Synergies between arable and dairy
– with a focus on effluent and nutrients

Steve Wilkins 2013 New Zealand Nuffield Scholar

A report for the New Zealand Nuffield Farming Scholarship Trust

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Executive Summary

Farming in New Zealand has changed dramatically in the last two decades with 283,700 hectares of land being converted to dairy between 1996 and 2008 (Land Use and Farming Intensity Report, 2013).

The New Zealand dairy system is unique in the respect that it is grass based with supplements and rations making up less than 25% of the diet, unlike other dairy systems throughout the world with comparable production figures, where the cattle are housed for at least a portion of the year and are fed a total mixed ration (TMR).

Milk production both per cow and per hectare, is also increasing (See Figure) and has resulted in demand for supplementary feeds grown outside the dairy farm gate. Much of this feed is sourced from the arable industry, whether that is from the supply of grains or from the production of winter forage crops.

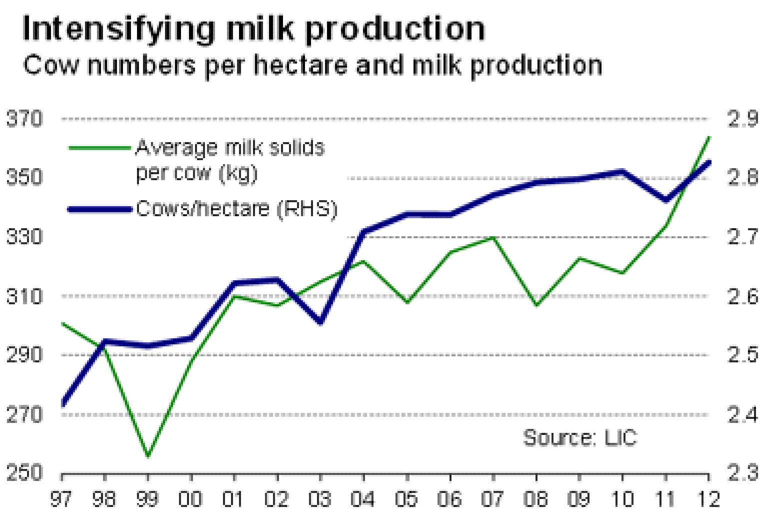


Figure 1: Shows the intensifying milk production

Given the growth and intensification of agriculture in New Zealand, we are faced with the prospect of more environmental regulation as government seeks to ensure a sustainable future for the environment.

Grass based grazing systems have little opportunity for the capture of nutrients and manure from grazing animals, unlike the housed systems, where effluent is captured and spread onto land, at a time when there is less potential for run-off and leaching. Arable systems have historically used artificial fertilisers in order to maximise production, however there is the opportunity to utilise the potentially excess nutrients within the dairy systems. This may be by piping liquids from the dairy to the arable farms, but will require the land use types to share the same geographical area in order for the cost of infrastructure to be viable.

The wintering of dairy stock is set to undergo some changes in the near future with regard to land use capabilities and nutrient run-off and the leaching. The off farm wintering is a very integral part of the overall dairy system and allows production to be pushed beyond the capabilities of a self-contained unit. The system again, places pressure on the environment when the cows are fed forage crops in situ with no opportunity to contain nutrients and effluent.

When we look at other systems around the world, a recurring theme is indoor wintering, and the control of the effluent that it brings. We are beginning to see some of these indoor wintering systems introduced in New Zealand, mostly on the dairy platform where there is the opportunity to milk later into the season and increasing milk production which offsets some the cost of infrastructure.

Implementing this system creates the potential for further nutrient overload within the dairy operation as more feed is introduced to the dairy platform; therefore it is only viable if the dairy operation is a self-contained unit.

If the dairy unit is not self-contained and is reliant on the arable farm as a source of feed over winter, the wintering barn or pad may need to be on the farm that the crop is grown in order to maintain the nutrient balance and reduce transport costs. This will however mean some fundamental changes in the cost structures that are currently in use are in order to ensure viability of both businesses and may require some transition period.

With respect to the opportunities for the arable industry to supply feeds better utilised by dairy cows, it appears there has been little work done in that field. The dairy industry in the US and the EU tend to focus on breeding feed efficiency into the animals and sourcing a range of products to formulate the diet required to enhance profitability.

Often products within the diet are by-products of other processes as opposed to a particular crop. This could be distillers grain from ethanol production, almond hulls, or even stale bread which can be sourced in the Netherlands and the UK at a cost cheaper than wheat. There is little scope individually for these crops to be tailored to a particular dairy diet, however when used in a blend, the mix can be adjusted to suit the requirements of the herd or in the individual cow.

The arable industry globally tends to be focused on breeding and agronomic management that allows for better water use efficiency, disease controls and nutrient deficiencies, and more recently the renewable fuels industry. This is wide-ranging and involves ethanol production, bio fuel production and feedstocks for anaerobic digestion. These are important for sustainability of the industry, but if we look at the feed industry there is little focus on the needs of the consumer.

Historically quality testing of feed grains has been related to the pig and poultry industries rather than the dairy industry. This differs from maize silage and other forages which have been selected for bovine animals.

The New Zealand arable industry is particularly innovative and adaptive to change and is well placed to participate in the dairy value chain and to assist with sustainable environmental outcomes.

Preface

We have all heard the figures; a world population of nine billion by 2050, more than 600 thousand hectares of productive land lost to urbanisation each year and deforestation wiping out plots of trees the size of thirty-six football fields every minute.

As a result, those involved in agriculture are tasked with providing the food for this ever increasing population, with less available land with which to do so.

The world population has doubled since 1963 therefore it is only natural the New Zealand agriculture industry has gone through some radical changes over the last fifty years. These include, but are not limited to, mechanisation, genetics and plant breeding. It would appear however that most of the low hanging fruit has been picked; therefore productivity and efficiency will be incremental for future gains.

Agriculture in New Zealand has become particularly innovative since the removal of government support in the 1980s. Our European counterparts often refer us to when they imagine themselves functioning in a free market environment.

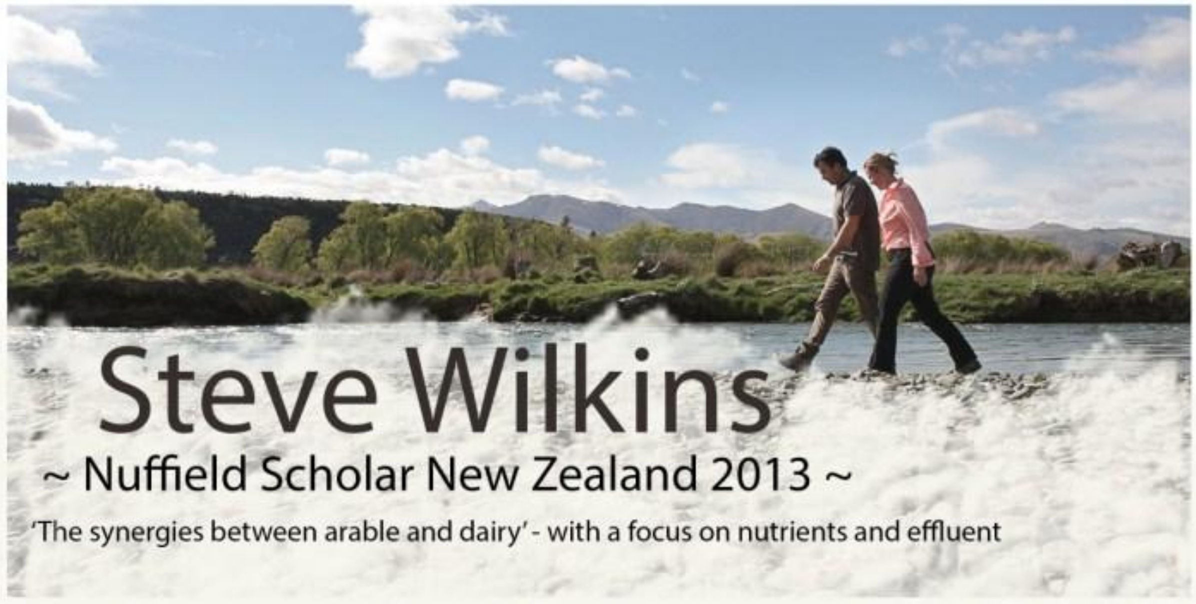
One of the factors that will likely influence increased food production in the future will be environmental regulation and public perception of agriculture. There are, however three legs to the 'Sustainability Stool', being the environmental, social and economic 'legs'. Without each of those in the correct proportions, there is little hope for its sustainability.

The purpose of this study is to identify areas where the Arable and Dairy industries can continue to be industry leading and keeping the 'sustainability stool' upright. All of this, while fitting within the environmental framework we are likely to be faced with in the future.

When I set out on this journey, I had what I thought was a reasonably clear picture of what I was going to find. However, I did not find that miracle crop to draw excess nutrients, or a one solution to retain and enhance our clean green image.

What I did find though were some great people willing to share their experiences, issues and successes. Through this report, I will endeavor to share them and provide some conclusions and recommendations.

Objectives



- To investigate opportunities for the arable industry to grow crops that have high nutrient use efficiency.
- To investigate dairy feed systems and identify opportunities for the arable industry.
- To investigate dairy and feedlot effluent systems.
- Look for opportunities for the arable industry to utilise excess nutrients from dairy systems.
- To identify systems that will allow the integration of dairy animals within arable systems, that are sustainable from an economic, environmental, and social perspective.
- Identify new technologies that will allow agriculture in New Zealand to retain its 'Clean Green' image and continue to be regarded as a highly innovative exporting country.

Acknowledgments

To be awarded a Nuffield scholarship has been particularly humbling and a most rewarding experience. To allow me to take part in the Nuffield programme there are many people who have encouraged and supported me, without which I could not have completed it.

Thank you to the Nuffield team, Julian Raine (Nuffield New Zealand Chair) and all the trustees of the Nuffield New Zealand Farming Trust for creating what has really been a unique opportunity.

To Barbie Barton (Secretary for Nuffield New Zealand), Richard Green (Director of Nuffield New Zealand) and thank you both for your support.

Stuart Wright (Nuffield International Chair) Craige McKenzie (Scholar 2008) and Mike Tayler (Scholar 2012) for giving me the inspiration for me to apply.

Jim Geltch and Nuffield Australia for putting together a brilliant Global Focus Program, which was one of the highlights of the entire experience. The memories and contacts will stay with me forever.

None of this would have been possible without the on-going sponsorship of our Nuffield partners; Agmardt, Dairy NZ, Beef + Lamb NZ and Farmers Mutual Group, who continue to invest in Nuffield and New Zealand agriculture.

Also our supporting sponsors Foundation for Arable Research, Mackenzie Charitable Trust and Landcorp; to all of you I am extremely grateful.

I would also like to thank Nick Pyke and Jeff Grant for their assistance in making this last year a life changing experience.

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There are many people who assisted with my study trip and I am grateful to them for their time, arranging meetings or contacts, the free wifi and a bed at the end of the day. They include, but are not limited to:

UK

Amy Jackson, Bill Clarke, Caroline Drummond, Caroline and Ross Miller, Chris and Charlotte Padfield, David and Katie Alvis, Gavin Green, Ian Piggot, Jake and Andrea Freestone, Jim Orson, Juno McKee, Lindsay Hargreaves, Martin Davies, Matt Bell, Matthew and Kate Hawthorne, Michael and Karen McLaren, Niall Armstrong, Nigel Schollan- Aberystwyth, Prof John Alliston, Rhonda Thompson, Rita Walsh, Robin Aird, Tony Pexton OBE, Tom and Emily Bradshaw.

America

Bart Ruth, Tony Anderson, Charlie and Margaret Carter, Philip Eby, Product Marketing Manager, New Holland Penn. John Daniels, Plant Manager, New Holland Penn. Deanne Meyer UC Davis, Dr. Dave Downey, Purdue University, Michael Schultz, Purdue University. Don Reicosky, Gary Zimmer, Dave Brandt, Luke VanTilburg, Joe Beiler. Don Rogers, Velmar Green.

Canada

Jo and Byron Matlock, Eric and Alena Matlock, Aaron and Pam Matlock, Ryan Albers, Susan Hosford, Brian Freeze PhD, Karen Beauchemin PhD.

Netherlands

Djuke Van der Maat, Henk Smit, Rick Devor , Jeroen Van Vejk, Ruud Joordens and John Smolenaars.

Belgium

Luc Ollevier.

France

Thaubid Dracorb.

Thanks to the Fellow delegates to the 2013 Worshipful Company of Farmers Advanced Management course. These 17 people have become lifelong friends and I look forward to the regular contact in the future.

Most importantly, thank you to my amazing wife, Heather, along with Hannah, Ella and Molly who have been incredibly supportive over the last 15 months and have picked up the slack in my absence. Also to the wider family and staff who have covered for me and ensured the business survived while allowing me to experience this incredible journey.

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Chapter 1 - USA

Farming systems in the US vary hugely across the country due to differing climates and geography; therefore there is no 'one fits all' system. Much of the decision-making in terms of farm management and operating systems is done so within the framework of a political system vastly different from that which we are used to New Zealand. To get a better understanding of this, we must first understand the US farm bill and its history.

Farm Bill

In the United States, the Farm Bill is the primary agricultural and food policy tool of the federal government.

It was created during the Great Depression to give financial assistance to farmers, who were struggling due to an excess crop supply creating low prices. It was also designed to control and maintain an adequate food supply. Congress passed the first farm bill, known as the Agriculture Adjustment Act (AAA), in 1933.

The bill allowed farmers to receive payment for not growing food on a percentage of their land as allocated by the United States Secretary of Agriculture. It also enabled the government to buy excess grain from farmers, which could then be sold later if bad weather or other circumstances negatively affected output. The AAA also included a nutrition program, the precursor to food stamps.

Soon after, Congress created a more permanent farm bill - the Agricultural Adjustment Act of 1938, which required updating every five years. However it wasn't until 1996 that the first major structural change was made to the farm bill when Congress decided farm incomes should be managed by the free market and stopped subsidizing farmland and purchasing extra grain. Instead, the government began requiring farmers to enroll in a crop insurance program in order to receive farm payments. This led to years of the highest farm subsidies in American history.

Direct payments also began in the late 1990s as a way to support struggling farmers, regardless of crop output. These payments allowed grain farmers to receive a government check every year based on yields and acreage of the farm as recorded the previous decade.

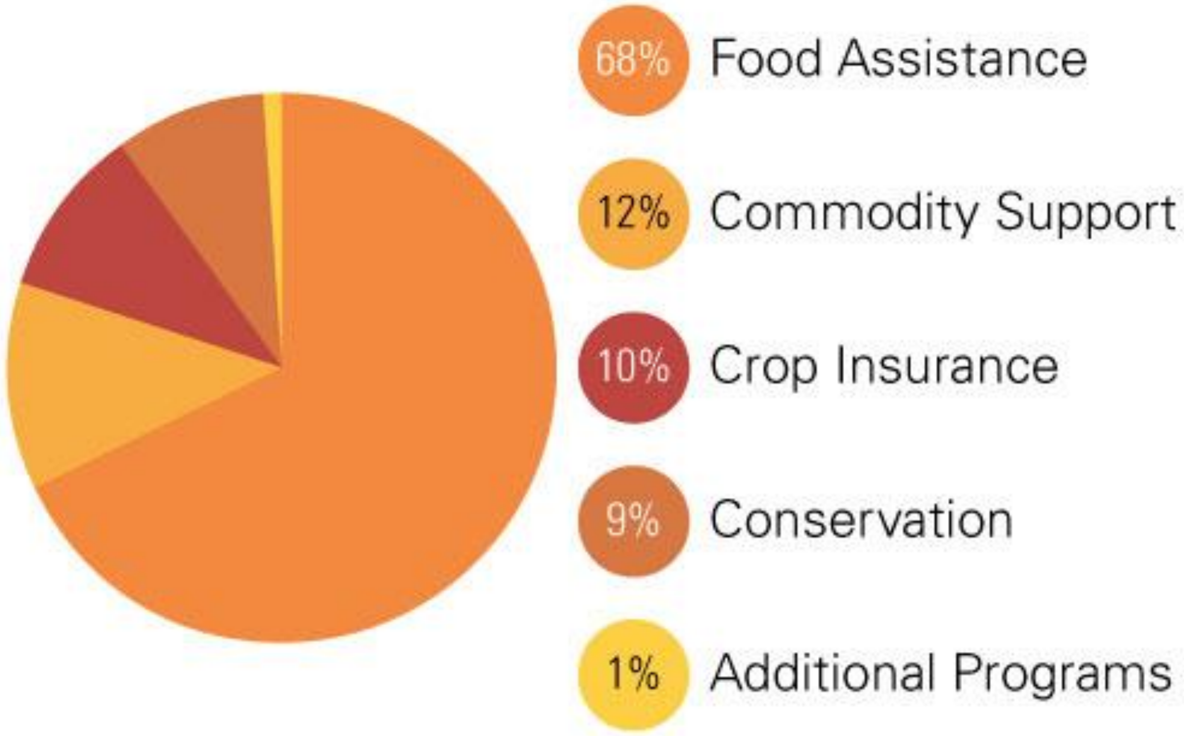


Figure 2: Break down of Food Bill percentages

More recently, in 2008, the farm bill was passed as the Food, Conservation and Energy Act. This bill included approximately $100 billion in annual spending for Department of Agriculture programs, around 80 percent of which was allocated for food stamps and other nutritional programs. This version was publicly controversial due to its high cost and the uneven distribution of subsidy money among farmers.

Between the passage of the 2008 farm bill and the creation of the 2013 bill, the food stamp program changed its name to the Supplemental Nutrition Assistance Program (SNAP), and nearly doubled in size. The proposed 2013 bill would cut funding to SNAP by about $400 million a year, which amounts to half a percent of spending from previous years. It would also reduce the government's responsibility to pay crop insurance premiums for farmers with adjusted gross incomes of more than $750,000. The new bill also proposes a new insurance program for dairy producers, which would cut costs by eliminating other dairy subsidies and price supports.

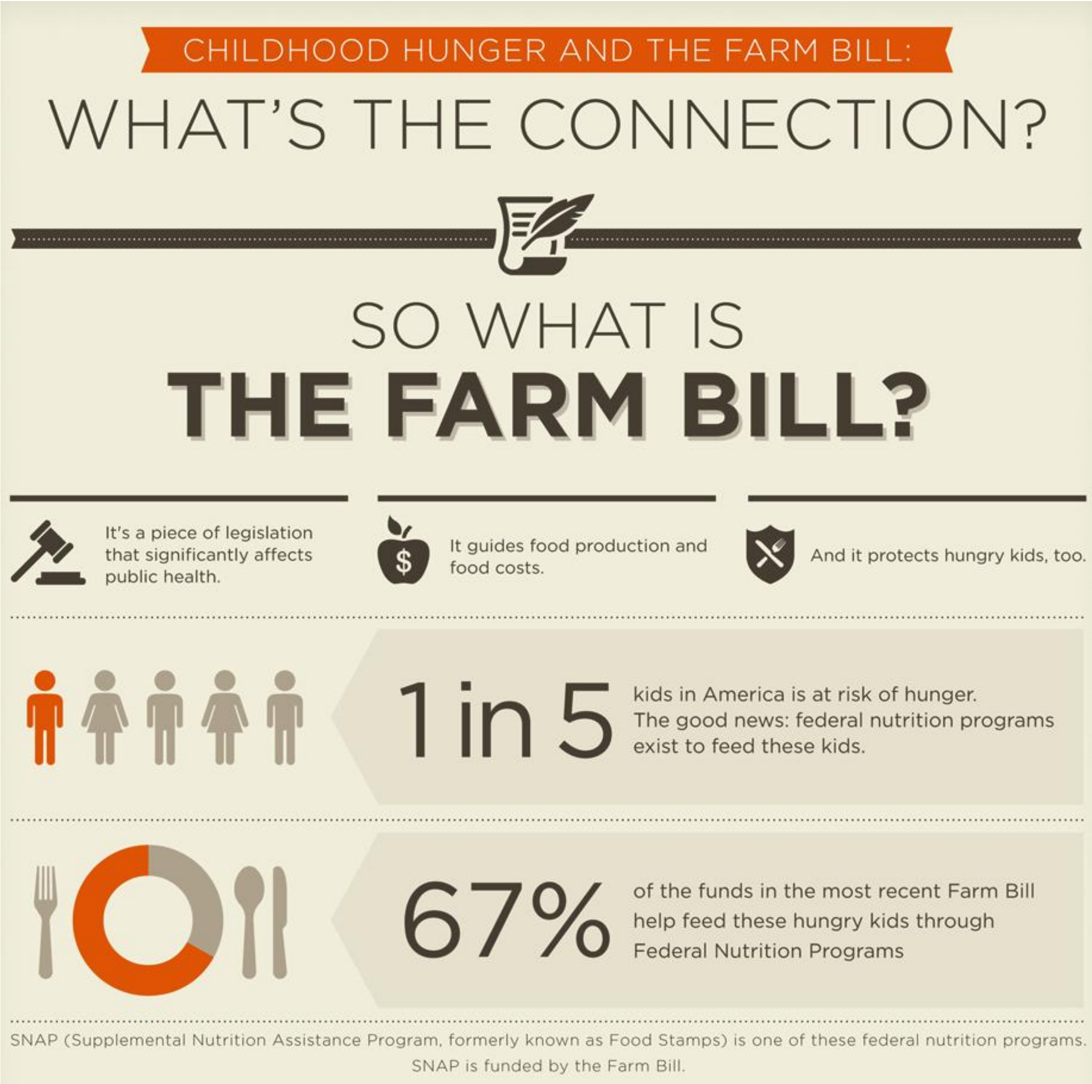


Figure 3: Another side to the Food Bill

So what did we learn from this?

Farm bills can be highly controversial and can impact international trade, environmental conservation, food safety, and the well being of rural communities. The agricultural subsidy programs mandated by the farm bills are the subjects of intense debate both within the U.S. and internationally.

At the time of writing this report, there had been no agreement on the latest negotiations for the new Farm Bill between the House and the Senate. The major issue is the size of cuts in food stamps for the poor.

From the figure below, we can see that nearly 80 percent or US$768 Billion of the Farm Bill budget is actually a social payment to society rather than providing agriculture with the smoothing effect to take out much of the uncertainty, particularly around climate associated with primary production. While the remaining 20 percent or US $206 Billion is still significant, it comes under immense pressure within the Farm Bill budget from voters and policy makers alike.

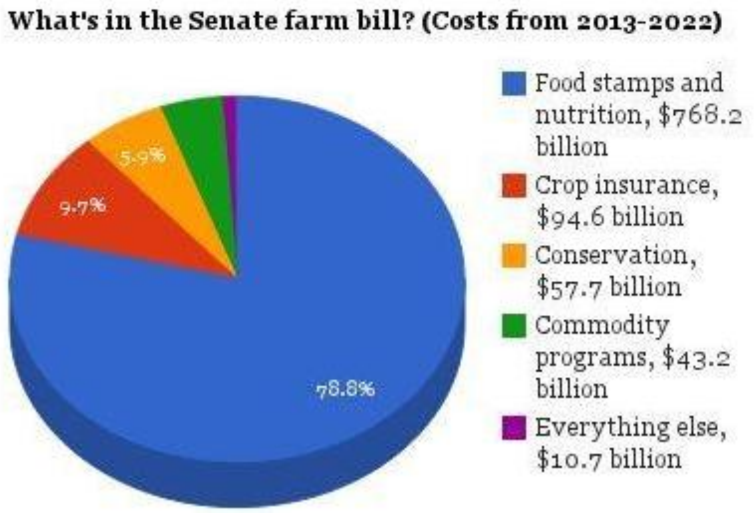


Figure 4: Projected cost breakdown for the farm bill

It must also be noted that Conservation gets some US$57 Billion in funding, much of which the US farmer feels he or she sees little of but serves to keep many bureaucrats in jobs (Carter 2013). It does however provide opportunities such as renewable fuels that would otherwise be economically unsustainable.

The US is the biggest exporter of food in the world and needs to look after its agricultural industry. Arguably many farmers would struggle to be viable without the Farm Bill but scheme such as this serve to provide a distortion for the likes of New Zealand with respect to cost of production and competitiveness in the market place.

US Ethanol Industry

The growing role of the ethanol industry as a supplier to the U.S. motor fuels market has reshaped the relationship between agriculture and energy markets.

Historically, the correlation between agricultural prices and energy prices was weak and primarily reflected the role of energy as an input in agricultural production. However, the growing use of corn to produce energy has strengthened the link between these two markets. Recent study suggests that price relationships between the U.S. corn and gasoline markets strengthened significantly after March 2008 and continue to be highly correlated. From March 2008 to March 2011, ethanol supply and demand accounted for about 23 percent of the variation in the price of corn, while corn market conditions accounted for about 27 percent of ethanol's price variation. At the same time, about 16 and 17 percent of gasoline price variation can be attributed to shocks to ethanol and corn markets, respectively.

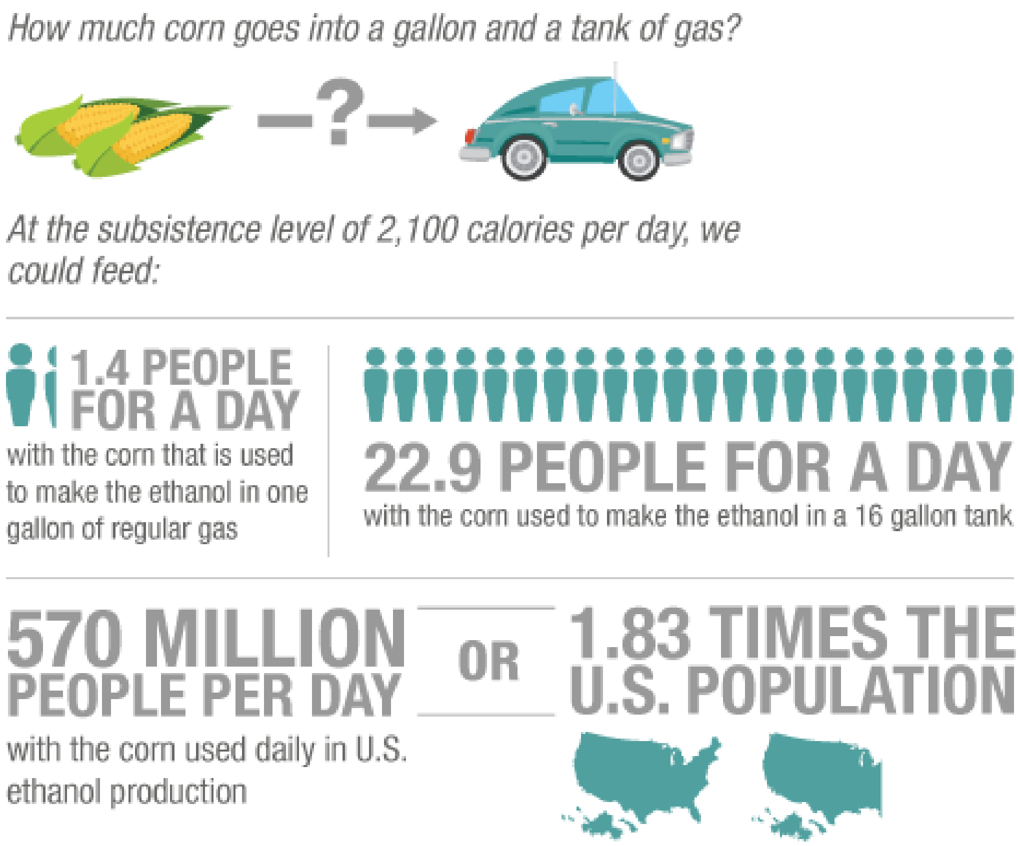


Figure 5: How much corn goes into a gallon and tank of gas?

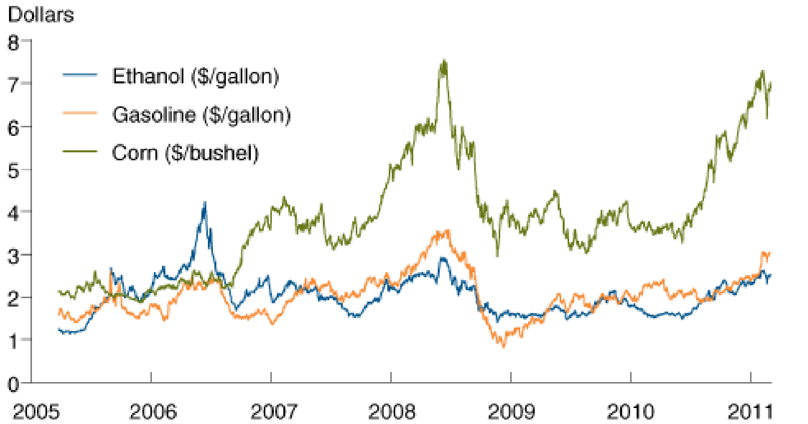
The impacts of corn and ethanol prices on gasoline price volatility are surprisingly large given that ethanol is only a small portion of the overall energy market. The related price dynamics and market adjustment warrant further study.

With the growing share of corn used in ethanol production, the corn market is increasingly exposed to demand-side shifts in the petroleum market based on ethanol's role as a gasoline substitute. U.S. corn-based ethanol production was 13.2 billion gallons in 2010, accounting for almost 40 percent of total U.S. corn use in the 2010 crop year. In the same period, ethanol was blended into over 90 percent of the Nation's gasoline supply, replacing about 445 million barrels of imported oil.

As gasoline prices rise, ethanol's appeal as a blend increases as does the profitability of ethanol production and the demand for corn.

While the agriculture and energy markets become more closely correlated, so, too, does the degree of price volatility between these markets. Energy markets are notoriously volatile, and this effect can now more easily pass onto agricultural commodity markets.

Corn, ethanol, and gasoline prices are highly correlated



Note: All prices are daily settlement prices of the nearest-to-maturity contracts traded in the corresponding futures markets, which are the Chicago Mercantile Exchange for corn and ethanol and the New York Mercantile Exchange for reformulated blend stock gasoline.

Source: USDA, Economic Research Service using data from Chicago Mercantile Exchange and New York Mercantile Exchange.

Figure 6: Correlation between corn, ethanol and gas prices

More efficient methods of mining fossil fuels, including fracking, means the US will be less reliant on the Middle East for fuel in the future. A proposal by the U.S. Environmental Protection Agency to reduce the amount of biofuels that oil companies must blend into gasoline and diesel from 18.15 billion gallons to 15.21 billion gallons in 2014 - including an implied reduction of corn ethanol from 14.4 billion gallons to near 13 billion gallons – has been negative for corn markets. Coupled with record-breaking corn yields, the corn price is dropping and creating opportunities for both beef and dairy producers.

Chapter 2 - US Case Studies

1. Ruth Farms, Rising City - Nebraska

Bart Ruth farms on around 2000 acres with his son Geoff. The farm is growing corn and soya beans. There is some land share farmed on either a 50/50 basis or 60/40 basis, with a very small amount on rental per acre.

Demand for corn from overseas as well as a strong domestic market in the form of ethanol production, has seen the price rallying to new heights in recent times. Prices up over US $ 8.00 a bu. are being reached and are now sitting at around US$ 4.60-$5.00 bu.

About five years ago, two dairy units were set up in the local area to milk between five and six thousand cows each. The units are built on quarter sections, being 160 acres. Because these dairy units have limited land attached to them, they are almost totally reliant on the surrounding cropping farms for corn - one of which is Ruth Farms.

The corn silage price is agreed upon by using a formula based on the corn price for the area, which in September 2013 was sitting at US$5.00 per b.u. This is then multiplied by a factor of eight. Therefore the price for the corn silage is US$40.00 per ton.

At the time of writing this report, the US corn price was sitting at US$4.12 and predictions are for this to slump to as low as US$2.75 by the time spring planting begins in April this year.

Some alfalfa is sourced locally; however, some 90% will come from as far away as Arizona which is 1200 miles (1931km). This is to guarantee the quality parameters are met as there is a preference for a RFV (Relative Feed Value) of 180 or more.

The need for the dairy units to have land to spread the effluent has led to new opportunities for Ruth Farms and others in the area to receive these nutrients back on to the farm.

This happens in two ways, firstly in liquid form through a network of 100 km of underground 250mm PVC piping to centre pivot irrigators. The piping has been laid at the dairy farms expense and is connected to the centre pivot irrigation infrastructure on the land owned by Ruth Farms.

The effluent lines have to be physically disconnected before water from the bores can be pumped through the centre pivots. This is to avoid any chance of the water bores being contaminated with the incoming effluent. The management of the effluent application is the responsibility of the dairy operation.

Secondly, by the injection of slurry from the settling ponds which are cleaned out twice a year.

The cost of the slurry injection is typically US$300 per ac. and this cost is shared 50: 50 between the dairy owner and the arable farmer, or in this case, Ruth Farms. The application of injecting is carried out by a contractor at a rate of 50 000 litres per ha or 5 mm per pass.

The total application for both products in a 12 month period provides the ability to grow the equivalent of a 220bu /ac.(13.5t/ha) corn crop, without the need for artificial fertiliser.

Would it work in New Zealand?

This system works very well for both parties involved. However, because the dairy is fully indoors and the cows are fed a TMR (Total Mixed Ration), the system in its present form would fit only a small number of farms in New Zealand. The concept however is very sound and with some adaption, is an option worthy of consideration.

2. Carter Farms - Thorntown Indiana

Charlie and Margaret Carter milk 120 small-framed Holstein Friesian cows in a mixed or hybrid system on 220 acres. Their system is relatively small by US standards and very traditional. The feed is made up of 50 percent pasture, 30 percent forage i.e. corn or silage and 20 percent grain.

Production is 18 500 lb milk/ cow, which equates to 670kgms/cow. Very dry seasons have meant that more supplements are required than ideal, therefore adding to the cost of production. Forage (grass and corn) is grown on farm and grain (corn, cotton seed, distiller's grain hulls) is bought in from an upstate co-op, where there is a bigger area of dairy and more options. The milk they produce is supplied to a co-op about an hour away. Their hay is generally made in May when there is excess grass within the rotation and corn is produced annually on 6 or 7 ha. Most of the local area is in beans and corn.

Around forty percent of US corn goes to ethanol production which means the Carters are relatively isolated in the respect that they are the only grassed based dairy in an area that is host to very few dairy operations of any sort.

Because the farm carries less than 300 cows and has land attached, there are no environmental regulations to adhere to. The effluent is injected into fields where possible and is spread on top discreetly when necessary. A contractor carries out these operations. The fact that all the effluent is spread onto the farm means there is no need for artificial fertiliser to be used on the farm.

So mustn't the whole system be nutrient negative if it is producing milk and exporting it off farm? The answer lies in the fact that the imported feed brings nutrients into the system.

The Carters need to update the milking parlour on the farm, but struggle to justify the expense being a small-scale operation. Perhaps a robotic milking system would have value here?

It would appear the system employed by the Carters is as close the New Zealand system as anything I experienced in the US, and the production figures are very respectable. It is however definitely not commonplace and things such as feed supply, milk distribution and labour supply are geared towards the Indoor System.

3. Fair Oaks Dairies - Indiana

Fair Oaks was established in 1998 with the purchase of one thousand acres and has since grown to the nineteen thousand acres it is today. The enterprise is owned by ten families and has its roots in California where a cooperative structure was established in the 1970s. They have a total of around 110 000 cows throughout the US. The Fair Oaks units employ 450 staff who earn around $40,000 per year.

Figure 7: Eighty-bale rotary milking parlour at Fair Oaks Dairies

The facility at Fair Oaks currently milks 32 000 cows three times a day through ten seventy-two bale rotary sheds. Current expansion will have another barn up and running later this year. Gary Corbett (CEO) suggested that the optimum size for the site would be 40 000 cows, based on available land and feed - no more than thirty percent of feed is bought in.

The milk produced by Fair Oaks is sold throughout America and is adjusted seasonally as to where it is directed, but generally goes as far as Florida. The price received is dependent on world powder prices. During my visit, Gary was very aware of the drought conditions in New Zealand at the time, and how that was influencing pricing. Just shows how far reaching the NZ drought and its flow on effects were.

The feed they use is made up of corn silage, alfalfa hay and silage, corn, soy, cotton meal and distillers grain from ethanol plants. The only job contracted out on the farm is the silage cutting. Contractors come in with 25 silage harvesters to cut the 500 000 tons required to feed the cows.

A vacuum system is used for removing effluent from barns where it is sent through an extraction system and the sand is either reused or spread on the land. Effluent is then put through the Bio Digestion system. Once the effluent is out if the digester it is separated with solids used as fertiliser and compost and water reused through the dairy and pumped through miles of pipe and irrigators. Macro nutrients are extracted through a complex centrifugal process and nitrogen is stabilised through a tower system using sulfuric acid.

Young stock are farmed out from weaning until 60 days prior to calving when they are bought back to the farm of origin. Steers are either sold or raised on co-op farms around the country.

Figure 8: Calf rearing shelters

Fair Oaks also boasts a huge restaurant and cheesery, as well as farm tours, which entertain around 500,000 visitors per year. This adds value to the product, but perhaps more importantly it brings the public closer to where their food is produced and helps to bridge the gap.

Fair Oaks is a very well run operation, which are leading the way in environmentally sustainable farming. The fact they are transparent in the way they interact with the consumer is testament to this.

Figure 9: Steve Wilkins; Gary Corbett CEO Fair Oaks Dairies; Pete Kaylock, Aust; David Cook, Aust.

a) Bio Digestion at Fair Oaks Dairy

Fair Oaks Dairy has two anaerobic digesters onsite: a large mixed-plug flow and a smaller vertical-plug flow. The dairy has approximately 12 000 lactating cows producing manure that feed the anaerobic digesters. Currently, no co-digestion is conducted, but in the past ethanol syrups collected from regional ethanol plants were co-digested and typically amounted to five percent of the feedstock.

Biogas produced from the anaerobic digesters is used to generate electricity and is also being used to produce compressed natural gas (CNG) for use as a transportation fuel.

The larger digester (mixed-plug flow) began operating in 2008 and receives manure from approximately 9 000 dairy cows each day. The larger digester produces approximately 133 ft^3 of biogas per head per day (based on 9 000 heads, the biogas production is 1,200,000 ft^3/day). End uses for biogas from this digester include on-farm electricity generation; use of waste heat to heat the digester, and CNG for use as transportation fuel in vehicles.

The larger digester is equipped with a 1,059 kW gen-set, which is used to produce electricity for on-farm use, and the waste heat recovered from the gen-set is used to heat the larger digester. Any excess electricity after the on-farm electricity needs are met is sold to the local utility. The larger digester is also equipped with a gas cleaning system that cleans and scrubs contaminants from the biogas to meet purity levels for use as a renewable transportation fuel. The farm operator expects to use the majority of the biogas for the purpose of producing CNG.

The smaller (vertical-plug flow) digester began operating in 2003 and receives manure from approximately 3 000 dairy cows each day. The digester produces an estimated 60 to 70 ft^3 of biogas per head per day (based on 3 000 head, the biogas production is 180,000 to 210,000 ft^3/day).

The smaller digester is equipped with two 350 kW gen-sets that are used to produce electricity for on-farm use, and any excess electricity produced is used at the dairy visitor centre. Waste heat from the gen-set is recovered and used to heat the digester.

The total turnkey cost (or capital cost) for the larger digester is US$12 million, and the equipment is estimated to have a project lifetime of 20 years. The farm financed approximately 99 percent of the up-front capital cost of the anaerobic digester using industrial revenue bonds. For this farm, the loan period was 15 to 20 years.

Figure 10: Fair Oaks Gas Station, Indiana

Annual operating and maintenance (O&M) costs for the large digester are estimated to be approximately five percent of the total capital cost (or approximately $600,000 per year). On-farm use of the generated electricity allows the farm to purchase less electricity for its operating needs. There are cost savings associated with the avoided electricity purchased for the farm and dairy visitor centre. In addition, the recovery of waste heat from the engine/gen-set to heat the digester allows the farm to avoid purchase of heating fuel for the digester.

As mentioned earlier, the farm operator expects the majority of the biogas produced from the digester to be employed in the production of renewable CNG. The renewable CNG is used to power CNG tractor-trailers that deliver milk to processing plants in three Midwestern states (these CNG-fuelled vehicles replaced diesel fuel-powered vehicles). The farm received a grant under a separate program for the extra CNG tanks to extend the range of these trucks powered by CNG. The farm has reduced its use of diesel fuel by 1.5 million gallons per year. There is a cost savings associated with the avoided costs of diesel fuel for dairy trucks. The surplus clean biogas not used for on-farm purposes will be piped and sold to a CNG fuelling station (although the sale price of the CNG is unknown). It is estimated that with the installation of the gas cleaning system in 2011 and the CNG sales to the fuelling station, the simple payback period for the gas cleaning system project will be approximately 3 years.

The smaller digester is older, and the total costs for the unit are not known. The annual O&M costs for the smaller digester are estimated to be US$100,000 per year.

A fleet of 42 milk-hauling trucks, equipped with Cummins Westport 8.9L natural gas engines, was purchased by Fair Oaks in late 2011. The CNG fleet transports fifty-three, 6,000 gallon loads of milk daily, equal to 7.5 million gallons per month or 90 million gallons of milk a year. The emissions and carbon footprint of CNG from the pipeline is over forty-percent less than that of diesel fuel – and that doesn't account for the reduced carbon footprint of using renewable natural gas.

The trucks are equipped with two extra tanks that enable the vehicles to travel up to 600 miles on one fuelling – in order to cover the distance to a milk plant in Murfeesboro, Tennessee that Fair Oaks supplies. The other milk plants are in Indianapolis and Winchester, Indiana. The extra tanks were paid for by a US$2 million grant from the Indiana Office of Energy Development. The project also received a US$750,000 grant from the Greater Indiana Clean Cities Coalition.

4. Anaerobic Digestion at Green Meadows Farm - Michigan

The Green Meadows Farm business milks 3 700 cows. They are a third generation family business and we met first with Valmer Green, the second generation farmer, then with Don Rogers, Operations Manager. Don is a Vietnam Vet, trained electrician and able to turn his hand to anything including dabbling in wheat futures.

The parlour milks 3 700 cows, three times a day, through a double 30 and a double 20 herringbone. They run two 12-hour shifts 24 hours a day. Fifty staff are involved in the milking with 87 staff in total.

The cows are producing 90lbs milk (not solids) per day on average. It is cooled and pumped directly into waiting semi trailers for delivery to the processing plant about 100 km away. Around 600 cows calve per month. Water use is around 1 million litres a day and the cows are bedded on a mixture of sand and gypsum. Effluent from the barns is put through a separator to take the sand out, which is then reused. The effluent is then heated to 35 degrees and put into a biodigestor for 21 days.

Figure 11: Velmar Green, Don Rogers, Steve Wilkins

The gas produced fuels a 1400hp Cat engine, which is coupled to a genset, putting electricity into the grid at a value of 8 cents/kw. The heat from the engine also warms the effluent going into the digester. Currently the effluent going into the digester is 2.75 percent solids. The ideal is five percent, which means it is very inefficient.

Ideally something would be added to 'feed' the digester, corn, or sugar beet corn oil from an ethanol plant, but these have become too expensive to be viable due to increases in price pushed by the demand for feedstock for ethanol production. This does however appear to be changing as corn prices continue to drop after peaking at around US $8 per bushel in 2012.

Figure 12: Don Rogers with 1400 hp Cat Generator

Michigan State Government put $2.5m into the set up of the Bio Digester and were to have an ongoing research and support relationship with Green Meadows, however the funding was cut and there is a classroom and resources on site that have not been used.

Chapter 3 - EUROPE

When we look at agricultural production systems in Europe it is often difficult to make comparisons with New Zealand as the political framework which both areas are bound to dictate how or why certain systems are implemented. First we must understand that framework, which in the case of Europe is the Common Agricultural Policy (CAP).

The Common Agricultural Policy

The Common Agricultural Policy (CAP) is one of the major European Union (EU) policies both in terms of budget and its impact on the EU's 500 million citizens. The agricultural sector provides 14 million jobs to farmers, generates around six percent of the EU's gross domestic product, and contributes to making the EU the second largest exporter of agricultural goods. However, the CAP is also one of the most controversial EU policies not only because of its substantial cost, but also because it is considered unfair, both internally (i.e. distribution of support within and among Member States) and on a global scale (i.e. harming agriculture in developing countries).

Initially focused on increasing agricultural productivity in the EU and securing availability of food supplies, the policy has gradually evolved, with the overall aim of becoming market orientated and less trade-distorting. At present, the CAP aims at ensuring a fair standard of living for farmers while safeguarding the countryside and providing a stable and safe food supply at affordable prices for customers.

The 50-year-old CAP is heading for a new reform to tackle current challenges such as climate change, food security and sustainable management of natural resources. Over the years, it has moved away from supporting market prices to support producers' income and rural development. Criticism has, however, remained, notably on the CAP's perceived inequity, its lack of transparency, its impact on poor food-exporting countries and it's stifling of innovation, to mention just a few.

The new round of reform is therefore aimed at making the CAP more equitable and greener, while maintaining its effectiveness and ensuring simple and competitive. In the Netherlands, thirty percent of subsidies are coupled to Greening. New initiatives include making direct payments more sustainable, more fairly distributed and aimed at active farmers, simplifying financial management, introducing new tools to help farmers cope with price income or price volatility and encouraging younger people into agriculture.

EU Dairy Quotas

The EU milk quota regime was introduced in 1984 to restrict milk production levels and control the high costs of managing surpluses of dairy products. There is some agreement that the quotas restricted dairy farmers from innovating, adapting and expanding to meet new demands, hence undermining the sector's competitiveness.

The EU has followed research-backed recommendations on the best strategy for gradually phasing out quotas to avoid rapid and disruptive price adjustments. The EU decided to increase national quotas by one percent per annum to slowly erode their value and thereby achieve a 'soft landing' for when the quotas expire completely on March 31 2015.

Ireland has had a relatively flat line in terms of production since the introduction of the quota system at around five billion litres per year (see below).

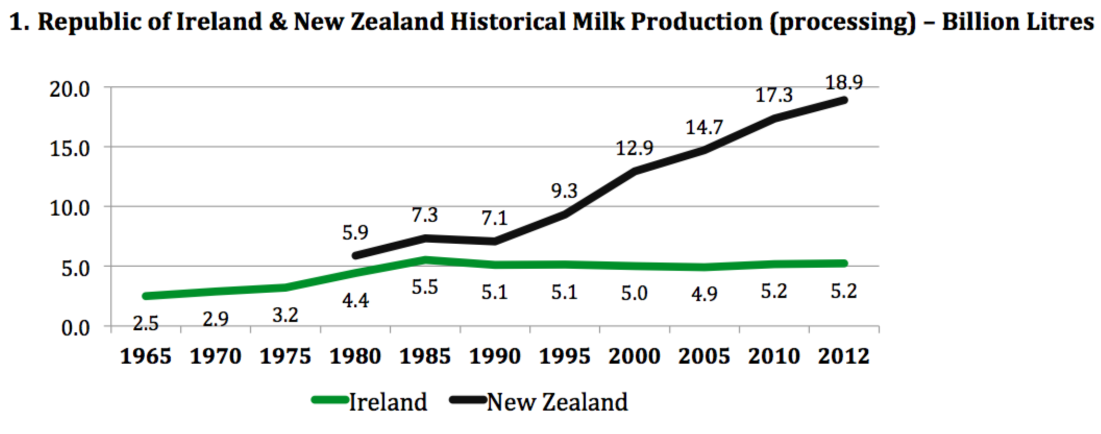


Figure 13: Ireland vs New Zealand milk history

They have set themselves a target of a 50% increase in dairy production by 2020, which would seem a very ambitious task taking into account the amount of infrastructure and capital investment required to meet this target. They are however very enthusiastic in their approach, and at a farm level, are retaining all available heifer calves, securing grazing land and investing in the milking facilities.

With the production system very similar to the New Zealand model, in that it is a grass based system, there is universal agreement within the Irish dairy industry that they will be better at implementing the New Zealand dairy system than New Zealand itself.

From a marketing perspective, the expectation is that the growing demand from Asia and China for dairy products is set to continue its upward trend has installed confidence in the Irish dairy industry. There is also an expectation that Ireland is well placed to supply Britain with all of its import requirements, which are currently worth €1.5 billion. Ireland already supplies the UK with milk to a value of €960 million.

The UK has aspirations of its own when the quota system is disestablished next year, planning to capitalise on its export avenues already in place for cheddar, butter and skimmed milk powder. With some yield improvements and adding 500,000 cows to the national flock, there is potential to produce an extra four billion litres of milk annually. This would effectively put thirty six percent of Ireland's dairy exports in the firing line.

The Netherlands operates under some of the strictest environmental regulatory parameters of any of the 28 EU states therefore increases in production post 31 March 2015 will be modest. This is reinforced by the fact that milk production in the Netherlands is at approximately thirteen tonnes per hectare (either because they produce more feed or buy it), in contrast to Ireland at approximately five and a half tonnes per hectare.

The Netherlands are however focusing a lot of attention towards Asia where the Dutch Wageningen University and Research Centre and Dutch dairy company Friesland Campina have recently signed an agreement to establish a China-based Sino-Dutch Dairy Development Centre. The centre will focus on improving dairy production, safety and quality levels throughout the entire dairy chain in China by sharing Dutch dairy expertise with Chinese experts and decision makers in dairy research and the dairy industry.

Chapter 4 - Case Studies

1. Joordens Seeds, Kessel Netherlands

Joordens Seeds is specialized in breeding, production and marketing of green manure crops, fodder brassica's, fodder grasses, turf grasses and biofumigation crops and is under the management of CEO Ruud Joordens.

Joordens Zaden BV was founded in 1921 as a trading company in agricultural seeds. Later they expanded to the fields of breeding and seed production. After being taken over in 1993 by the French company Société R.A.G.T. Joordens Zaden BV are now involved in an even wider range of varieties to commercialize on the national and inter-national markets. In 2006 Joordens participated in founding SEED FORCE Ltd in New Zealand.

Many different species of seeds are produced by Joordens in the Netherlands and abroad. During the last 60 years, Joordens have built up relationships with skilled farmers, who have produced a wide range of seeds, such as grasses, mustard, fodder radish and turnip. At their processing plant in Kessel the seeds are dried, cleaned and packed using some of the most up to date equipment available.

On a worldwide scale, Joordens work together with seed companies in Canada, Czech Republic, Denmark, Hungary, Italy, New Zealand, Poland, Romania, Uruguay, United Kingdom and the United States.

a) Biofumigants

In recent times Joordens research has focused on the developments of biofumigants. For many years chemical fumigants were on the market to support farmers in reducing soil borne diseases. Now with limitations on the use of these chemical products, to prevent environmental damage, farmers see increase of soil born diseases.

With Brassicas like oil seed, radish, white mustard, Ethiopian mustard and fodder rape, it is possible to reduce and control soil-born diseases. This can be achieved thanks to the resistances of these plants or with biofumigation.

Growers are finding they can cut costs, preserve the environment and even boost yields by using plant-based biofumigants rather than conventional fumigants like methyl bromide to control soil born pests in fields.

The most commonly used biofumigants are members of the Brassica family, and mustard species in particular. They contain glucosinolates—compounds that makes some mustards hot—that can be deadly to weeds, soil born pathogens and nematodes.

When Brassicas are disked, cells are broken and release glucosinolates. They combine with a naturally occurring enzyme and water, producing a fumigant that's similar to metam sodium.

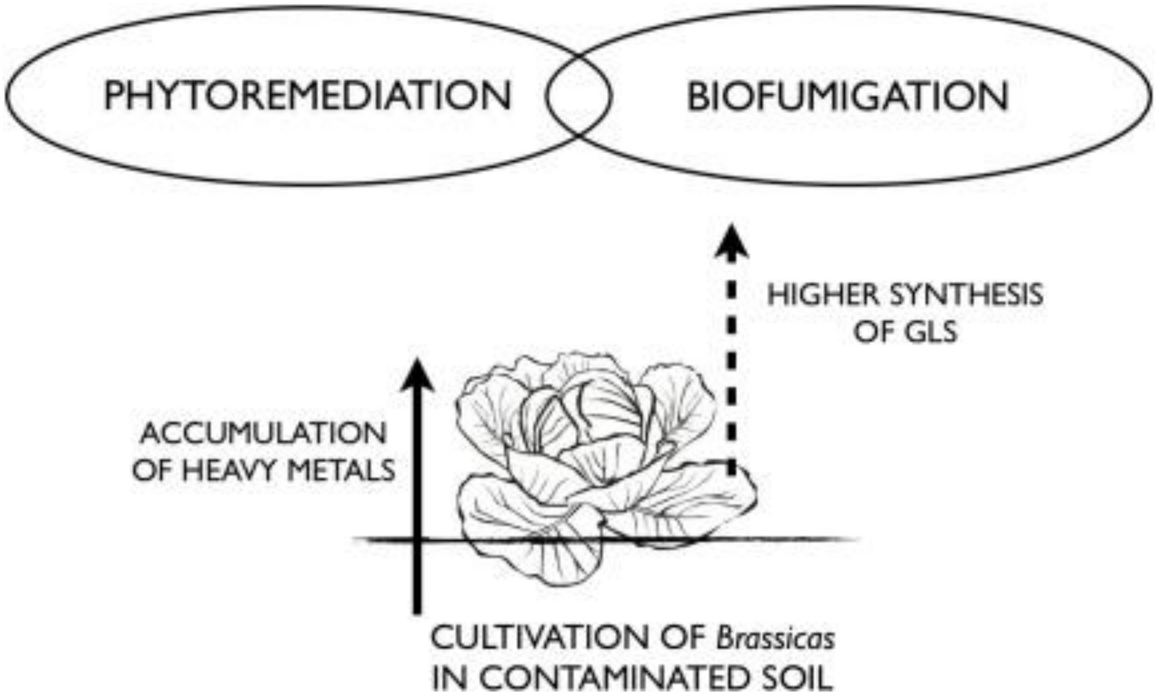


Figure 14: Biofumigation

Not only are biofumigants a more economical, safer way to control pests, but incorporating the plants into the ground leads to increased soil organic matter, which can result in better yields and larger, healthier plants. This is of particular interest to the agricultural regions like the US Midwest where crop rotations are very short.

Biofumigants are natural products that don't pose a risk to the environment, and they don't pose a health risk to the people who use them. (Joorden, 2013)

But the plant-based system carries its own set of challenges, including additional management and water requirements, timing of incorporation, and mixed results, depending on the soil pest spectrum.

Biofumigants may have a fit with animal systems in the future if they were to be root active and the foliage could be used for forage. If the biofumigant were to remain active after passing through the animal there may be options to apply this in effluent form or to pelletise to reduce transport costs. This is an area that warrants further investigation.

b) Fodder beet

In Northern Europe, fodder beet roots have been used as fodder since the Middle Ages. They became a major winter feed for cattle in the 1800s. Traditional fodder beets had multigerm seeds (resulting in clusters of 2 or 3 plants) that required the manual separation (thinning) of the young plants. This labour-intensive aspect of fodder beet cropping led to its decline after World War II and fodder beets were replaced by maize in ruminant diets. The development of monogerm varieties in the 1970s allowed full mechanization and higher yields, resulting in a renewed interest in fodder beets.

Three types of fodder beet varieties have been defined depending on their DM content: fodder (< 12 % DM), fodder-sugar (12-16 % DM) and sugar-fodder (16-20 %). As a rule, beet varieties are only accepted as sugar beet if the DM is higher than 20 % and the beet is white.

As fodder beet gains in popularity in New Zealand, new strategies need to be developed with respect to utilising crops that have the ability to yield 25 to 30 t per hectare or more. The traditional system for forage brassica and beets has been to feed in situ *(*by animals in the field*)*, however with increased dairy cattle numbers and the demands placed on wintering operations, this system may have a limited life span from an environmental perspective.

Fodder beet grown in the Netherlands for dairy cattle is almost exclusively lifted and stored in a bunker, being fed to the animals in a feed pad or housed situation.

It should be noted however, that there is currently only around 300 ha of fodder beet grown in the Netherlands, compared with estimates for New Zealand of 25000ha. Maize silage is the more favoured feed source, particularly the south of the Netherlands, where the climate is more suited to maize. Fodder beet is a more expensive crop to grow than maize and with the beet harvest taking place in the late autumn and winter with large and heavy equipment, this often has a detrimental effect on soil structure. It is not uncommon for 20 t per hectare of soil to be removed from the field with the beet during the harvesting process.

By lifting the beets mechanically there is the opportunity to harvest when damage to soils can be minimised, as opposed to having stock pugging soils over a 10 week period of winter. But probably the biggest advantage of mechanically lifting is being able to manage the run-off and the leaching of nutrients from the soil when the forage is then fed to stock in a housed or feedlot scenario. This does however mean there is an extra cost which ultimately, if in a dairy operation, has to come from the milk.

Figure 15: Fodder beet

Fodder beet roots are harvested when physiological maturity is reached - when basal leaves are dried. However, as roots do not spoil in soil, early harvest is not necessary and roots can remain in the soil as long as no damaging frost below- 5°C occurs. If the roots are removed from the soil they can be stored in large outdoor clamps (covered with straw to protect from frost) for 4-5 months provided they were healthy and had not been damaged during harvest. Frozen beets can be left to unfreeze and must then be fed to animals as soon as possible.

We in New Zealand are looking to fodder beet to give a higher yield per ha than our more traditional brassica crops, with expectations of in excess of 25 and 30 t/ha. From a practical viewpoint it is difficult for these yields to be utilized to an acceptable degree in grazed situation. Which leaves only the lifting and feeding scenario?

As with any winter forage crop, repetitive cropping in the same area has a negative effect on soil structure through pugging. There is also a need to keep the rotation out to five or more years in order to minimise the risk of root diseases and weed control issues.

c) Anaerobic digestion

In Europe there is some focus on anaerobic digestion, popularly known as 'AD'. This is the controlled break down of organic matter in the absence of air to produce a combustible biogas and nutrient rich organic by-product. AD systems can be located either on-farm or at a larger Centralised Anaerobic Digestion management facility (CAD plant).

Theoretically, AD technology can have multiple benefits: helping to mitigate climate change; and helping to manage manures, slurries and waste.

Organic material (feedstock) is collected and stored in a closed, airless container that acts as the 'digester'. During 20 – 40 days, depending on the internal temperature of the digester, bacteria break down the feedstock creating biogas. The biogas can be combusted to generate heat or electricity, and in some circumstances can be cleaned and pressurised for use as a vehicle fuel, or put into the gas grid.

The other product digestate, is a nutrient source and soil conditioner, in which the nutrient nitrogen is more readily available than in raw manures. In order to maintain a high efficiency within the AD plant, energy crops such as whole-crop silage, maize or grass leys, crop co-products such as brewers and grains are usually added.

A 250kW farm-scale digester processing manures from a herd of 500 cows and supplemented with silage energy crops would cost £0.75-1 million ($1.5-$2m NZD).
Feed in Tariffs (FIT) mean that energy produced in the AD plants, and affectively channelled into the grid, is subject to a subsidy by the EU, which

is guaranteed for a period of 20 years. This gives some confidence to invest in the required infrastructure. Based on the above investment, energy revenues of £200-300,000 would be expected, giving a payback time of 5-7 years.

2. Agrifirm, Netherlands

Rick deVor is a dairy nutritionist specialist with Agrifirm in the Netherlands. Agrifirm is a cooperative enterprise in which more than 15,000 Dutch farmers and horticulturalists have combined their purchasing power. Agrifirm was founded in 2010 due to a successive merger of regional cooperatives and now has a staff of 3 000 worldwide. The enterprise operates as a link for farmers being currently active throughout the entire Netherlands. The co-operative also has business units in Belgium, Germany, France, Spain, Romania, Hungary, Poland, Ukraine and China. The head office is located in Apeldoorn, the Netherlands.

Agrifirm provides products and services to Arable farming with seeds, fertilizers and pesticides. In addition, Agrifirm provides feed solutions for cattle, the poultry industry, and the pork sector.

Rick also farms 90 dairy cows near Utrecht, where he milks three days per week and employs help for the other four days. The making of silage and daily feeding of the cows is left to a contractor which means the milking and management of the cows requires approximately 1 hour per day. Cows are fed grass silage, which gives enough protein in the diet and are supplemented with maize or wheat for energy. But because the wheat moves through the rumen too fast, beet pulp is used as a form of 'slow energy' to assist with digestion and nutrient efficiency.

Ric's job as a nutritionist involves working with clients on a one-on-one basis to evaluate the production of the farm and then tailor a diet to achieve the desired outcome. It may be that there are one or several areas to target from increased milk production, increased protein, to improved animal health.

A software program lists the potential constituents and allows for them to be included in the diet in variable rates. This gives the farmer a view of an expected outcome for the particular diet including the total cost, this allows the opportunity to make some well informed decisions rather than guessing and waiting to see what the outcome might look like.

The scenario that we looked at for one of Ricks clients showed a total cost for a 27kgdm diet of €3.51 (NZ$5.80) or €0.13 (NZ$0.21) kgdm. This includes the feed grown on farm and is valued according to its actual cost of production. The program showed the expected income from this diet to be €0.53 (NZ$0.88) kgdm.

Of particular note was the comprehensive list of available constituents for the diet including distillers grain, PKE, stale bread, and oilseed cake, all of which can be supplied by Agrifirm.

3. Kemble Farms - Cirencester, Gloucestershire

In 2005, Kemble Farms began investigating the possibility of using renewable energy. After a visit to German digesters early in 2006 and application for the Jan 2007 Bio-Energy Capital Grants Scheme, where 37% of the £1.2m ($2.4m) was sourced, digester building commenced during the winter of 2007/8.

Figure 14: Kemble Farms Anaerobic digestion tanks

The Farm hopes to recover the capital cost in approximately 7 years. Because of several amendments to the plant, annual running costs are difficult to quantify, but are estimated to be in the region of £33,000 per annum.

Kemble Farms is a 950ha farm (of which 830ha is available for digestate spreading), with further 450ha contract farmed. Wheat, barley, beans and oilseed rape is grown, along with 55ha energy maize, 145 ha forage maize and 40ha of grass leys. The farm's herd of 750 dairy cows is generally housed indoors year round, especially when in prime milk.

All housed cows are bedded on sawdust, with beds being refreshed at every milking and all this goes into the digester. Transition cows, hospitalised animals, and young stock are bedded on straw which is not put into the digester, but is composted before being incorporated into fields.

At the time of my visit in January 2013 the plant was not supplying energy into the grid due to ongoing issues with the generator. The fuel being produced and used to run the generator was of a low standard that was causing the engine to fail, with several engines having been installed and fail, leading to repairs in the vicinity of £40K. Equally significant was the cost of continuing to 'feed' the AD plant during these periods of repairs. As the digester process has a cycle time of some 21 days, any disruption to the process means the cycle as to the restarted on day 1.

Anaerobic digesters are relatively new in terms of on farm methods of further processing animal waste and while there are some successful plants in Germany, most other parts of Europe are still in the developmental stages.

The governmental support for these projects makes them a more attractive proposition than would otherwise be the case. With that in mind I do not believe there is a place for anaerobic digesters in New Zealand in the short term. However, as technology improves and the dynamics of agriculture evolve, this will change.

Chapter 5 - Indoor Wintering

While attending Worshipful Company of Farmers Advanced Agricultural Business Management Course in Cirencester the delegates were given the opportunity to put forward for discussion, a topic of relevance within their own business. I made the comment that New Zealand was reaching a crossroads where some decisions will need to be made as to which direction the arable and dairy industries need to take with regard to the future of winter grazing of dairy cattle.

The question that I posed to the group was which direction do we take? Do we move to a system where the animals spend a portion of the year indoors? The answer came in the form of another question, what do you want to do that for? You have the best dairy system in the world!

While that may be the case there is no denying the fact that if the dairy numbers in New Zealand are to increase some changes will need to be made, and one of the options to be investigated has to be a system where we can better manage potential nutrient losses. It would seem a cut and carry system is the most practical way of achieving this.

Large-scale dairy production operations in both the US and Europe are almost solely based on an indoor feeding regime with the cows held indoors most of the year. The feed grown for the animals is predominantly grown in close proximity to the housing, with most operations being at least 70% self-sufficient in feed. The remainder is imported to the operation and is generally in the form of by products of other crops i.e. distillers grain, cotton seed hulls, almond hulls, food waste, and PKE.

In New Zealand the situation is slightly different. Dairy farms tend to be milking platforms and any supplements that are made on the platform are often to do with retaining pasture quality. The majority of the supplements are then bought in from other farms, whether owned by the dairy operation or other separate identities. These farms are often not on the immediate boundary of the dairy operation and in some cases fifty or even one hundred kilometres away.

The reason for this is because the land neighbouring dairy operation usually has a value that is related to milk production and which is in excess of its productive value as a source of feed. Therefore the feed is likely to be sourced from the land that has a value that is more in line with its productive capabilities.

The feed requirement of a dairy cow in winter in a traditional New Zealand system is 15 kg DM per day depending on size and breed. By putting this animal into a housed or feed pad situation, the feed requirement can drop to around 12 kg DM per day or a 20% saving in feed. This equates to a saving of approximately $70 per cow (based on a feed value of $0.32 per kilogram DM) over the 10-week period.

Utilisation of crop feed in situ is likely to be 80% and rarely more than 85%. In the housed system this figure increases to approximately 95%, which equates to approximately $35 per cow over the same 10-week period.

Based on the above figures, the savings feed on their own would not justify the expense of setting up a housed system however there are many other considerations to take into account.

If the housed system were to be set up on the dairy platform, there would be the opportunity to extend the lactation thereby generating extra milk production and income. This would mean importing feeds from other sources, in many cases this would be from the arable industry.

If you look at the nutrient loading of many dairy operations in New Zealand, this may not be a long-term option as our regulators impose restrictions around nutrient build-ups.

By transporting the cows to the arable farms, as this is currently the case with traditional wintering systems, the build up of nutrients from the dairy can be avoided. The arable farm has the opportunity to provide the facilities for the animals, whether that is a feed pad, a herd home, or free stall barn facility. It means the nutrients and effluent that are derived from the wintering operation and have a value of approx $0.12 per kg DM consumed or $96 per cow (Dalley 2012), stay on the farm where the feed is grown and can be returned to the land at a time in the year that is most suited from an environmental perspective.

The capital outlay such an operation can range from $500 per cow for a simple pad system, to over $2600 per cow for a free stall barn.

On the figures suggested above there is little opportunity for a return on investment based on feed savings and nutrient retention alone. This will require some fundamental changes to the cost structures of our dairy wintering systems, but it does appear likely that environmental regulation will play some part in shaping these changes.

Chapter 6 - Worshipful Company of Farmers Advanced Agricultural Business Management Course

The first engagement as a Nuffield Scholar was to attend the Advanced Agricultural Business Management Course. The Worshipful Company of Farmers at the Royal Agricultural College in Cirencester, England ran this.

Prof. John Alliston and Rita Walsh facilitated the course with assistance from Rhonda Thompson.

The three-week course covered:

- Business Development.
- Time Management.
- Case Studies.
- Personal Development.
- Media Management.
- Presentations from policy makers and business leaders.
- Global agricultural and political awareness.

The delegates were exposed to around 45 speakers over the three weeks, including;

- Prof Allan Buckwell from CLA
- George Dunn of the Tennant Farmers Organisation
- Tom Hind of the National Farmers Union.
- John Alvis from Lye Cross Farms, Somerset.
- Richard Benyon MP and Minister for National Environment and Fisheries.
- Emma Penny from the Farmers Guardian.
- Peter Morris - about relationships with the media.
- Christine Tacon the newly appointed Supermarket Ombudsman.
- Dr James Jones – CAP.
- Dr Alistair Leake –Environmental Policy
- Angus Chalmers - Marketing
- Adrian Ivory - Relationships with Supermarkets
- Steve Thomas - Capital Investment
- Caroline Drummond from LEAF - The Environment and Relationships with the Public
- Andrew Ward - Modern Cereal Management
- Duncan Sinclair, Agriculture Manager for Waitrose

- Anne Steele from the Waitrose Primary Producers Group.
- Prof. David Harvey, Professor of Agricultural Economics at Newcastle University.
- Hamish Gow Massey University - Value and value chains.
- Tony Pexton OBE - Nuffield Scholar who spent 20 years with the NFU as a Liveryman with the WCF.

My thoughts since my return to New Zealand have been on some of the topics we spent considerable time on for example - CAP Reform and the uncertainty it brings to the UK farmers. Many of the delegates see the Single Farm Payment as a social payment and feel it should be directed to the areas of society that need it. At around 230 pounds a hectare, it is a huge part of a farms income. It does however distort land values and contract farming agreements.

Within the group it was felt that these payments would or should be phased out. Capitalising three years of payments was seen as a way of softening the blow and allowing time for adaption.

Being the only Kiwi on the team, I gave an overview as to how agriculture in New Zealand adapted after having Supplementary Minimum Pricing (SMP) taken away in the 1980's. Yes it was tough for a few years and people did walk off the land but I do not think any farmer in New Zealand wants to go back to that system.

I do believe that the Single Farm Payment (SFP) is making UK agriculture complacent and unmotivated to become more profitable. This view is shared by Paul Adam, an Australian colleague on the course, who is more than happy to see the support in the UK continue. If it were to be discontinued, I would say UK agriculture would become more competitive in the market place over time, perhaps to the detriment of us in the Southern Hemisphere.

Value chains or supply chains were something that came up often. There is a trend for the supermarkets to be seen to be more involved in the production of food, and offer traceability. This adds cost to food production and being told that having quality assurance systems give us "market access" simply isn't enough. For it to be a true value chain means that everyone in that chain gets a fair and transparent share of its value.

One of a supermarkets biggest fear is an empty shelf. While I am not suggesting that farmers should hold the supermarkets to ransom, I do believe farmers are at times their own worst enemy because they are individuals by nature. Primary Producers need to stick together so as not to get picked off one at a time by the buyers of what they are producing.

Interesting to note that a dairy farm I visited in Gloucestershire was supplying milk to a prominent supermarket chain through a processor and had several compliance hurdles to overcome to the extent that his milk cost 4p/litre more to produce. For his effort, he received an additional 5p/litre for his milk. Hardly worth the effort when you consider the fact there is no contract, so there is potential for him to lose his market at any time.

Current state of play on farm in the UK

I stayed with a couple of delegates from the course during my time in the UK. While they were both arable farmers and their problems related more to that industry, the weather was the biggest issue, with double the annual rainfall in the 2012 calendar year. Therefore their yields have been knocked around severely. A trying harvest then led to difficulties establishing crops in the autumn, and getting herbicides on at the appropriate time proved to be near impossible. This left some crops looking very much worse for wear coming in to the early spring. Subsequently it led to a relatively poor 2013 harvest.

Other issues facing them were the continual loss of chemicals to legislation, limiting the ability to deal with pests in an economic way. From what I saw, Blackgrass is one of the worst problems UK arable farmers in the UK are faced with. Definitely something we don't want in New Zealand.

Likewise, livestock farmers are struggling to be profitable. Indoor systems, high cost of feed and the high cost of compliance being major factors.

New Zealand lamb is perceived as undercutting the market also, and I cannot blame UK farmers for thinking that way when you see New Zealand lamb on the same shelf in the supermarket as UK lamb yet theirs is 40% more expensive. I am assured that is to with special pricing, promotions and lost leaders. I do, however, struggle with this and seeing this in the supermarkets, does not paint a good picture.

Chapter 7 - Conclusions

Agricultural systems in New Zealand are somewhat unique when comparing with systems used by our counterparts in some of the more developed agricultural countries.

This is particularly evident in the dairy industry, where the housing of cows is the norm for at least part of the season in North America and Europe. While this adds cost to the production system, it does give some control to the flow of nutrients back to the land. There is an argument for the amount of fossil fuels needed to then bring the feed to the animals, which is an area for further discussion.

New Zealand's grass based dairy system would appear to have a limited life span in its current form if cow numbers are to increase at a similar rate as they have done since 2003. In the absence of subsidies, the New Zealand agricultural industry has become very innovative in its approach to solving economic problems better than most of their northern hemisphere counterparts. An area that needs focus or attention in the immediate future is the environmental sustainability. But we need to use all three pillars - the environmental, the economic and the social pillars.

As New Zealand farming systems evolve it will be essential that nutrients from the dairy enterprise are transferred to the cropping enterprise. From my study I see the best model for this being to move the cows for winter grazing to feed pads on cropping pads to allow for efficient delivery of nutrients.

If you take the example of the dairy and arable farms in Nebraska, both are reliant upon one another and use a formula to negotiate pricing to ensure both parties can remain economically sustainable.
There needs to be further work in this area in terms of cost within a New Zealand system.

The next part of the challenge is to make sure the environmental aspect remains sustainable. Regulation has not achieved this in the US or Britain, but rather limits production and creates little incentive to reduce nutrient losses.

We are already making significant improvements to the water quality of our New Zealand streams and rivers, but much of this improvement is clouded by the lack of reliable data as to the actual numbers pertaining to the water quality at the starting point. This, coupled with the lead in time for changes in management of the environment, whether that is in the agricultural, industrial or urban sectors, means progress will not be immediate.

If we look at the arable industry, New Zealand's cereal production is relatively insignificant as a percentage of world production at around 0.4 % or 1 million tonnes of total global production of 2241 million tonnes.

Therefore the industry has very little influence over global prices and should focus on high value niche markets overseas, in particular the Asian region. But by far the bigger market for arable will be New Zealand dairy industry in the supply of medium protein feeds that will increase production and decrease nutrient discharges from dairy systems.

The cost of fertiliser in New Zealand is on average higher than most other countries that I visited. In the for example, the urea price in the UK was sitting at £250 (NZ$500) per ton delivered on farm (Padfield2013) at a time when the New Zealand price was NZ$730 per ton.

This is in part due to the higher freight component to get the product to the southern hemisphere (although we do have a urea plant in Taranaki), but also there is limited competition from organic fertilizer. Unlike both Europe and the US, where animal and human waste are readily available at economic values. Making better use of locally produced organic fertiliser seems a logical step.

The value of organic fertiliser should be valued on a formula taking into consideration urea prices, transport and spreading costs.

The urea market has traditionally been volatile due to production capabilities but there are currently several nitrogen capacity projects the planning stages, many in the US. Most of these won't see fruition until the market rises from its current low. Based on this it, I expect the supply will match demand in the future. Pricing will therefore be stable but above the current low pricing we are experiencing.

By better utilizing our organic fertiliser, we will create further competition in the marketplace, which will improve the affordability.

New Zealand and its small population has many advantages over many other parts of the world in that fertile productive land is not as at risk to urbanisation, environmental pressure is not as great, and the consumer in general it is more closely 'linked to the land'. This does however leave us with fewer opportunities to capitalise on a large consumer base in close proximity to where we farm. Therefore somewhere in the range of 80% of NZ food production is exported.

This means that there is limited opportunity for the recycling of by-products whether that is distillers' grain from ethanol production, stale bread from the supermarkets or chicken litter and human waste from local municipalities.

We do have the opportunity in New Zealand to make better use of our organic nutrients produced on dairy farms by returning them to the area where the feed is grown and there needs to be a focus on the fundamentals of this, rather than wait for the environmental regulators to make the decision on our behalf.

The way these organic nutrients behave with in the soil is an area that raises many questions.
When is the right time to apply the dairy effluent?
How much nitrogen is mineralised?

This is an area that requires further research in New Zealand but also in collaboration with our research partners globally, in order to make best use of the resource economically and environmentally.

From a crop protection perspective, loss of chemistry is a real threat to European agriculture. It seems likely that the 800 active ingredients that are currently available for crop protection will be slashed to 100 in the next five years. Organophosphates and neonicotinoids alone account for some 250 of the active ingredients unlikely to be reregistered due to environmental restrictions.

For us, I think this means a wait and see approach in the short term as Europe comes to terms with the implications of operating in an environment with fewer options for pest control. Diversity and integration of our rotations across all sectors of New Zealand agriculture will be a key factor in insuring continued efficacy and low environmental impact from our pesticides.

EU policy is often the driver for on-farm management decisions in European agriculture. Many farming enterprises have diversified into what could be called non-core income streams. Bio digestion and renewable energy have gained popularity in recent years, along with on farm diversification into office lets. However most of these systems would struggle to support themselves without some form of government intervention.

Biodigestion cannot pay its own way in a subsidised environment; therefore I don't believe it can in a non-supported environment such as New Zealand. Should energy prices drop in future which appears likely, the case for biodigestion looks even shakier. Let the Manufacturers get the problems ironed out by which time there will be some better science and more efficient units.

The same could be said for the US Policy, with incentive schemes to help smooth income and ease the burden on capital investment. The US Farm Bill was set up in the late 1930s to help lower the cost of living and offer some guarantees to the farmers of the Midwest. Although now very much lacking teeth and focusing on food security and nutrition, it still provides crop insurance and income smoothing the American farmer. Again this provides the opportunity to structure the farm business in such a way that may not be economically sustainable without government support.

I have gained an appreciation of both the US Farm Bill and the Common Agricultural Policy over the last 12 months. Both of these systems have an effect on agriculture in New Zealand, not only because we compete in many of the same markets with their products, but also these support mechanisms have an effect on the world prices for many of our inputs including fuel and fertiliser.

Furthermore I understand they were introduced to enable food to be produced at a price that is affordable for all consumers and to assist the agricultural industry through periods of economic and climate adversity.

As with many such schemes, the law of unintended consequences comes into play. Consumers now expect food will cost less than 10% of the average wage. Many farmers in the US and Europe would struggle to be profitable without some form of government support and many of the more forward thinking operators would argue that the government support actually stops innovation.

When in discussions with European Farmers, NGO's and Policy makers, it is very clear that New Zealand is looked upon as a case study to a free market environment and is highly regarded with respect to the resilience shown by its agricultural industries in the 25 years since subsidies were discontinued.

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