INTENSIVE OFF PASTURE DAIRY FARMING: IS IT SUSTAINABLE

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Abstract

Dairying remains New Zealand's largest and most successful industry. A growing global population and higher rates of urbanisation have largely contributed to increased demand in milk globally. Current demand has driven the market and led to continued dairy development and conversion of land use to dairying within New Zealand. This intensification has placed significantly increased pressure on the use and subsequent deterioration of natural resources, particularly freshwater quality.

The challenge of economic prosperity verses environmental protection remains a contentious conflict. Ambitious targets set through Central Government to both double the value of agricultural exports along with significantly improve the impact of dairying on the environment has put the dairy industry further under the microscope. It is unlikely future production growth will be achieved through large scale land use change due to more stringent regulations. So the question remains, how does New Zealand's dairy industry remain globally relevant while decreasing its environmental impact?

One such consideration has been that of intensifying existing farm systems through the introduction of off pasture cow housing facilities. A much higher milk production is generally reflected through such systems as a result of introducing additional supplementary feed which is better utilized by the receiving stock. This report focuses on intensive off pasture dairy farming and whether this can be undertaken sustainably as a long term practice. Sustainability has been considered holistically as incorporating economic viability, environmental responsibility, social acceptance and cultural sensitivities.

Economically, a higher cost of production along with a higher capital investment to incorporate the required infrastructure has led to lower profit margins being achieved on farm, this is particularly evident during low pay-out seasons. The increase in debt to enable the development of off pasture housing also erodes the equity which farmers have in their land. The further lack of cost control on external supplementary feeds is also likely to push the prices upward as demand

for high quality supplements grows. These factors demonstrate how difficult it is to compete with the more efficient intensive farming systems operating within the Northern Hemisphere.

Environmentally, the concept of taking cows of pasture is well documented as a mitigation tool to reduce nitrogen leaching associated with direct deposition of urine to pasture. If off pasture systems were incorporated purely for environmental reasons and no subsequent intensification of the system was undertaken for economic purposes they would undoubtedly be environmentally accountable. However the trend of subsequent intensification which follows the development of animal housing make the practice questionable at best.

Socially, New Zealand farmers are historically skilled pasture managers and often these skills are not easily transferrable to the more complex off pasture systems. The current demographic and level of intellect within the dairying community would not support a large scale shift to more intensive dairy systems. Equally the nostalgic value that New Zealand society puts on pasture grazed cows compared to the widely misunderstood "factory farming" housing systems would also be a challenge for the industry if more farmers went this way.

Culturally, further understanding is yet required to formulate a comprehensive picture of the sensitivities associated with intensive farming. However the tension between commercial ambitions and environmental protection will likely be an ongoing conflict.

Based on these factors it has been concluded that intensive off pasture dairy farming is not sustainable if it was to be encouraged throughout the dairy industry. Stronger leadership to encourage further focus on per cow production rather than the historic per hectare production is required to achieve both the economic and environmental ambitions of New Zealand. Once this has been achieved more thought should be applied to how the dairy industry market their product globally. Additional value should be attainable on the basis of New Zealand's pasture based systems and the positives that consumers associate with a "clean green free range" product. It is time for New Zealand to cash in on its reliable export history and strong focus on customer relationships to establish market premiums for the uniqueness of this product which remains globally unparalleled.

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Introduction

Contextual Background

New Zealand's iconic landscapes have a rich heritage in regards to agriculture. This is particularly evident with relation to dairying where both evolution and innovation of the industry have allowed New Zealand to become the highest dairy export nation globally. Dairying exports continue to drive New Zealand's economy, the record breaking 2013/14 dairy farming season contributed one third of New Zealand's merchandise exports at a revenue of $17.6 billion, a staggering 46% of the total primary industry export market (DairyNZ, 2014a). With over 12,000 dairy herds nationally, milking 4.8 million cows on 1.7 million hectares more than 18.9 billion litres of milk was produced and processed by almost 40,000 people directly employed in the industry (NZIER, 2014).

Such has been the prosperity of New Zealand's dairy industry that rapid expansion has been experienced over the past two decades. A significant portion of this expansion has come from conversion of South Island sheep and beef farms primarily as water for land irrigation has become more widely available. Further conversion of often marginal forestry land through pine clearance has seen further expansion in parts of the North Island. While intensification of farm systems through improved animal and pasture genetics along with increased nitrogen fertiliser use and supplementary feeding has led to cow numbers increasing by 89% in the past 20 years (DairyNZ, 2014b).

The propensity to grow has been the result of globally identified mega trends from consumers. Growing populations and emerging markets have seen the likes of China and Southeast Asia become significant global players. While an increasing urbanisation movement and higher discretionary incomes along with a focus on the nutritional benefits of dairy has seen demand for a higher protein diet surge (ANZ Focus, 2012).

The intensification of New Zealand's dairy industry has placed significantly increased pressure on the use and subsequent deterioration of natural resources. Such has led to a largely negative and sometimes hostile perception of the rural community by their urban counterparts. Of specific

concern is the declining quality of freshwater resources, a concerning side effect given the role this resource also plays in our national identity. Fish and Game were particularly successful in launching the "Dirty Dairying" awareness campaign in 2001, something which has continuously plagued the industry through highlighting poor practice such as stock in waterways. This movement along with increased public scrutiny and declining national water quality trends has fundamentally been responsible for the renewed regulatory pressure on agriculture to minimise their environmental impact.

Study Rationale

Central Government along with the dairy industry continue to pursue growth in both the value and volume of milk products to protect New Zealand's strong export position to supply the growing global demand. This growth is an integral component to the New Zealand Government's Business Growth Agenda (BGA) and economic policy.

The Ministry for Primary Industries (MPI) recently unveiled ambitious targets within their 2030 Strategy to double the current value of New Zealand's primary industry exports by 2025(Ministry for Primary Industries, 2013). Doubling the value of primary industry products relates specifically to export earnings and as such is unlikely to directly correlate with doubling the volume of output. More emphasis is being placed on producing higher value products (e.g. paediatric nutritional formulas) rather than our historical focus on commodity products (e.g. whole milk powder) while also exploring new primary industry export markets and products. Although New Zealand's primary industries are broader than agriculture or dairying specifically, the significant influence dairy has on primary industries exports will mean it plays a significant role in MPI's strategy. Regardless of the intentions around increasing the value of agricultural exports it is inevitable that some of this additional value will be attributed to an increase in volume.

This is also reflected by Fonterra, the dairy industries biggest player, and their V3 strategy. The V3 strategy focuses on increasing the volume of milk production to protect market position, increasing the value of milk through high value products and increasing the velocity at which the strategy is executed (Fonterra, 2014).

At the same time Central Government are also embarking on the most significant reform to the Resource Management Act since its inception in 1991. This is by the way of the renewed National Policy Statement on Freshwater management (NPS-FM). The NPS-FM provides a National Framework that directs how councils are to go about setting objectives, policies and rules about fresh water in their regional plans. This collaborative process will involve community participation to determine what the acceptable water quality or quantity limits are for each regions varying water catchments. The overall objective is to encourage the sustainable management of land use and development to ensure that the quality of fresh water within a region is maintained or improved. Regional Councils are currently tasked with reviewing their regional policy statements and plans to ensure they meet the NPS-FM objectives (Ministry for the Environment, 2014).

Similarly the industry have also responded with the Sustainable Dairying: Water Accord (SD:WA) an updated version of its predecessor the Clean Streams Accord. The SD:WA is a voluntary commitment to New Zealand by the dairy sector which seeks to set industry bottom lines to enhance the overall performance of dairy farming and its effects on freshwater. The accord outlines a range of voluntary objectives (e.g. riparian management, effluent management, nutrient management, etc.) that must be met by farmers within a certain timeframe, all of which are to be implemented and reported on by the dairy processing companies (DELG, 2013).

The tensions between the two ambitious objectives of economic prosperity and environmental protection is a constant conflict. It is seemingly unlikely that the desired growth objectives will continue to come from large scale conversion of alternative land use given the current regulatory climate. As further environmental restrictions are making it more difficult to access additional land many farmers are looking at how they can produce more milk with less land. The dairy industry have therefore been tasked with examining farm production systems to explore how a less is more approach may be adopted, i.e. increasing milk production while reducing farming's environmental impact.

One such consideration has been that of intensifying existing farm systems through the introduction of off pasture cow housing facilities. A much higher milk production is generally reflected through such systems as a result of introducing additional supplementary feed which is better utilized by the receiving stock.

Objectives

The concept of intensification is born out of a drive to produce more from the same amount of land. Simply increasing the stocking density of cows per hectare has not been considered as part of this discussion due to the well documented environmental impact of urine patches on nitrogen leaching. Intensive dairy farming for the purpose of this report will therefore only look at the use of off pasture animal housing facilities and the increasing use of supplementary feed and stocking rate to produce more milk from the same amount of land.

Sustainability is often grossly misconstrued as relating purely to that of environmental protection. This is one component, but at a broader level sustainability must incorporate much more than that. Sustainability must be economically viable, environmentally responsible, socially acceptable and culturally sensitive. A significant amount of isolated research has already been undertaken with regard to these individual factors, particularly with reference to the economics and environment. However without considering these factors collectively it is difficult to accurately examine whether an activity can be maintained. With that, it is the objective of this report to consider intensive off pasture dairy farming holistically to determine if it is a sustainable practice long term.

Dairying and the Environment

Dairy farming has become a highly controversial practice in recent years due to its well documented environmental challenges. The issues are often prone to over-sensationalised reports by media and adversaries which largely focus on the negatives. This information tends to inform the opinions of the urban community who have largely alienated the rural sector. Regardless, it is generally accepted that significant environmental improvements will be required. This, along with deteriorating public perceptions will undeniably be the biggest obstacle which the dairy

industry will need to overcome to secure long term viability going forward. Although not specifically outlined in the above scope this section has intentionally been included to provide further context as to the wider scale of this subject rather than just in regards to intensive farming systems.

Of most significant concern has been the declining fresh water quality trends identified within many of New Zealand's streams, rivers and lakes. The primary concern surrounding water quality and agriculture relates to non-point source contamination from nutrients, sediments and pathogens.

In 2012 the Parliamentary Commissioner for the Environment completed a report on water quality in New Zealand in an attempt to understand the effects and more effectively communicate the complex science behind it. Although further science is required to fully understand the cause and effect relationship of contaminants and water quality most agree that nutrients by way of nitrogen and phosphorus are largely responsible for deteriorating water quality. For that purpose this report from an environmental perspective will focus primarily on these.

What is currently known and widely accepted is that these nutrients enter either groundwater through leaching or surface water following overland runoff and eventually find their way to freshwater bodies such as streams, rivers and lakes. Once there these nutrients play a similar role in assisting growth of vegetation as is intended when applied to land (PCE, 2012).

The most common and widespread impact of nutrient pollution in freshwater is the excessive growth of unwanted plants. The process of eutrophication lending to nutrient enrichment of water bodies results in further growth of plants. Of most prominence in recent years has been the emergence of summer algal blooms. These occur when phytoplankton rapidly multiply as a result of excessive nutrients. The floating plants are a significant visual pollutant while also affecting contact recreation (swimming and boating) and fishing, both of which form a significant psyche of the kiwi summer culture. Toxic blooms have also been more frequent by way of cyanobacteria, or blue-green algal blooms and have been responsible for the death of

animals such as dogs. In essence these plants grow extremely fast in response to additional nutrients while also absorbing a significant amount of oxygen from the water to the point that it can suffocate and destroy other aquatic habitat. The loss of oxygen from the water column also causes anoxia which can ultimately decimate fish populations (Dodds, 2007 & PCE, 2012).

Although not widespread there have been some nationally significant lakes which have experienced such degradation and brought these issues into the spotlight through mainstream media. One such example is Lake Rotorua which had been prone to frequent summer algal blooms resulting from excessive nutrient contamination (Hamilton 2005a & Hamilton 2005b). Although currently improving significant nutrient restrictions are being developed through regulation in an attempt to reduce the total nitrogen entering the lake by 420 tonnes by 2032 (Rotorua Te Arawa Lakes Programme, 2014).

Another significant impact of nutrient enrichment on fresh water quality is nitrate and ammonia toxicity. Both relate specifically to excessive nitrogen contamination and can result in harmful and possibly fatal effects on humans, animals and aquatic wildlife (PCE, 2012).

A further Parliamentary Commissioner's report completed in 2013 further elaborated on water quality in New Zealand looking specifically at the impact of land use and consequent nutrient pollution. This honest and influential assessment links intensification of land use change, of which dairying has been the most significant contributor, and the increasing trends of nutrient contamination. Both land use change and nutrient loads in water have been nationally modelled and the results depict a grim reality.

Surprising this report is not all doom and gloom, it has a refreshingly optimistic undertone which seeks to offer solutions rather than focus significantly on the problem. Although not squarely placing the responsibility on any one land use or generation the report does unfortunately suggest that without significantly more intervention a continuation of deterioration in water quality will undoubtedly occur. Dr Jan Wright (Parliamentary Commissioner for the Environment) rightfully pays homage to the considerable mitigation efforts which the farming fraternity has invested heavily in, while indicating that more still must be collectively done (PCE, 2013).

While the impact of nutrients on water bodies can vary, it is clear that if nutrient loads increase significantly, so too does the pressure on water quality.

Intensive Farming and Sustainability

Economically Viable?

Historically speaking New Zealand's dairy industries global competitive advantage has been a result of our low cost pasture production system. New Zealand's temperate climate derived from our geographic location, coupled with fertile soils and good contours ensures an advantageous pasture growing and grazing environment. Traditionally, stocking rates have reflected grass grown in terms of kgDM/ha and the subsequent cost of production from milk harvested has been low. As stocking rates have slowly increased a growing reliance on imported supplementary feeds such as palm kernel has slowly eroded this low cost competitive advantage (Moynihan, 2012).

While our geographic location is one of our strengths our isolation is also a significant weakness. Higher costs associated with complex global distribution networks often mean crude export profits are reduced due to products travelling significant distances to reach the market place. With higher transport costs it is therefore imperative that cost of production is lower than that of the competitors.

With the shift in dairy production methods DairyNZ have developed a systems 1-5 classification reflecting the proportion of the cow's diet which is made up of supplementary feed inputs. This ranges from the less intensive system 1 farm where all stock are self-contained and fed only grass to the highly intensive system 5 farm where imported feeds are used year round and may equate to more than 50% of the cows diet. Recent high pay-out seasons and continual drive for greater production have seen more farmer's transition to more intensive high cost systems. Since the year 2000 farmers importing more than 25% of their cows' diet has increased from 13% to 28% (Bell, 2014).

High cost production systems can be profitable in high pay-out seasons where the cost of additional feed to meet increased production objectives is less than the monetary value received from the additional volume produced. High input systems profit margins do not however fear so well in low pay-out years when the cost of production remains high while the return on investment is severely diminished. David McCall, DairyNZ's General Manager for Research and Development has suggested the break even milk price for these systems is likely to be over $5.00 kg/MS, so once again in a high pay-out year a higher production would increase the return but for low pay-out year's low cost production systems would remain the most economically resilient (McCall, 2014a).

A large portion of supplementary feed inputs are imported into New Zealand which immediately puts us at a disadvantage to our competitors in the US and Europe. One of the major weaknesses of New Zealand's high input dairy systems is that there is little ability to control the cost of external supplementary feeding. Such systems are very sensitive to supplementary feed costs, an increase in these costs can rapidly push the system into a negative profitability situation (Journeaux, P., 2013). The basic theory of supply and demand will undoubtedly dictate a higher price for supplements as demand increases if more farmers choose this route going forward.

Many dairy commentators are suggesting we cannot beat the Northern Hemisphere at their own game. High input systems in US and Europe have greater accessibility to low cost corn, grain and cereals due to efficiencies in production and the size and scale of this commodity market. Their competiveness is that they are becoming exceedingly proficient across the board which continues to drive the cost of production lower. Their ability to instantaneously tweak systems in response to a high global milk price allows them to quickly expand their volume of milk produced and flood the market. With a renewed focus on exporting milk powder and targeting some of the same higher value markets as New Zealand, this has been a significant factor in price volatility which has so frequently plagued the milk pay-out in recent years (Lee, 2014, Kloeten, 2014 & McCall, 2014b). Table 1 below demonstrates a comparison of several costs associated with intensification in which it is undeniably clear that New Zealand cannot expect to be cost competitive in this system.

Table 1: Comparison of operation costs of dairy farming confinement systems in New Zealand and the US

	US	NZ
Feed costs ($/kgDM)		
Corn silage	0.16-0.25	0.35-0.40
Lucerne hay/grass silage	0.3-0.4	0.3-0.5
Grain	0.24-0.38	0.45-0.55
Pasture		0.09
Labour cost ($/hour)	$8-$10	$14-$30
Confinement infrastructure cost ($/cow)	$1100-$1500	$2500-$3000

Source: DairyNZ, 2014c "USA: we can beat them, but not at their own game", Inside Dairy: Your levy in action, DairyNZ, Hamilton.

While increased supplementary feeding generally defines the system 5 farms it is the infrastructural housing requirements which enables it. This depreciating asset is the most significant capital cost of intensification. The cost of incorporating animal housing can vary from $1500-$3000 per cow (Journeaux, 2013), a significant investment given these systems are often highly stocked. The additional cost of production associated with intensive systems can also be attributed to increased costs such as increased labour, machinery, animal health and higher energy consumptive use (De Klein & Ledgard, 2001). Although operating profits are higher, the high farm working expenses mean the cash surplus is small in comparison to low input systems.

High profits do reflect a higher return on assets, however as farms have intensified so too has the level of debt associated with expansion. DairyNZ's 2012/13 economic survey outlines high input systems as having the highest debt to asset ratio at an average of 48.4% (DairyNZ, 2014b). Focus on chasing higher production rather than profit has consequently been pursued to service this debt which further hinders the level of equity farmers have within their business.

A decline in the cash operating surplus as a result of servicing higher debt levels is often a symptom associated with intensification. An economic analysis of intensifying farm systems through the construction of animal houses to enable off pasture grazing and a reduction in nitrogen lost was recently undertaken within Horizons region as a response the impending nutrient limits set under the One Plan. The study found that the proportion of dairy farmers unable to meet farm working expenses, drawings and interest payments would increase from 12% to 32% (DairyNZ, 2013).

Fortunately it is not all bad as there are some financial benefits associated with intensive farming systems. Ensuring stock are off pasture when heavily saturated reduces soil compaction and potential pugging damage which can enable increased pasture production. The utilisation of supplementary feed is much higher as less high quality feed is treaded into the ground. This ensures more of the allocated feed is ingested by the stock which improves condition and subsequently higher per cow production. The length of the lactation season can be expanded through additional supplementary feed which can increase profits in drought affected years when others are forced to dry off early. There are offset costs with cows able to be wintered on-farm rather than securing additional off-farm grazing which is becoming increasingly difficult to source.

And finally, the most significant and well documented positive financial contributions of such systems relates to the ability to recycle captured nutrients. All effluent from animal housing facilities must be adequately contained and managed, this generally lends to having large effluent holding ponds. This allows the redistribution of nutrients to land when the soils can absorb, at the required application rates to be utilised for optimum growth. In most cases if managed appropriately this will lead to significant reductions in the capital costs of imported synthetic fertilisers (Christensen, 2013, Journeaux, 2013).

If exceptionally managed, the financial benefits of off pasture systems may be able to outweigh the negatives. However it takes a vastly skilled person to manage these complex systems and it is generally accepted that the majority of the current farming demographic are not geared up to make the transition. And once again if a significant shift in production systems was to occur it is

expected that the price of supplementary feed will become increasingly difficult to source due to availability and cost.

Environmentally Responsible?

The Parliamentary Commissioner for the Environment's 2004 report "Growing for good: Intensive farming, sustainability and New Zealand's environment" defines sustainability from an environmental perspective as "maintaining and enhancing natural capital and the services it provides" and "not destroying the life supporting capabilities that current and future generations depend on". This is entirely accurate of the current dilemma facing the dairy industry, the consuming conflict of economic prosperity today verses environmental protection long term.

As has largely been the focus of this report intense environmental scrutiny has led to increasing pressure being placed on existing dairy systems. In recent years significant focus and research has been placed on off pasture dairy systems as a potential solution to the environmental degradation. Nitrogen is a soluble nutrient and as such cannot be held within the soil profile, what is not used for plant growth is therefore rapidly leached through sub surface drainage to groundwater. A cow urine patch can have up to 800-1000 kg's of nitrogen, soils ability to utilise these concentrations are limited to a likely maximum of 50-100kg's of nitrogen dependant on soil and climatic conditions at any one time (Di & Cameron, 2002 & Di & Cameron 2007). Although condensed to one spot these heavy concentrations are responsible for a significant amount of nitrogen leaching at a farm scale, especially on heavily stocked farms.

Having the ability to take cows off pasture and consequently capture their urine therefore has significant environmental benefits, this is particularly evident during periods of substantial drainage in late autumn, winter and spring. Not only does this significantly reduce the direct deposition of nitrogen through urine but it also allows the nutrients to be evenly re-distributed at times and rates which allow the soils to fully absorb and utilise the nitrogen and other essential nutrients for pasture growth (de Klein, 2001, de Klein & Ledgard, 2001, MacDonald *et al.*, 2014).

A newly constructed freestall barn at Massey University has allowed scientific trials to measure the environmental impact of such infrastructure under numerous grazing regimes. Trials undertaken via Christine Christensen's Doctor of Philosophy in Soil Science, demonstrated a 42% reduction in nitrogen leached under a duration controlled grazing regime. Duration controlled grazing is a practice whereby cows are grazed on pasture daily but removed after a certain period, generally no more than 4 hours, and taken to the freestall barn to ruminate and rest. This period is when the majority of excreta is produced following rumination (Draganova *et al.*, 2010). Although this practice doesn't directly demonstrate an intensive off pasture system due to the lack of supplementary feeding it does provide a controlled scientifically accurate interpretation of the nitrogen leaching reductions which can be achieved in a New Zealand setting. Several other studies have demonstrated similar nitrogen leaching losses of between 35-50%, with increased losses associated with higher supplementary feed inputs (de Klein & Ledgard, 2001 & Journeaux, P., 2013).

These studies have focused primarily on off pasture systems for "environmental" purposes and not necessarily the intensification in stocking rates and feeding regimes which generally follow the incorporation of such infrastructure for "economic" purposes. The significant capital investment required to fund the development of animal housing, even if incorporated for "environmental" reasons generally dictates that higher levels of production are required to service the often significant debt farmers have taken on to build. Further economic analysis of one such systems in Horizons identified that as an environmental mitigation tool animal housing may be problematic, especially in a low pay-out year. The level of intensification required to make the system economically viable was measured as a 17% increase in cow numbers and a 71% increase in milk solids production. Even with a uniform redistribution of nutrients back to pasture there is still a significant increase in nutrients cycling through the system and in regards to nitrogen leaching no significant improvements. Essentially a better environmental outcome can absolutely be achieved if the housing in incorporated at no further cows/production, but the higher the intensification the higher the losses (Journeaux, 2013).

As well as the potential to reduce nitrogen losses, off pasture dairy systems also have significant benefits in reducing losses of phosphorus. Phosphorus content of excreta is particularly high and

additionally binds strongly to soil particles, the main pathway of loss to waterways is therefore through surface runoff of particulate soil material and excreta (McDowell *et al.*, 2008). High soil moisture on dairy farms in winter and spring often leads to soil compaction and treading damage from stock, following frequent rainfall events the subsequent loss of phosphorus and sediments through runoff is heightened (Smith & Monaghan, 2003).

As dairying has intensified greater competition for productive land has led to stock being wintered on more marginal land. A large portion of resultant dairy support land currently used for winter grazing purposes is steeper and more prone to erosion following rainfall events and compaction damage from stock. However of greater concern is the predominant trend of intensively stocked strip grazed winter fodder crops which are now common practice around New Zealand. The recently cultivated soils are much less cohesive and more susceptible to phosphorus runoff.

In the same study mentioned above, Christensen also identified a 32% decrease in phosphorus loss as a result of taking stock off pasture, particularly during critical times during winter (Christensen, 2013).

Through minimising compaction damage in winter and overgrazing in summer off pasture systems can further preserve the quality and quantity of pasture grown. Treading damage has been demonstrated to reduce pasture growth rates by as much as 30-50% (Horne & Singleton, 1997). While additional studies have shown that by removing cows from pasture at key times an increase of 0.5-2 tonnes of dry matter production per hectare could be produced annually. The benefits of additional pasture grown can reduce undersowing for pasture renewal by 90% (MacDonald, *et al.*, 2014). Off pasture grazing therefore also protects the soils ability grow more grass which can lead to subsequent production gains.

Along with the diffuse loss of nutrients winter and spring pasture grazing can also lead to pathogen contamination of water bodies. Similarly to phosphorus runoff faecal microbial organisms are also accelerated with surface runoff transporting excreta material. This can also be hazardous to human health (Muirhead *et al.*, 2005).

As in most cases there are unvaryingly negatives associated. Although the uniform distribution of collected nitrogen back to land can have significant pasture growth benefits the storing of nitrogen for long periods will lead to an increase in nitrogen being lost to the atmosphere as ammonia. Research suggests that as much as 50% of nitrogen may be lost if stored over a 9 month period (Longhurst, *et al.*, 2006).

Socially Acceptable?

When determining social acceptance both internal and external social perceptions must be taken into consideration. The internal perspective has loosely been framed as the farming fraternity itself. A staunch collective who have historically farmed a pasture based system, are they ready or do they accept such fundamental change? Externally, socially perceptions incorporate a much broader cross section which includes customers, consumers and most importantly the public of New Zealand.

New Zealand dairy farmers are renowned for their ability to innovate, think the first refrigeration unit which allowed export of butter and cheese to be undertaken, or the setting up the global dairy trade which has now become a leading price reference indicator globally. Where there is an obstacle the New Zealand dairy industry will generally find a way to overcome it, the question is is intensive off pasture dairy farming the way to go?

DairyNZ models farmer's profitability for each of the 1-5 dairy systems through DairyBase and presents this information annually through the DairyNZ Economic Survey. What is consistently demonstrated is that farmers can operate very effectively in each dairy system from a profitability perspective. Generally the top percentile of farmers in regards to profitability are represented right through the 1-5 systems, which demonstrates that all systems have the ability to be operated profitably (DairyNZ, 2014b). What the survey doesn't fully demonstrate is the different skillsets that are required to manage each of the systems, i.e. system 1 farmers must be top pasture managers whereas system 5 farmers need superior stock and labour management skills.

The demographic and education profile of dairy farmers is undoubtedly improving, particularly in the recently developed progressive dairying areas of Canterbury and Southland. Better utilisation of innovative technology and advancements in farm management techniques have assisted the industry to achieve its world best status (Dillon *et al.*, 2014). A small group of early adopters have demonstrated that intensive system changes can be successfully implemented. However, at a broader scale this evolution has not yet progressed as far as complete system changes, rather continuing to focus on how to operate existing systems more efficiently.

When analysing the historical dairy strongholds of Northland, Waikato and Taranaki who very much still operate traditional cows and grass farming systems, it is difficult to see the paradigm shift that would be required to so drastically change current practices. The level of complexity and intellectual capacity associated with managing multifaceted off pasture dairy systems is not suited to everyone, especially not the current aging dairy population which would require a significant shift in mentality. Further emphasis would need to be placed on extension programmes from within the industry to assist farmers in developing the specialised skillset required to operate such systems effectively (Journeaux, 2013).

Although many traditional farmers have increased stocking rates and subsequent production most have done so without incorporating any additional off pasture infrastructure. The focus for much of the aging farming community is currently centred on reducing mortgages as many start to consider a life after farming. A reluctance to increase current debt levels to meet the capital requirements of off pasture system housing is therefore common (Journeaux, 2013).

The social sustainability indicator in evaluating the quality of life for the farming community has often been identified as work life balance. An attraction of the traditional system 1 cows and grass farming system has always been the work life balance which can be achieved. Increasing the labour requirement and associated micro-management will slowly erode this lifestyle and may provide difficulties in attracting and further recruiting young people into the dairy industry (Dillon *et al.*, 2014).

Externally, the dairy industry's customers are wanting more from their products, consumers are wanting a greater level of transparency and most importantly communities have a much stronger voice in regards to how natural resources are used.

Perception is reality and what is termed a social licence to operate is becoming the new norm. If communities regard the environmental damage from farming as unacceptable farmers are likely to lose their licence to operate in society. Further emphasis is consequently being placed on community consultation under the new regulations being implemented through the National Policy Statement on Freshwater Management (Ministry for the Environment, 2014). Public perception will play a significant role in the industry's ability to grow, figure 1 below demonstrates a significant portion of New Zealand perceive dairying as having an environmental impact (Moynihan, 2012).

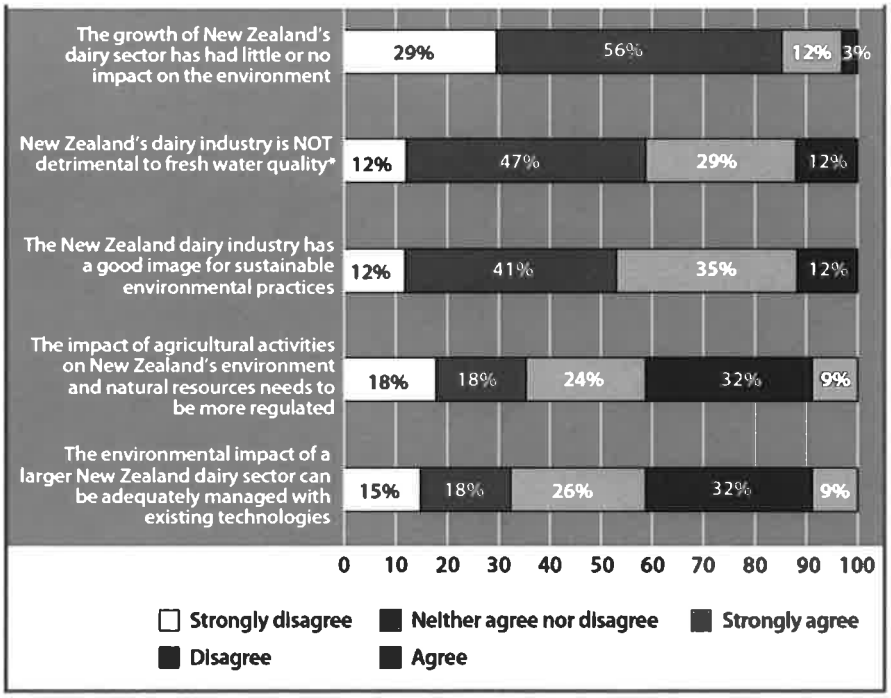

Figure 1: Perceived environmental impacts from a larger New Zealand dairy sector 2011
Source: Moynihan, H., 2012, "Rabobank global focus: NZ Dairy – from a torrent to a trickle"

On that basis communities are likely to support such measures which will reduce dairyings environmental impact, or will they? Along with environmental expectations there also significant

pressures on the dairy industry to ensure animal welfare measures are a key consideration to the dairying operation. Awareness of the controversial treatment of primary production animals has been frequently publicised within New Zealand media in recent years. Animal welfare lobbyist groups such as SAFE have successfully campaigned for the abolition of pig gestation stalls on the basis of animal cruelty (NZ Herald, 2010), this has also had significant damage on NZ Pork's reputation and hindered the public's willingness to buy pork on the basis of how it was produced. Similarly is the frequently debated topic of inducing dairy cows, historically this has been undertaken to ensure a tight calving pattern can be achieved and that cows can be artificially inseminated for the following season. After mounting public pressure this practice is also being phased out with the expectation that no dairy cows are artificially induced from the 1 June 2015 (DairyNZ, 2013d).

The New Zealand Animal Welfare Act (1999) recognises the internationally renowned and accepted five freedoms which must be afforded to any animal in captivity. The five freedoms include:

1. Proper and sufficient food and water
2. Adequate shelter
3. The opportunity to display normal patterns of behaviour
4. Physical handling in a way which minimises the likelihood of unnecessary pain or distress
5. Protection from, and rapid diagnosis of, any significant injury or disease

All of these freedoms are readily achievable with respect to off pasture grazing systems, however perceptions don't always reflect the truth. The perception from New Zealand society is that confining animals doesn't provide the opportunity to display normal patterns of behaviour. In poorly managed systems there may be some truth to that argument but generally stock are still given ample opportunity for exercise and pasture grazing when conditions suit. Interestingly, New Zealand perceive this practice as factory farming, whereas our Northern Hemisphere competitors often criticise the lack of adequate shelter offered as barbaric (Jack, 2009). Here at home public perceptions continue to reflect an idealised existence for farmed animals (Webster,

2000). The stoic notion that cows should continue to graze a wide expanse of pasture covered paddocks in a free range setting is entrenched into their psyche.

In 2009 several companies attempted to get consent to house 18,000 cows on 8,555 hectares of the pristine Mackenzie basin. The controversial concept proposed housing the cows in cubicle freestall barns 24 hours a day from March to October and for 12 hours per day for the remainder of the year. A staggering 1.1 million litres of effluent would have had to have been redistributed to land daily. As expected the New Zealand public vigorously opposed this concept and as political pressure mounted the application was eventually squashed in the High Court when challenged by the Environmental Defence Society (Forest and Bird, n.d. & Mackenzie Guardians, 2010). This recent emotive display largely depicts the current feelings towards such intensive off pasture systems in New Zealand, particularly at a large scale.

This attitude towards animal housing may change in coming years, as wintering practices continue to display images of stock up to their knees in mud it is likely that further emphasis will be placed on the ability to periodically remove stock from pastures. The provision of shelter is significantly advantageous in terms of growth, production, reproduction and disease minimisation (Fisher, 2007 & Pow, et al., 2014). Intensive off pasture grazing systems are particularly susceptible to animal health concerns such as mastitis and feet problems associated with time spent on concrete (Verkerk, 2011). These components need to be managed closely in such systems to avoid further scrutiny, as history has so frequently demonstrated it only takes one or two poor performers to drag an industry down.

Similarly to the New Zealand public, global customers and consumers are also demanding more from their milk products. As affluence improves in high value markets there is a greater desire by customers to know where their milk came from and how it was produced. Historically New Zealand's "clean green" reputation, competitive pricing and outstanding food safety record have afforded entrance to these high value markets. The perceived market premiums for these components are in reality now a minimum expectation for maintaining market access. However, our global point of difference and that which remains our competitive advantage is the association of New Zealand milk products with our unique free range pastoral grazing systems.

Any significant shift from this will erode such distinctiveness and the positives that consumers associated with it (Jack, 2009 & Kloeten, 2014).

With increased transparency from grass to glass through improved food traceability, testing and accountability customers are much more aware of where there food is coming from. A recent study on consumer attitudes and willingness to pay for attributes of New Zealand foods was undertaken in the UK, China and India. Among all countries food safety was rated the most important food attribute. Not surprisingly following recent food safety scares China was willing to pay more for food safety certification, this is particularly evident within infant nutrition market (Saunders, et al., 2013). The global shockwave which spread following Fonterra's botulism scare last year further emphasises the importance of this attribute. In conjunction to food safety animal welfare is now also a component in which additional market access is achieved. In an increasingly urbanized global marketplace customers are more distant from rural communities, consumers expect high quality products from an environmentally and animal friendly agricultural industry (Clark *et al.*, 2007 & Latvala *et al.*, 2013).

Culturally Sensitive?

The cultural sensitivities of intensifying dairying has not yet been subject to significant research, however an ethical struggle is clearly developing. The Parliamentary Commissioner for the Environment's 2004 "Growing for Good" report referred to cultural capital as the "values, histories, traditions and practices that link a specific group of people together". Maori have historically held a deep spiritual bond to the land, Papatuanuku, the Earth Mother, who is considered to sustain all life is who Maori connect. In recent years and particularly since the formation of the RMA Maori have played an increasingly active role in environmental resource management. Traditionally, Maori believe in a strong affinity between themselves and the natural world. This connection is expressed through Kaitiakitanga, a way of managing and conserving the environment through exercising guardianship. Today there is growing interest in Kaitiakitanga as tribes rebuild their association with the environment and their culture. Maori regard land, water and soil as taonga or treasures, and consider themselves to be guardians of these taonga which provides a source of unity and identity for tangata whenua (PCE, 1998 & Waikato Regional Council, n.d.).

On that basis it would be safe to assume that Maori would fundamentally opposed any intensification in regards to the additional pressure this places on resources. However, the underlying ethical struggle relates to the significant commercial interests of many of these tribes and the increasing investment into primary production. Although significant underlying values of environmental stewardship remain there is also the desire to growth the wealth of iwi to support the greater tribe and community. Ngai Tahu in particular have significant economic ambitions to grow their agricultural investments, with a proposed $600 million project to convert forestry land to dairy their aim is to establish $1.5 billion in agricultural assets in the next 15 years.

This specific forestry block is located within a particularly sensitive catchment within Canterbury where strict nitrogen limits are already being proposed due to currently unsustainable loads. Currently Ngai Tahu have only been granted a nitrogen leaching allowance of 6.6kg per hectare per year due to the receiving environments inability to naturally process further additions. This figure is currently the subject of an appeal as such levels are unobtainable under current dairying practices (Robinson, 2014 & Wood, 2014). One slight possibility could be housing cows off pasture fulltime to reduce the impact of nitrogen leaching from urine deposition. Appealing this limit must certainly raise the questions of where Ngai Tahu's current motives lie. The conflict of economic prosperity for their tribe will undoubtedly challenge the ethos of environmental guardianship. Although the two are not necessarily mutually exclusive, the significant financial investment that would be required to enable the desired environmental outcomes is likely to test the moral compass.

Discussion

Intensive dairy farming is a contentious subject, so many conflicts arise when considered under the holistic concept of sustainability. Evidence suggests these systems may be environmentally responsible however are they socially acceptable when traditional ideals of pastoral based farming systems are so entrenched into our society? Are they culturally sensitive in considering the values that Maori place on natural resources and protecting these taonga? And most importantly are they economically viable long term for both the farming community and New

Zealand? The challenge remains, how does the dairy industry balance the short term economic benefits to New Zealand with the long term damage to natural capital and the associated costs to society?

The most significant component to consider regarding sustainability from the farmer's perspective is economic viability, if an activity is not profitable it will not sustain the test of time. It is a credit to the dairy industry and the fluidity it has demonstrated over time to continually evolve and remain a profitable practice. But by continually chasing high production systems to satisfy the demand from the industry and market do we further place the individual farmer in a precarious financial position? There are clearly opportunities during high pay-out years for healthy profit returns for more intensive farms, this was demonstrated in the 2013/14 farming season, but is it economically sustainable in the long term when the industry has gone from a record high to an almost record low?

There are plenty of conflicting reports surrounding the value of milk going forward. The milk processors would have their suppliers believe that the growing demand for high quality milk will reflect in a greater monetary value being returned for their products. On the same hand economists are predicting the demand for dairy commodities such as whole milk powder to be flat over the next 10 years. This doesn't bode well for a processing industry heavily geared with expensive stainless steel factories predominantly producing milk powders. One thing is for sure, the current market is unpredictable as has so frequently been reflected this during the last 10 years (ANZ Focus, 2012 & Moynihan, 2012).

Integrating the required infrastructure when intensifying systems comes with a significant capital investment, and once incorporated these systems have very little flexibility to change during periods of low international dairy prices. More often than not this capital is invested through increased debt levels, servicing this debt is usually undertaken via chasing the perceived higher value of higher production regardless of the cost of that production (Journeaux, 2013).

As earlier discussed, price volatility and the ability of northern hemisphere competitors to ramp up production to supply the previously untouched export market has put New Zealand dairy

farms and our historically low cost competitive advantage under the microscope. Evidence suggests we cannot compete in a costly high input high production system as additional supplementary feed is neither readily or financially available (Lee, 2014, Kloeten, 2014 & McCall, 2014b). Those farmers who have successfully transitioned into profitable intensive off pasture systems generally have support blocks where a large portion of the supplementary feed is cut and carried back to the milking platform to be feed under the associated controlled conditions. This select group still have the ability to control the cost of feed inputs as their prices aren't necessarily influenced by external factors. Growing maize and similar pasture substitutes within the wider farm system allows price control and financial stability. However not all farmers have this luxury, Palm Kernel Expeller, the primary imported supplementary feed has steadily been increasing in price as demand continues to rise, the five year average for palm kernel has been approximately $270 per tonne up from its lowest recorded price of $160 per tonne (Fox, 2014). In the 2013/14 farming season a total of 950 million kg's of palm kernel was imported (Hutching, 2014), if demand continues to rise as producers chase high production this will likely force the price up and the associated cost of production higher, is this trend economically viable long term? Unlikely.

The concept of taking cows of pasture is well documented as a mitigation tool to reduce nitrogen leaching associated with direct deposition of urine to pasture. If off pasture systems were incorporated purely for environmental reasons and no subsequent intensification of the system was undertaken for economic purposes they would undoubtedly be environmentally accountable (de Klein, 2001, de Klein & Ledgard, 2001, Di & Cameron, 2002, Di & Cameron 2007, Christensen, 2013 & MacDonald *et al.*, 2014). However the trend of subsequent intensification which follows the development of animal housing make the practice questionable at best. Yes, there are other significant environmental benefits associated in regards to phosphorus, soils and pasture management but the primary regulatory focus at a national perspective remains squarely on reducing the nitrogen load entering water.

New Zealand farmers are historically skilled pasture managers and often these skills are not easily transferrable to the more complex off pasture systems. The current demographic and level of intellect within the dairying community would not support a large scale shift to more intensive

dairy systems. Equally the nostalgic value that New Zealand society puts on pasture grazed cows compared to the widely misunderstood "factory farming" housing systems would also be a challenge for the industry if more farmers went this way. This was seen with the public uproar which shadowed the concept of large scale intensive farming within the Mackenzie Basin.

More understanding is yet required to formulate a comprehensive picture of the cultural sensitivities associated with intensive farming. However the tension between commercial ambitions and environmental protection will be an ongoing conflict.

Conclusion

The dairy industries biggest challenge will undoubtedly be remaining profitable while changing practices to reflects better environmental outcomes. Significant tensions between New Zealand's ambition to grow and the ecosystems ability to support this growth will be a source of ongoing conflict. Ultimately New Zealand will be forced to address the dilemma of environmental protection verses economic prosperity.

So in relation to the question, is intensive off pasture dairy farming sustainable? Unlikely. The economic viability of this practice is questionable especially in a low pay out year where the cost of production leaves little margin for profit. If systems are not economically viable long term the function of sustainability is lost and the subsequent quality of life filtering right throughout both urban and rural society will lead to greater division of socio-economic class. Environmentally the concept of taking cows off pasture is sound however further intensification is likely to remove any of the environmentally associated headroom that is created. Increasingly negative public perceptions and a seemingly likely social license to operate may restrict such levels of intensification while the majority of the current farming community are not geared up to transition to such a production shift. Cultural tensions will undoubtedly question the moral compass of Maori values attributed to environmental guardianship as ambitious commercial targets become entrenched into Iwi owned farming ventures.

Leonie Guiney, winner of the "Best Low-Input System" award in the 2014 Dairy Business of the Year Award put it best in a recent Dairy Exporter article, "On farm we are galloping toward playing the intensive, housed supplementary feed dependent farming game instead of our own game of seasonal pasture utilisation, at which were excellent, its nonsensical logic, we have overstocked farms in the business of converting imported feed into milk rather than pasture into profit" (Lee, 2014).

So herein lies the problem, if the future of New Zealand's dairy industry doesn't lie in intensive farm systems where do we go from here to achieve our ambitious economic and environment targets? Stronger leadership is needed from the dairy industry with a continued focus on profit rather than production to support our current farmer's future success. A more progressive direction which is beginning to gain traction within the industry is the position of less cows feed better and an increased focus on per cow production rather than the historic per hectare production. Through focusing on profit on farm rather than production many of the environmental ambitions will likely be achieved through association. Once we can fully address environmental concerns more thought should be applied to how we market our product globally. New Zealand's milk powder remains a commodity traded product even though many believe it is not, additional value should be attainable on the basis of New Zealand's pasture based systems and the positives that consumers associate with a "clean green free range" product. Market premiums should be sought for the uniqueness of this product which remains globally unparalleled. It is time for New Zealand to cash is on our reliable export history and strong focus on customer relationships to realise the future value that should be attributed to our dairy products. Achieving this will ensure New Zealand's dairy industry remains holistically sustainable.

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