Enhancing the Resilience of Dairy Farms in the high rainfall regions.

Riding the volatility rollercoaster.

A report for NUFFIELD AUSTRALIA FARMING SCHOLARS

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Foreword

Dairy farming has been a rollercoaster ride over recent years. The combination of volatile milk markets, challenging climatic conditions and increasing input costs has many within the dairy industry wondering what the future holds.

With an expected increase in demand for milk products globally the challenge is to understand what type of dairy business will best be able to meet growing demand.

The purpose of this paper is to investigate resilience thinking as a method to clearly understand the complexity of dairy farm operations.

Milk from grass has been the cornerstone of the Australian dairy industry. The low cost nature of pasture based systems has enabled Australia to become a competitive player on the international milk market. Pasture based dairy operations can produce milk at a low cost but they are also very complex systems with many interactions. The Australian dairy industry must consider if it is possible to look at pasture based dairy operations in a new way to enhance business resilience, ensuring dairy businesses remain viable into the future.

In 2009-10, 45% of Australia's milk was produced in Gippsland and Western Victoria. The dairy operations in the higher rainfall areas (>750mm annual rainfall) of these regions are the focus of this report. Much of this report is also relevant to the dairy industry in high rainfall regions of temperate Australia. Where possible I have broadened the context of the report out to include the entire Australian dairy industry.

The proportion of Australia's milk exported has decreased over recent years. Around 50% of Australia's milk was exported in 2009-10 (Dairy Australia, 2010). Most dairy farmers in the high rainfall temperate regions either sell their milk to export focused processors or to processors who base their price on the export milk markets.

My Nuffield Scholarship has taken me to New Zealand, the United Kingdom, USA, Mexico, Brazil, Uruguay, France, Netherlands and Sweden. This report is a collation of experiences from my Nuffield travels and current literature.

Acknowledgments

I would like to thank all those involved Nuffield Australia for providing me with the opportunity to step outside my business and enjoy the Nuffield experience.

The Gardiner Foundation's support of Nuffield Australia is providing Victorian dairy farmers with an opportunity to view our industry with a global perspective and I thank them for their support.

The Global focus tour group - I thank you for friendship and making the tour such an inspiring and memorable one.

To all those who helped me during my Nuffield travels, the generosity provided by so many people made my Nuffield experience truly memorable.

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Finally I would like to thank my wife Gillian, for her unwavering support and encouragement throughout my Nuffield Scholarship year. Hugh and George my boys, for their patience and understanding, letting Daddy travel the world when he should have been fixing the cubby house.

Abbreviations

ADHIS	-Australian Dairy Herd Improvement Scheme
APR	-Australian Profit Ranking
KgMS/ha	- kilograms of milk solids per hectare
LIC	-Livestock Improvement Corporation
MJME	- mega joule of metabolisable energy
RA	- Resilience Alliance

Executive Summary

The combination of volatile milk markets, challenging climatic conditions and increasing input costs has many within the dairy industry wondering what the future holds. Demand for milk is expected to rise globally with growing awareness of milk's nutritional value and functional diversity, and the improvement of living standards in developing economies. The challenge for dairy farmers is how best to position their business to manage the volatility whilst capitalising on the opportunities.

This report seeks to demonstrate how systems thinking can assist dairy farmers in the high rainfall temperate zones of Australia to manage their businesses more effectively. There is a need within the dairy industry to deal with greater complexity, yet a lot of current business management tends to focus on managing details in isolation.

The Australian dairy herd is facing some fertility and inbreeding challenges and crossbreeding with three unrelated breeds may provide a solution for dairy farmers. Trials overseas have shown significant increases in profitability using cross breeding. It would be useful for the Australian dairy industry to explore this option further. High producing cows within many herds may not be generating profit as herd managers believe they are. Detailed in-herd benchmarking could assist in identifying what type of cows are generating profit.

Pasture utilisation is a key profit driver on pasture based dairy farms in the higher rainfall regions of temperate Australia. Regular and accurate total farm pasture cover measurements and detailed record keeping of farm cover, growth rates and pasture demand are the key tools for improving pasture utilisation.

An unintended outcome of my studies was the reinforcement of the importance of communication within the dairy industry. Many of the technologies to improve the resilience of dairy farms already exist. The communication, sharing and uptake of these messages could be enhanced through improved communication. The traditional method of farmer discussion groups and the newer opportunities provided by social media were both observed working effectively overseas.

It is hoped that this report will encourage dairy farmers to look at their operation in new ways and endeavour to gain a greater understanding of the interactions within their farming systems.

Introduction

In 2009 when I applied for a Nuffield scholarship global dairy commodity markets were at the bottom of a record slump and producers were looking for ways to minimise the losses. Less than 18 months earlier producers around the globe were ramping up production to meet unprecedented demand for milk products.

I was keen to understand these global fluctuations, their drivers and how the markets bode for the future. More importantly though I wanted to understand how the best dairy managers were positioning their businesses for the future. I was interested to understand how others around the world were dealing with market fluctuations together with climatic pressures, pressures on agricultural land and the decreasing terms of trade. All of these factors impact on my own dairy business in South Gippsland, Victoria.

Industry Background

Dairy farming over the last four years has been a rollercoaster ride. The global dairy market, like most commodity markets globally has undergone extreme volatility since early 2007. From 2007 through to 2010, market volatility has been greater than any time in the preceding twenty years.

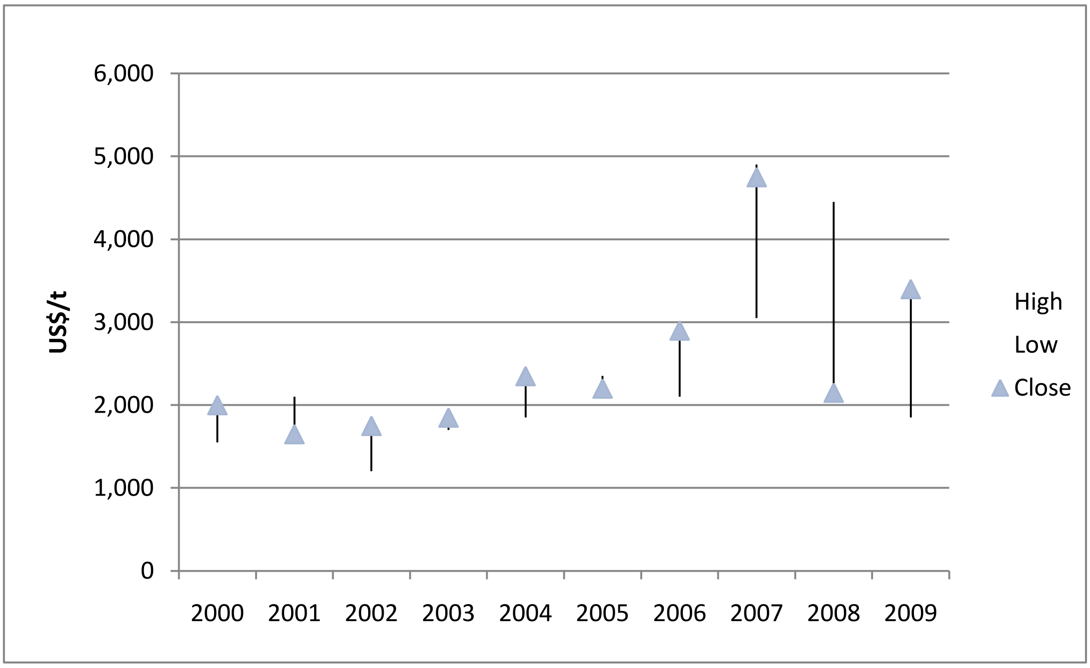

Figure 1. Increasing volatility in Australian dairy trade. Spot price ranges for Whole Milk Powder per year since 2000 (Harvey, 2010)

The annual Situation and Outlook report produced by Dairy Australia summarises; *The feeling of a rollercoaster ride was enhanced by similar volatility in dairy farm inputs and some challenging seasonal conditions. "Market and margin volatility has undermined confidence for many dairy producers, in particular younger farmers and those with low equity. Caught by the sudden downturn in milk price, they are financially stretched and uncertain of their ability to withstand future volatility in their returns."* (Dairy Australia, 2010)

The volatility in both inputs and outputs has left many dairy operations feeling of vulnerable. The period of market volatility has coincided with an extended period of reduced annual rainfall. This has had a range of impacts on high rainfall dairy farms;

- reduced runoff,
- extended period of pasture deficits through the summer/autumn
- increased winter pasture production potential

The uncertainty has been exacerbated by potential impacts of policy change on farm. The carbon emissions of agriculture in particular ruminant production are gaining increased attention. Even if agriculture is not included in a carbon trading/emissions trading scheme there is potential for markets to discriminate against products produced with high emissions.

Increasing community interest in the environmental impacts of the dairy industry, combined with developing consumer interest in the production of food products adds to the complexity of issues dairy producers are facing.

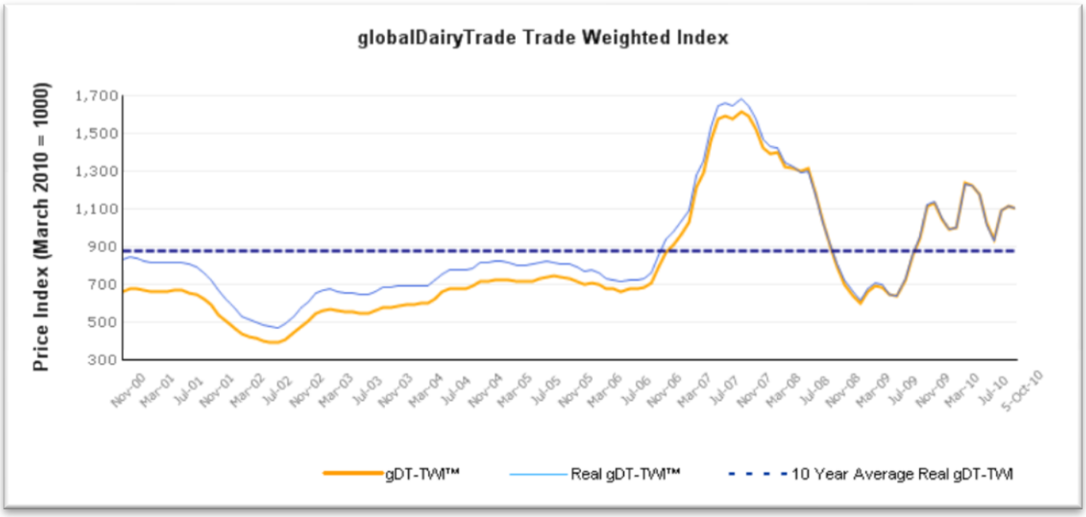

Figure 2 Fonterra globalDairyTrade trade weighted index Oct. 2000-2010 demonstrates the 'rollercoaster' (Fonterra Co-operative Group Limited , 2010)

Global demand for milk is expected to increase with growing awareness of milk's nutritional value and functional diversity, and the improvement of living standards in developing economies. The challenge for dairy farmers is how best to position their business to manage the volatility whilst capitalising on these opportunities.

Objectives

The key objectives of my Nuffield Scholarship were:

- To better understand resilience thinking in order to identify the key opportunities for dairy farm operations to enhance their ability to adapt and manage change.
- To investigate on farm strategies to enhance the resilience of dairy farms in the high rainfall regions including breeding strategies and perennial ryegrass pasture utilisation.

Systems Thinking

Pasture based dairy farming is often viewed as a simplistic farming system. The interactions between pastures, cow production, cow health and climate create a very complex system. When increasingly volatile markets, economics and changing social expectations are included the complexity of the challenges facing the industry are apparent. If farmers are to remain viable into the future they need to be able to understand and react to a diverse range of systems interactions.

It is evident that some of the best system thinkers in the world are farmers. They may not have the terminology to define the *state-change processes* of their system but they do deal with adaptive cycles and thresholds on a daily basis. There is a need within the dairy industry to deal with greater complexity, yet a lot of current business management tends to focus on managing details in isolation.

In an effort to develop our dairy operations we have endeavoured to optimise key components of our system in isolation, whilst at times neglecting to recognise the impacts on the entire system. An excellent example of this is the reduction of reproductive performance of dairy cows. Significant gains have been made in dairy cow production globally in the last 30 years but the decline in reproductive performance is well documented (Lucy, 2001), (Royal, 2008).

A more systems based approach to breeding would allow for greater importance being placed on traits which do not provide an immediate production response such as longevity. Whilst systems based thinking appears obvious in retrospect, there are many other examples in the dairy industry such as the decline of reproductive performance of dairy cows, where a lack of systems thinking has resulted in our farm businesses becoming more vulnerable.

The concept of systems thinking is critical not only to on farm management and planning but to enable cohesive and targeted industry planning, this is where the science of systems thinking may play its' most important role. A well developed systems approach to planning becomes increasingly important as the complexity of pressures impacting on the industry increases.

Carbon emissions from the production of food will become an increasingly important issue as carbon trading/emissions trading schemes are put into place. A systems thinking approach is critical to not only understand the emissions from food production but also to identify methods to reduce the emissions per unit of food produced.

The communication of systems thinking is reliant on clear and consistent usage of terminology which can explain and define a system and how is operates. One approach to systems thinking is resilience thinking which is advocated by the Resilience Alliance.

Resilience Thinking

Resilience has become an increasingly used term in recent years. "Our farming operations must become more resilient" is a common statement. This is not surprising given is definition of resilience, "Resilience is the capacity of a system to absorb disturbance and still retain its basic function and structure" (Walker, 2006)

The level of pressures and disturbance the dairy industry has faced over recent years requires dairy farms to absorb gross change whilst maintaining the business in a position where it has the ability to capitalise on opportunities that arise and reduce the consequence of negative impacts. Traditional business risk management could be seen as a path to dairy farm resilience, the structure of "Resilience Thinking" as described by the Resilience Alliance provides some structure for a greater level of systems thinking.

The Resilience Alliance (RA) is a research organisation comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems. Resilience thinking as prescribed by the RA is not an alternative or replacement for sustainability but provides a framework to help us understand the keys to sustainability.

Understanding the resilience of a system in RA terms involves identifying the limits or thresholds to the system and how it operates. Understanding the thresholds enables us to think about how do we stay and manage a system within those limits and sets the boundaries for a safe place to operate. It also helps to identify what do we want to be resilient to: What are the potential threats that could impact on the system?

The RA has its foundation in ecological and social ecological sciences and has broadened its' work out into many other fields. Resilience thinking provides a frame work for some very insightful case studies in the agricultural systems. A 2006 study of the Goulbourn-Broken Catchment (Anderies, 2006) highlights how efficient farmers have become increasingly vulnerable to future shocks due to a loss of resilience in their farming system.

Resilience thinking at times appears to be convoluted academic theory and sometimes appears to be in conflict with proponents of *Dynamical Systems Thinking* which use the terms stocks, flows and feedback to define a system. Most of the concepts involved in resilience thinking are not new but they do provide a reminder to ask important questions:

- Is this system approaching a threshold or tipping point?
- What management action do you need to consider to avoid such a threshold?
- What are the key variables driving the system?

The academic debate over how best to describe and define systems, their components and interactions is in many respects less important to systems managers (e.g. farmers) than the primary concepts. As Bawden (1991) stated when talking about systems thinking in agriculture 'we must learn how to come to terms with complexity and chaos and develop learning strategies that enable us…to deal with such dimensions'. A greater understanding of the farming system will enable dairy farms to respond to the complex range of pressures they face.

Resilience and the Dairy Industry

When analysing dairy farming systems in the high rainfall areas of Australia with a *resilience thinking* approach it appears many thresholds are being approached on farms. Two examples of this are;

- The reproductive performance of many herds is declining, forcing managers to move away from calving cows seasonally to match pasture growth, requiring more replacement stock and incurring extra costs associated with reproduction management.
- Changing climatic and economic circumstances are forcing many farmers to source more costly feed supplies whilst they are failing to optimise their use of home grown perennial ryegrass pastures.

There are opportunities to improve both pasture management and cow efficiency on most high rainfall dairy operations in temperate Australia.

Breeding

Reduced reproductive performance is having a significant economic impact on many dairy herds. There are many factors which are contributing to the decline in reproductive performance but the selection of a genetic base focused primarily on milk production is a significant factor. Fulkerson et.al. 2008 state "if the selection for milk production continues in Australia in the same manner, farmers will have to modify their production system accordingly by feeding higher levels of concentrates to cows (to reach potential production) or abandon seasonal calving due to poorer reproductive performance, or both. Both would result in an increased cost of milk production and a walk away from predominantly grazing, pasture-based system, which has been, and to date is, the largest competitive advantage of the Australian dairy industry."

The Australian dairy industry through the Australian Dairy Herd Improvement Scheme (ADHIS) has become increasingly focused on health and fertility traits since the introduction of the Australian Profit Ranking (APR) in 2001. In recognition of the need to further change the national herds breeding focus in April 2010 the APR calculation was updated to, place approximately double the emphasis on daughter fertility, survival, and mastitis resistance.

In general, traits related to fertility, health and survival have low heritabilities of less than 0.15%, production traits like milk or protein yield are moderately heritable, with heritability from 0.15% to about 0.40%. Traits such as fat and protein percent tend to have the highest heritabilities, above 0.40%.

Heritability is a measure of the degree (0 to 100%) to which offspring resemble their parents for a specific trait. Heritability helps explain the degree to which genes control the expression of a trait and therefore the 'rate' of change able through breeding. "When asked if the Holstein's issues with longevity and reproduction could be addressed within the breed rather than by crossbreeding, Mike Osmundson of Creative Genetics of California, said, 'yes – but only if you've got 350 years'. "There's only so much time to turn the ship around before it sinks and already now it's got water on board," (Pugh, 2008).

Inbreeding

Also contributing to the challenge facing the predominantly pure bred Australian dairy herd are inbreeding issues. If current mating practices continue, inbreeding will increase by about 0.2% and 0.3% per year in Holstein/Friesian and in Jersey animals, respectively, between 2002 and 2008 (Haile-Marian, 2007).

Two bulls born in the 1960s – Elevation and Chief – together comprise about 30% of the Holstein breed today. Inbreeding reduces farm income by increasing stillbirths, reducing cow fertility, inhibiting disease resistance, and shortening herd life. A study from the USA estimates over the lifetime of a registered Holstein cow the net economic loss per 1% of inbreeding is US$22 (manufacturing milk) to $24 (liquid milk) per lactation (Smith L.A., 1998). In the USA, the source of much of Australia's Holstein genetics, the predicted level of inbreeding by 2020 will be 20% (Hansen, 2000).

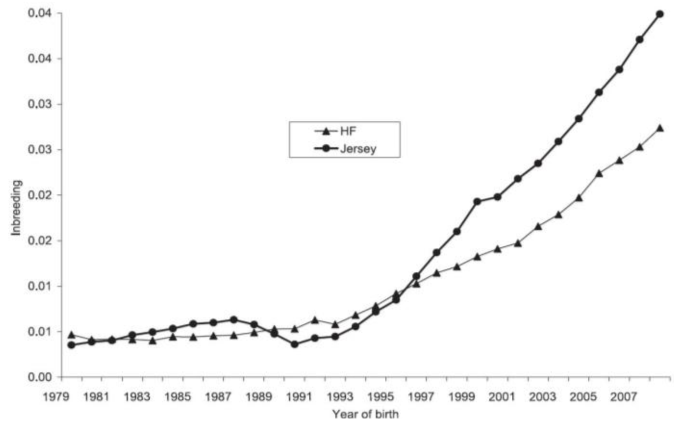

Figure 3. Past, current and future inbreeding in Australian Holstein-Friesian and Jersey cattle. (Haile-Marian, 2007)

There are potential approaches to help the industry mitigate inbreeding within the Australian industry. Haile-Marian (2007) suggests inbreeding can be reduce when breeding decisions are made with an appropiate weighting placed on the financial impacts of inbreeding. Genomics also has the potential to reduce inbreeding whilst still advancing breeding objectivies.

Crossbreeding

Cows have two genes at every location on their chromosomes – one from each parent. The inbreeding coefficient measures the percentage of those pairs of two genes that are identical because they came from the same ancestor. As the inbreeding % goes up, the likelihood of doubling up on genetic recessive genes (of either major or minor consequence) becomes greater. The effects of heterosis are the opposite of the effects of inbreeding depression. At each location on the pairs of chromosomes, the two genes are much less likely to be identical with crossbreeding than with same-breed matings.

Heterosis is a bonus that comes on top of the average genetic level of the two parent breeds and should be about 5% for production and at least 10% for mortality, fertility, health, and survival .Whilst two breed cross provides 100% heterosis for the first generation with multiple generations the level of heterosis reduces to 67%. The higher number of breeds in the cross breeding program the greater percentage of heterosis can be maintained, but it remains important to use breeds which will complement the farming system (see Table 1). There is very little extra heterosis that can be gained out of using more than three breeds in a crossbred system.

Generation	2 breeds	3 breeds	4 breeds
1	100	100	100
2	50	100	100
3	75	75	100
4	63	88	88
5	69	88	94
6	66	84	94
7	67	86	94
8	67	86	93

Table 1. Heterosis by generation for crossbreeding using 2, 3 and 4 unrelated breeds. (Creative Genetics of California, 2010)

Trials carried out by the University of Minnesota on six dairy operations in California over five lactations have shown a significant economic advantage in crossbred cows over Holstein cows. The trial bred Holstein cows to Normande, Montbeliarde and Scandinavian Red artificial insemination sires. The trial showed significant reductions in the number of still born calves to crossbred cows and reduced calving difficulty particularly to Montbeliarde cross and Scandinavian Red cross cows. All the crossbreds showed a significant reduction in the number of deaths prior and during to the first lactation. The crossbred cows showed improved reproductive performance and survival (cull and death) over the pure Holstein cows. The Montbeliarde cross and Scandinavian Red cross cows showed a 3% milk solids decline over the Holstein, but with 21-24% more crossbred cows calving for their fourth lactation and improved reproductive efficiency the lifetime profitability of the crossbreds is significantly higher than the Holstein.

Figure 4. Holstein-Swedish Red-Montbeliarde cross cow at the University of Minnesota, St. Paul.

Trait	**Pure Holstein**	**Normande-Holstein**	**Montbeliarde-Holstein**	**Scand. Red-Holstein**
Cows	168	168	369	218
Days in the herd	857	1,067	1,122	1,062
Lifetime profit	$3,819	$4,433	$5,194	$4,859
Difference	**---------**	**+$613**	**+$1,375**	**+$1,040**
% of Holstein		+16%	+36%	+27%

Profit within the 4-year period (1,461 days) after first calving

Table 2. Lifetime profit within 4 years of first calving (ignoring health costs) (Heines, 2010)

The potential of crossbreeding in pasture based herds in Australia has gained attention in recently. (Auldist, 2007) (Malcolm, 2005). Two breed crosses have been the focus of the majority of cross breeding studies in both Australia and New Zealand with Holstein/Friesians and Jersey the breeds used. Livestock Improvement Corporation (LIC) have marketed Holstein/Friesian Jersey crossbreed bulls for many years with excellent uptake. The number of crossbred calves reared in New Zealand each year now exceeds the number of Holstein/Friesian calves.

There has been increasing attention on Scandinavian Red genetics in Australia in recent years and to a far lesser extent Montbeliarde. Trials carried out by the University of Minnesota clearly demonstrate there is potential for breeds other than Holstein and Jersey in Australian dairy systems. While the Californian dairy systems are very different to many which exist in Australia, the two standout breeds in the California trials - Montbeliarde and Scandinavian Red, both originate from regions where cow diets usually contain large amounts of forage. Both these breeds are thought to have good feed conversion efficiency for pasture based diets.

Scandinavian Red

The Scandinavian Red cattle originate from importations of Ayrshires and Dairy Shorthorns from the UK. The pure mature cow is between 140-145 cm height at rump and weight 550-650 kg. The breed benefits from the selection of both production traits and functional traits since 1975, many years before USA or Australia industries began broad scale selection for functional traits.

Figure 5. Swedish Red-Holstein cross cow

Montbeliarde

The Montbeliarde breed originates from the eastern Comté region of France. The Montbeliarde is a genuine dairy breed, not a dual purpose breed. The breed has grown in popularity around the world in recent years and has a significant progeny test program, 380,000 cows were herd tested in France in 2007.

The breed standard of a mature cow is 145-150 cm (very similar to Holstein), but they carry a lot more muscle than Holstein cows. There does appear to be some variation in the size of this breed offering potential to select for small lines if that is desired for pasture based herds. Many Montbeliarde cross cows that I saw in Brittany-France are no larger (often smaller) than their dams.


Figure 6. Pure bred Montbeliarde cows in Comté-France

Many herds of Montbeliarde cows in eastern France are producing in excess of 500kg of milk solids of a diet containing very little grain or concentrate. Due to regulations relating to cheese production the diet of many of these cows is pasture through the summer months and a hay/silage type fodder in the winter when they are housed. It would appear that this breed of cow is very efficient in terms of feed conversion efficiency when fed a diet high in forage.

The Sacred Cow

Breeding decisions made on dairy farms can have a significant impact on farm management yet there are few tools within in the industry to assist with making decisions about breeding. The publicly available tools which do exist are either designed to operate within breed and don’t account for the individual farm system or focus purely on production. As a result the gains of heterosis are not actively promoted and more importantly the cows which are generating the profit within the herd are not identified. In order to breed more profitable cows we must be able to identify what type of cow is generating the most profit. I would hypothesise that the cows generating the most within a herd would often not be the cows identified by farmers as their best cows.

Currently farms that undertake herd testing receive a PI (Performance Index) for each cow at each test and at the completion of the lactation. This highlights the cows with the highest production. Profitable cows must be good producers but they also need to operate at a low cost. Fertility, mastitis resistance and longevity all contribute to the profitability of a cow. Whilst these traits are included in APR ranking of sires and cows within the Australian herd this ranking does not accurately (and is not designed to) demonstrate the economics within a herd.

In herd benchmarking, analysing not only profitability traits but functional traits (fertility, mastitis resistance, longevity etc.) has the potential to help farm managers make more informed decisions about their breeding pathways.

The maintenance requirement of cows within a herd can also be accounted for within the in herd benchmarking process to recognise the cost of maintaining cows with larger body weight.

Bell Cow - In herd Benchmarking

Figure 7. The "Bell Cow" a Holstein, Jersey, Montbeliarde cross.

It was tradition in parts of the European Alps for the best cow in the herd to get the biggest bell around her neck. French farmer Erwan Leroux from the Brittany region has taken the bell cow tradition and applied modern science. The Leroux operation is a very low cost system and in order to extract the maximum efficiency from the cows Erwan has developed a spreadsheet to calculate his most efficient cow at the end of each season. Mastitis, lameness, somatic cell count, inseminations required for pregnancy, cow live weight as well as production levels are added to the spreadsheet for each cow in the herd. The spreadsheet then calculates the potential profitability of the farm if the herd was made up of cows identical to each individual cow in the herd. The cow providing the most profit to the herd is awarded a cow bell and she wears the bell for the entirety of the following season as a constant reminder of where the profit is generated within the herd.

Calculations used to identify the bell cow within each dairy herd will vary from operation to operation but the concept of identifying the factors which are eroding profit remains constant.

Pasture Management

Best Management Practice

Pasture utilisation is a key profit driver on pasture based dairy farms in the higher rainfall regions of temperate Australia. Farms that perform in the top 10% of key economic indicators regularly have far higher pasture utilisation than less profitable operations. The perennial ryegrass pasture based diets of southern Australia have been integral to the competitive advantage that the region has had in the global market place. Australian dairy farmers producing milk for export markets, have historically been efficient low cost producers of milk.

Lincoln University in New Zealand and the DemoDairy project in western Victoria have demonstrated that by applying best management practices to pasture management the economic performance of the farm is significantly enhanced.

The pasture management system used at the Lincoln University dairy farm is the main reason the farm is in the top 1% of dairy farms for production and profitability in New Zealand. The Lincoln University dairy is producing over 40% more kgMS/ha than the average dairy in the Canterbury region. This success is primarily attributed to seven focus points for the farms pasture management.

Pasture management methods used at Lincoln are

- using industry best practice and proven science ie. limit nitrogen to 200kg/year
- walking the farm weekly to measure pastures & twice weekly in spring
- managing the ryegrass to keep it at the three leaf stage when it is maximizing growth
- keeping the grass at its highest energy level for the cows
- graphing the information from the pasture walk into a feed wedge
- minimizing supplement inputs
- focusing on keeping costs down

Many pasture managers in the UK and some in Brittany, France are using very similar rules to maintain pastures on their dairy farms. A key difference to the common dairy system in Australia is the level of supplement fed. The level of pasture measurement carried out on average Australian farms would be far less rigorous than on these high pasture performance farms. Regular and accurate total farm pasture cover measurements and detailed record keeping of farm cover, growth rates and pasture demand are often quoted as the key tools on farms gaining above district average pasture utilisation. These are simple techniques but often not carried out on many pasture based dairy farms in Australia. Does the average 1.4 tonnes of grain fed to cows in Southern Victoria mean we have a lesser need to monitor our pastures?

Filling the feed gap

The 'SuperProductivity' Demonstration Farmlet trials at Ruakura, Hamilton aimed to increase milk solids production per hectare by 17% to 1750 kg/MS/ha with all home grown feed. The results of the trial fell just short of the 17% target, the conclusion of the three year trial highlights the challenges faced by dairy farm managers in high rainfall non-irrigated areas.

'SuperProductivity' project manager, Chris Glassey recognises that the greatest challenge is to manage fodder yield between years in a variable rain fed environment (Glassey, 2009). The feed deficit faced by this trial from January to May is similar in timing to feed deficits faced by many non-irrigated rain fed temperate Australian farms.

Though the total budgeted energy requirement was grown on farm to meet the production targets, the milk solids targets were not met because the "energy yield was reduced by ensiling and storage losses of crops" (Glassey, 2009). This highlights an efficiency in direct grazing systems. Chicory was successfully used in the later part of this trial to assist filling the late summer autumn feed gap with yields of 16.8 t DM/ha and 40% increase over turnip yields.

Business Strategy

Business management is a major aspect of managing the resilience of an operation. Traditional business risk management must be seen as a component of resilience management. Business management decisions are greatly impacted on by local legislation, local markets, and the individual production system, therefore business strategies are not covered in detail in this report.

Dairy industry structure and markets vary significantly throughout the world. The common themes expressed by dairy farm managers when asked how they plan to manage market volatility into the future was equity management and cost reduction. There is a desire to operate at higher equity levels during periods of volatility in farm gate milk price. Many pasture based farmers expressed a strong commitment to reducing cost structures in contrast the TMR (total mixed ration)/housed operations I visited had a greater focus on increasing production.

Future Pressures

Managing GHG emissions – Carbon policy

Agriculture accounts for about 17% of Australia's greenhouse gas emissions. The dairy industry accounts for 10% of agricultural emissions, or less than 2% of total national emissions (Christie, 2008). Current research suggest pasture based dairy farms could reduce GHG emissions by 20-32% (Beukes, 2009) (Christie, 2008).

Beukes et al (2009) research on New Zealand pasture based dairy farms suggests the following GHG abatement strategies;

- Use of high genetic merit crossbred cows leading to low involuntary culling and still producing 430kg milk solids/yr.
- Improved pasture management to increase average pasture and silage quality by 1 MJ ME/kg Dry Matter.
- Reduced use of nitrogen from fertilisers and "best practice" application of nitrification inhibitors.

Australian research suggest the greatest reduction in GHG emissions/t MS will occur with the all-inclusive abatement strategy of increased herd weight, feed intakes and milk production while using feeding additives to reduce emissions and applying fertilisers coated with a nitrification inhibitor (Christie, 2008).

Greenhouse gas emissions may pose a challenge to the dairy industry but there is potential to reduce dairy farm GHG emissions. Breeding more efficient cows and improved pasture management appear to hold significant potential to reduce the dairy's GHG emissions. The efficiency of the cows and the diet they are fed may have more impact on a farm operations GHG emissions than whether the farming system eg. high input or organic. When GHG emissions are considered cow and pasture efficiency become critical drivers to all pasture based operations.

Unintended Outcomes

Communication

Throughout my Nuffield travels, communication became a common theme. A major component of resilience and systems thinking is defining the processes so they can be clearly defined and communicated. Many of the actions which could enhance the resilience of farms are not new but extension is a constant challenge for agriculture. If the dairy industry has entered a new phase of enhanced volatility the need for effective communication within the industry becomes increasingly important.

Two differing methods of communication stood out during my travels, discussion groups and social media. Discussion groups have been used in the dairy industry in Victoria for a long time but the value of this type of group interaction and peer based learning cannot be over looked.

Social media is the use of internet based technologies to interact with others; it is effectively internet based discussion groups. Social media covers formal internet based discussion groups such as Facebook, Twitter, Linkedin and UdderlyFantastic. It also covers less structured media such as blogs. With over 9 million Australians engaging on Facebook and 2.5 million on Twitter, the potential of social media to connect and inform like-minded people should not be ignored.

The potential for these new technologies agriculture are twofold.

- Firstly they provide an opportunity for farmers to communicate, interact, share and gather information. Distance and isolation can be barriers to communication in agriculture; social media can help to remove these barriers.
- Social media is also being used extensively in the USA to advocate the benefits of agriculture to consumers. It can provide an effective conduit between the producer and consumer.

Recommendations

Systems thinking

- A systems thinking approach needs to be encouraged at both farm level and service provider/policy level so that the complex interactions on farm are considered in all decision making.

Breeding

- Detailed in-herd benchmarking could assist in identifying what type of cows are generating profit on Australian dairy farms.

- Further research is required into the potential of crossbreeding in Australian dairy farming systems.

Pastures

- Methods to increase the adoption of best management practices of pasture management need to be developed.

Communication

- Discussion groups cannot be overlooked as important learning opportunities in the industry.

- Social media has potential to further connect and inform the Australian agricultural sector.

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Plain English Compendium Summary

Project Title:	Enhancing the Resilience of Dairy Farms in the high rainfall regions
Nuffield Australia Project No.:	1002
Scholar:	Graeme Nicoll
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Objectives	The objectives of this report are to demonstrate how systems thinking can assist the dairy farmers in the high rainfall temperate zones of Australia to manage their businesses more effectively.
Background	Pasture based dairy farming is reliant on many complex interactions and systems thinking has the potential to improve decision making on farm and within the wider industry. Cow efficiency and improved pasture utilisation have been identified as two methods of improving pasture based dairy operations.
Research	Research was undertaken in Australia, New Zealand, the Americas and Europe with visits to research and extension organisations, industry support and service providers as well as many on farm visits.
Outcomes	The promotion of a systems thinking approach could improve the understanding of complex systems and improve the communication about how agricultural systems operate. There are opportunities to improve both pasture management and cow efficiency on most high rainfall dairy operations in temperate Australia.
Implications	It is hoped that this report will encourage dairy farmers to look at their operation in new ways and endeavour to gain a greater understanding of the interactions within their farming system.
Publications	