dairy 1994

In the year 2000, Alma then again wanted to make things right and decided to seek the advice of the family accountant, who was also a trusted friend and confidant. He suggested a solicitor in the same office as he worked, who would be able to help, The solicitor went through the process of transferring properties into joint tenants (so as to safeguard Alma that in the event that Grant should pre-decease her, she could still decide about what to do with the properties), and was also asked to write a will for Alma. This also seemed to take forever, as the solicitor was very disorganised.

When he finally finished the transfers it was decided that he would not be used to write Alma's will as his advice was unsatisfactory and he had no knowledge of the ***Family Provisions Act***. Alma then decided that she would ask the family accountant to write the will, as he knew the business well and also knew what Alma had wanted for many years. He agreed to write up a will that would suffice until a more suitable solicitor was found. Alma was put into hospital, and passed away suddenly.

Succession Planning gone wrong! Like Crows hovering above!!

Then it hit the fan, the half siblings, wanted to stay in Alma's house, to go through her belongings, and search the house, for business papers, or anything else they could use to speed division of the estate up. The executor was contacted and he stated that no one was to enter the house. The half siblings thought Grant was the executor (as he had previously been), and when they found out he wasn't, they insisted on knowing who the executor was so that they could contact him. They were anxious to see the will and to have it read before the funeral. They were put out that they hadn't been advised about the updated "will" and having a non beneficiary as executor, they might be able to get things all divided up in the next couple of days, so that they could get home (to spend their inherited wealth no doubt). One of the half siblings claimed that Grant would have to sell one of the properties, and her husband determined that Grant was only the defacto owner of the properties, until probate was granted.

The executor approached a solicitor, to work on behalf of the estate as well Grant's family. This solicitor indicated to us that he didn't think that it was going to be a problem, as most of the estate has been distributed before or at the time of death due to the joint tenancy, and that the half siblings didn't have a case. Which at the time made us feel better although not totally convinced, as the executor was not entirely happy with this advice (having some experience in these matters). After letters back and forth between the other solicitor and ours, the wife of our solicitor became unwell forcing him to hand our case onto a locum, thinking that it was only for preparation of the affidavit. We went through the history yet again, as well as the back and forth of letters, only to be told that we would have to seek other advice (as the original solicitor's wife was not getting better and that the locum was unable to continue). It was given to a Sydney Barrister for his opinion. Opening a new can of worms - "Notional Estate".

Notional Estate

Notional Estate changed the value of the estate from $100,000.00 to $3,000,000.00 Notional Estate, which can consist of anything held jointly, for any length of time, including properties, shares (publicly listed or co-operative), bank account, even Dairy adjustment monies.

Yet again we had to find another solicitor. It was advised that we had a choice of two who would take us on, one in Wollongong and the other in Sydney. It was decided for ease of travel to see the solicitor in Wollongong as this could be done in-between or after milking.

Finally we had solicitor number 3 and someone that finally took the case seriously. He indicated to us that we must make an offer as soon as possible, as he knew the opposing solicitors who had a reputation for running up costs which we would have to pay. After all the other advice that we had received and our belief of what would happen, we didn't feel the need to give them anything. They had not indicated what they wanted or what they thought that they were entitled to.

The more we saw our solicitor Matt the more we trusted him, and we realised that he wasn't in this job just for the money, he really cared about what was happening to us, and although it wasn't right it was the law! Now that injury litigation was being clamped down on, this was the next best way for many solicitors to make a living. He said to settle it as quickly as possible, and get back to farming, as we were not going to win.

It was suggested that we look up other cases on the internet, so that we would get some sort of idea of what we would be up for. In doing so we came across several cases to do with farming, one of which we phoned, to get their point of view, and we were shocked to hear what was said about the judges, and one comment in particular struck a chord,

"If the Judge thinks you've got a dollar he'll give it away, he thinks' he's Father Christmas".

The more cases we saw, that what we believed was the right thing to do, in most cases, abide by the contents of the will of the deceased, was not the outcome.

The Family Provisions Act intrudes on testamentary freedom.

Matt our solicitor time and time again asked the opposing party what they wanted, yet received no reply! We had put several offers of settlement across the table to which we've still never received a reply!!

The siblings just kept sending accusations that Jane and Grant did nothing on the farm, and how it would be better if we sold off land and ran fewer cattle. Apparently then we did not have to employ anyone, as one of their many specialists stated (a forensic accountant). Our solicitor received a Subpoena for financial records, cattle valuations, farming equipment, dairy plant, and properties, all of which had to be done several times before they were satisfied they had the highest valuation, enabling them (the husband accountant to rework the accounts) to value Alma's share in the farming partnership to be approximately 10 times what the farm accountant had worked out. We were beginning to think that they wanted us to sell up and divide the farm up so that they would get a lump sum.

In the mean time both of Grant's siblings decided to give up work, one left her husband, and moved out of the house, the other one sold a property that they owned, and gave the proceeds to their son as well as a brand new car. All in an attempt to make their needs seem greater, to enable a larger provision being order. Grant's niece also wanted in on the action claiming that she was an eligible person.

For all of these claims we had to find the evidence, to support the truth that they had been given everything that they had been entitled to. Many sleepless nights ensued, looking through old cheque books, scraps of paper, note books, and alike. They could basically say anything they liked and the onus was on us to prove that they were wrong.

Seeing that this was all going pear shaped, Jane decided that she would seek help from anyone, and everyone, writing letters to local government, state government, newspapers. All in vain, as nobody was willing to do anything until the court had made their decision. But by that time it would be too late for us.

Nobody has any energy or time left after being put through all of this. It was hard enough to get up in the morning knowing the large sum of monies to be paid out, never mind the years of earning that could have to be handed over for no wrong doing on our behalf.

All this was on top of having to deal with deregulation, and low milk price.

Be Careful who you trust-many people are very opportunistic

This put enormous pressure on us. Coming from a small town, people all have different opinions and everyone seemed to hear a different rumour. We even had a local real estate agent (related to Grant) with someone interested in our property, and sent them to contact the half siblings looking for a quick sale! This was done knowing that the siblings didn't even own the property.

Even employees become unsure of their job due to rumours, and one employee took advantage of the situation, being very manipulative, out for all she could get (as the saying goes 'give you a kick in guts while your down').

Jane was diagnosed with depression, having many of the symptoms, waking up at 2 or 3am, finding it hard to sleep, feeling that you have no control of your life, that not knowing how things are going to turn out, no matter what you do, it is most likely going to benefit those who are attacking you. We feel it was now more likely the reality of the situation.

On top of it all we had the 1 in 100 year drought and post deregulation milk price to contend with!

In most cases things are over in a matter of months, but ours dragged on for years. Our life was in limbo during all of that time. We were given several opportunities to buy neighbouring properties, 3 in fact. As farmers, we all know opportunities like this don't come up every day, but were unable to act upon these offers, and of course, land prices have sky rocketed, so now the opportunities have been lost.

This has had a terrible impact upon our lives, our children's lives, and lives of our families, to say nothing of the time lost fighting a seemingly never ending battle. A battle which we were never going to win, we were only fighting to limit the loss, the financial costs associated with solicitors and with going to court. And the lost time spending with our small children, which we will never get back.

Hope it never happens to you! Check it out now!! Right Now!!!

1. Get good advice
2. Get more good advice; check that they are experienced in family provisions act.
3. Know what the most likely outcome is in passing on the family farm.
4. Know the risks in passing on the family farm
5. Do your homework, plan out what is likely to happen.
6. Plan early how to avoid trouble
7. Get advice early and know the laws that apply
8. Trust the advice and act on it as soon as possible
9. Make sure you are satisfied, that this is what you want
10. If it does happen to you settle it early if you can and get back to doing what you enjoy - DAIRY FARMING (at least most days that is! It's much nicer than court even on your worst days.)

And even when you think you've got it covered don't be surprised, when they say money changes everything, (not to everyone, but to most).

Although in our case I don't think anything that we could have done would have avoided what went on, knowing who we were dealing with. That's why our case has changed the law, to a certain extent, limiting the costs awarded in such a case. So if nothing else came out of our battle, others will benefit from what we have endured. "OUR LOSS IS YOUR GAIN"