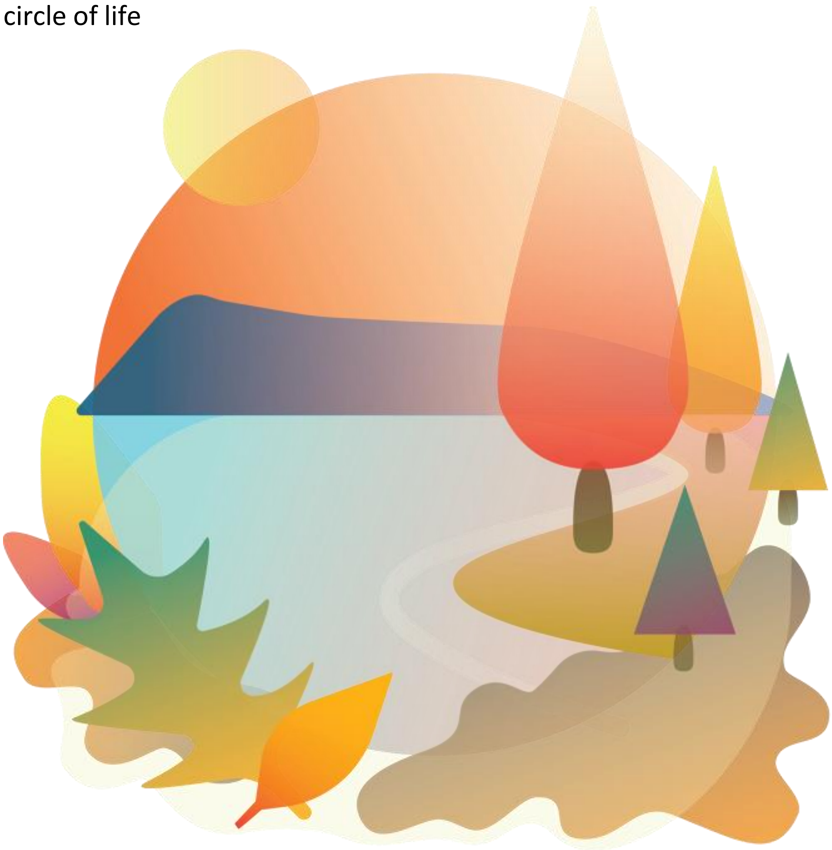
KELLOGG
RURAL LEADERSHIP
PROGRAMME

Biologically Integrated Organic Dairy and Vegetable Growing

A regenerating circle of life



Kellogg Rural Leadership Programme

Course 38 2018

Sam Hogg

MINGIROA FARM

Acknowledgments

A big thank you to everyone and everything in my life that has got me to this point right now. I haven't done much really, I'm just a product of my environment. Luckily I have been blessed with an incredible environment. Loving family, friends, workmates and a beautiful country. I couldn't have done this without anyone or anything.

Cheers Richo, Sal, Ally, Honk, T, Misty, Gordo, JJ, Yvonne, Pete and Paul you're all awesome.

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Background

There is great disconnect in society when it comes to externalities and who pays for these. Specifically in agriculture, the common goods be it air, water and soil are getting destroyed by modern farming methods. It is these very foundations that everything is built on, not just a farm or some food. Environmental limits are well and truly being meet here in New Zealand and globally. We cannot continue down this path for too much longer without seriously altering our sources of nutrition, our lifestyles, or finding a new planet and doing it all over again.

As farmers we have a huge responsibility to not only grow food but to care for the land and the resources of the world. Every decision we make when we farm holds environmental consequences, be it good or bad. We need to look for new ways of doing things to ensure our farming systems are not buoyed along by environmental destruction somewhere else. We need to find ways to minimize off farm inputs and start regenerating our soils. We need to keep the land productive but not at the cost of degradation. We need to start effectively managing the complex biological relationships that underpin a farms success, rather than being dependent on synthetic chemicals. We need to work with nature, rather than wage a war against it. We need to increase profitability. We need to find ways to bring community and vocation back to farming.

Objective

The objective of this report is quite simply to find a more 'complete' and realistic food growing solution for our farm Mingiroa Farm, that can then be modelled and modified to suit other farms not just nationally but globally. Bearing in mind that every farm and farmer is unique so I'm not advocating for a carbon copy approach, but fortunately the fundamentals of nature and life are all the same so hopefully it will provide a good starting point, inspiration or at least bring about some questions.

Method

The research was initially looking at the regenerative agriculture principles to base a more complete food growing off and looking at modern industrial agriculture and where this may be failing. It then looks to our family farm, Mingiroa Farm as a case study and the opportunities present in the current system. With the help of textbooks, journal articles, interviews and Alex Novak a complete model has been planned and budgeted to understand how this may look and the financial implications of shifting and running such a system.

Introduction

This project began with a two hundred square metre vegetable garden in 2017. I naively like most, thought vegetables were the answer to all the world's problems. So I schooled myself up on all things vegetable at a market garden level. I wanted a complete system in which there were minimal external inputs. If there was a word to define the fundamental philosophy and system I was wanting to follow it would be permaculture. Bill Mollison and David Holmgren coined the term in the 70's. It is an agriculture philosophy based around using the resources that we have around us to their fullest potential. By observing and learning how for example nature replenishes its soil, protects sand conserves its water resources and adapts to specific climates we can mimic these processes in our daily life and establish a balance which will provide us with the things that we need without hurting the environment. (Mollison, Holgren 1978)

The large nutrient requirements for vegetables poised a problem. However, natures non-animal solution to this is quite simply making compost and letting the soil rest. The resting was already done with the ground being a lawn for the last 10 years and pasture for the previous 50, compost was the job on. So I spent many hours mowing and raking any nitrogenous or carbonaceous material I could find in my immediate surroundings and putting it all in various heaps to undergo a hot compost. I thought heck this isn't necessarily the easiest thing to do in the world, but I constantly reminded myself that easy isn't necessarily good or right. I thought I would end up with ample nutrients in the form of compost, but the more I put in the quicker it seemed to break down and reduce considerably in volume. Although I never got the compost tested to understand the nutrient content of it, it was quite clear by the start of the growing season I had nowhere near enough compost and ended up purchasing three metres squared for a petty price of $90 per square metre. Which got me thinking, with the land area and work required for me to make my own compost, this price was incredibly cheap, cheap enough to sell my permaculture principles for this season anyhow and buy in fertility.

I soon consoled one of the leading market gardeners in New Zealand, Jodi Roebuck at a course he was running at his home. He had been through the same physical and thought process his first growing season. He went crazy all year with mower and rake but could never make enough compost for that sort of price. The reality is that most organic market gardeners worldwide are all buying their fertility in. I felt their systems on the outside appeared sustainable but really are built on large amounts of energy and nutrients which are bought in at a price in which the externalities or true cost accounting for damage to the common good for example land, air and water are never entirely realised. Which I saw as a fundamental flaw in the sustainability of the vegetable solution. There must be a better way. This project is an attempt to find a more complete food growing solution working with all aspects of nature to not merely be sustainable but be constantly improving the environment around us, regenerating it so we as the caretakers for now, can pass it to the next generation in a better state in which we received it.

(Figure 1 Development of my vegetable garden 2017)

MINGIROA FARM

Regenerative Agriculture

Firstly I shall look to regenerative agriculture for overarching principles which need to be met by a more complete or holistic solution. But what is Regenerative Agriculture?

"Regenerative Agriculture is a system of farming principles and practices that increases biodiversity, enriches soils, improves watersheds, and enhances ecosystem services. Regenerative Agriculture aims to capture carbon in soil and aboveground biomass, reversing current global trends of atmospheric accumulation.
At the same time, it offers increased yields, resilience to climate instability, and higher health and vitality for farming and ranching communities.
The systems draws from decades of scientific and applied research by the global communities of organic farming, agroecology, Holistic Management and agroforestry." (www.regenerativeagriculturedefinition.com)

So rather than merely sustaining the natural environment, regeneration equates to constant improvement. It doesn't just consider the natural environment though, as seen by it's four principles:

1. Progressively improve whole ecosystems (soil, water & biodiversity)
2. Create context-specific decisions and make holistic decisions that express the essence of each farm
3. Ensure and develop just and reciprocal relationships amongst small stakeholders.
4. Continually grow and evolve individuals, farms and communities to express their innate potential. (www.regenerativeagriculturedefinition.com)

The fundamentals of what I consider a more 'complete' solution can't be summed up any better than these principles.

Charles Massey builds on our definition in his interview :

> "Regenerative agriculture contests the industrial model in that it encompasses various types of farming that seek to enable natural systems and functions to not just be renewed but also to do the renewing: to allow self-organisation of natural systems back to healthy function.
>
> In its original derivation, the verb 'regenerate' also has moral and ethical connotations. So I would say that organic farming is one of a range of practices that

comprise regenerative agriculture: from holistic/ecological grazing, to agroforestry, biological cropping, pasture- and No-kill cropping; biodynamics and more." (https://www.echo.net.au/2018/08/charles-massy-interview/)

Regenerative agriculture takes a nature centric view on farming, but with the belief that the health of nature, the community and profitability are all tied together. Profitability should not come first but will be a by-product of getting the environmental and social side of things sorted out. It certainly does need to be considered as we're all strapped with the shackles of modern day society such as interest and high costs of living, but it should certainly not come at the cost the health of the community and the environment. Considering these overarching principles I shall examine the current industrial model and what may be a proposed regenerative solution for Mingiroa Farm.

Global Industrial Agriculture

I don't think there would be much argument in saying that modern industrial agriculture is not fulfilling any of the regenerative principles or is by any means merely sustainable. The expansion of large scale industrialised monoculture farming systems has come at the cost of smaller, diversified family farming systems. This began with the European Colonial plantations of the 1500-1800s (McMichael 2009, Perfecto et al. 2009) and expanded with mechanization of agriculture in the late 1800s and the introduction of synthetic fertilisers and pesticides post ww11. This final step known as the "Green Revolution" was an integrated system of pesticides, chemical fertilizers, and genetically uniform and high-yielding crop varieties that governments, companies, and foundations vigorously promoted around the world (Evenson and Gollin 2003, Smil 2004).

By the year 2000 due to the expansion of industrialized agriculture global nitrogen use had increased eightfold, phosphorus use tri-fold, global pesticide production eleven fold and the worlds irrigated cropland had doubled in area (Tilman et al. 2001). Synthetic nitrogen consumption in NZ alone from 1990 to 2015 has increased from 60,000 tonnes to 420,000 tonnes.(http://www.fertiliser.org.nz/Site/about/fertiliser_use_in_nz.aspx)

This has certainly led to production gains within the agricultural industry and as of the 21st century there was more than enough calories to feed the world. Which is great but this does not mean to say the whole world was fed with one billion of the world hungry and a further one billion suffering from micronutrient deficiencies. This is a bit of a paradox that occurs due to many people still lacking access to sufficiently diverse and healthy food due to global distribution issues. (IAAKSTD 2009).

However, these production gains have come with huge costs; polluting waterways, creating dead zones in the oceans, destroying biodiverse habitats, releasing toxins into food chains, endangering public health via disease outbreaks and pesticide exposures, and contributing to climate change (Horrigan et al. 2002, Tilman et al. 2002, Diaz and Rosenberg 2008, Marks et al. 2010, Foley et al. 2011). These numerous environmental and social externalities create huge economic costs that industrialized food producers seldom pay. For example in the United States pesticide use alone has been accounted to cause up to $10 billion in damage to humans and ecosystems every year (Pimentel 2005).

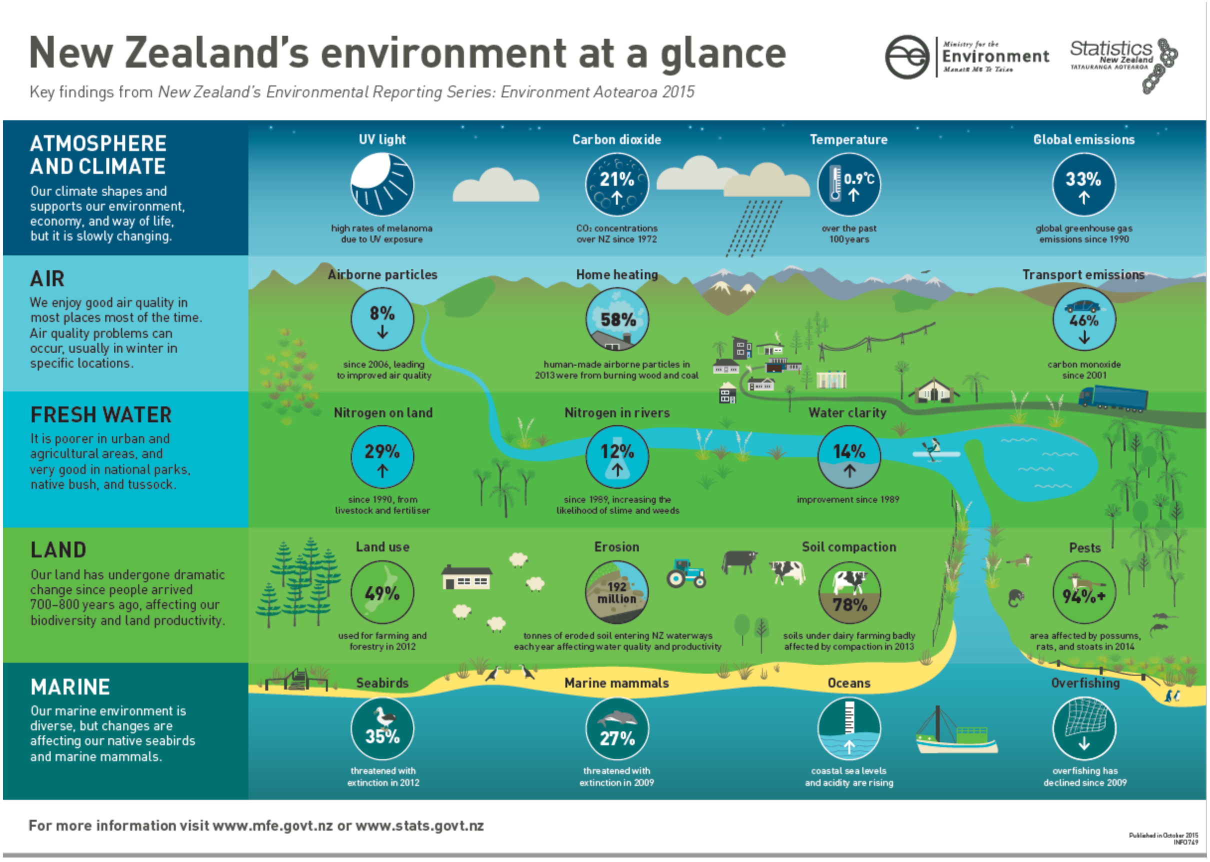
When we hear this term of industrial agriculture, feed lots, rainforest deforestation, hectares and hectares of grain and soybean under irrigation may spring to mind. Yes these examples may be the height of this system, but it is important to note any farming system using technology and external inputs to boost yields is very much a part of this system. And even these examples can even be easily found right here in New Zealand, with ANZCO's Wakanui grain finishing feedlot capable of holding 19,00 cattle springing to mind.

Bear in mind we are the 31st least populated country in the world,

(https://data.worldbank.org/indicator/EN.POP.DNST?view=map&year_high_desc=false)
and one of the last countries to be colonised and subsequently farmed with 50 percent of the land in native bush when the English began colonisation around 1840.

https://teara.govt.nz/en/interactive/11674/deforestation-of-new-zealand.

With 49 % of our land farmed, this infograph from the Ministry of the Environment sums up the environmental cost industrial agriculture is having on our environment.



(Figure 2 Infograph with key environmental statistics 2015 http://www.mfe.govt.nz/publications/environmental-reporting/new-zealands-environment-glance)

Not only are public goods destroyed under this system but there are further social costs. Farmers must now negotiate with corporate food buyers, buy agrochemical and seed inputs from agents and seek loans from banks. Farmers rely on such relationships to compete effectively and to manage increasingly changing ecological conditions. These relationships often push individual farms to increased dependence on banks, damaging livelihoods, and undermining collaborative social learning groups as farmers specialize in a single crop and maximize short-term yields with the increasing use of external inputs, to meet loan repayments. The economic pressures in these tightly linked systems generally corrode ecosystem services, which are the very foundation of on which they are made. (Kremen et al. 2012). Here in New Zealand we have all witnessed how technology has made redundant once thriving rural communities by reducing labour required on farm. We currently seem to have this town vs country polarisation and finger pointing over who is at fault for the environmental damage and not to mention consistently high suicide rates within farmers, whereby more die by their own hand than in on farm accidents.

(https://www.nzherald.co.nz/wairarapa-times age/news/article.cfm?c_id=1503414&objectid=11342705)

These all are shocking indicators of a system that is failing everybody. A system where yields reign supreme, resources are unlimited, and the short term is all that is considered.

With huge input costs, homogenous operations, high debt levels, high stress levels and monstrous ecological devastation all manners of life are out of balance and cannot continue in such a state for too much longer without something giving. It certainly doesn't take a rocket scientist to see that the current system of modern industrial agriculture is just not working and fails on all levels of the regenerative principles.

This problem is not by any stretch small, it affects and includes every cellular life on this planet. It is a holistic problem that requires a holistic solution. As Albert Einstein famously said:

" We cannot solve our problems with the same thinking we used when we created them."

Technology has got us to this place, it certainly won't get us out. Technology may be a part of the solution but it will never be the whole solution. Technology is far too centred on solving one problem, which may come at the expense of something else. The purpose of technology is to make our lives easier, but this will never come at the expense of our livelihood. The solution must come from a whole new level of consciousness. A consciousness that considers all parts and levels of life. The fundamentals of a healthy planet and life must first be understood and respected before we work out technologies role in helping us get here.

We need a solution that benefits every cellular life on this planet, not just accept humans will walk this earth with a footprint but that we can play a part in improving this world to hand it to the next world in a better state than we received it. A solution that goes beyond the root of everything that all begins with our fundamental relationship to the soil.

MINGIROA FARM

Established 1852

Case Study

Recent history and current system

We as a farm and a family are certainly contributors to this problem. The farm has had many different 'careers' but the most recent is undoubtedly the most energy intensive and environmentally damaging.

In 2007 we converted to dairy for succession reasons. Due to a combination of sharemilker pressures, greed and unawareness of the large environmental toll we geared up for a system 5 farm, milking 450 cows over a 150ha platform, importing on average 300 tonnes of palm kernel expeller and 300 tonnes of maize and or grass silage bought in or grown at our runoff under a 2 year rotation, conventional cropping regime. Furthermore, 50kg of Urea was applied per hectare each year and 30 tonne of turnips were grown each year on the platform as a summer crop and regressing strategy.

The costs of this system were huge. Environmentally, financially and mentally. It's very hard to quantify the environmental and mental however financially over the course of the recent dairy downturn and with a sharemilker leaving we eroded nearly 1 million in equity having to cash flow these enormous costs without the pay back for the milk. We quickly got together as a family following this period and sort about righting our wrongs, finding a more sustainable dairying solution both environmentally and financially and soon made the decision to convert to organic dairy.

Having had 16 hectares of land managed organically in the early 2000's for direct market vegetable production the idea didn't frighten us quite like it does for many. We already understood that weeds are generally symptoms of an unbalanced soil, nature can and will heal itself if left to its own devices and the attitude of preventative farming rather than curative farming sat well with us.

Biological Farming

We were quickly led down the path of biological farming by Greg Barclay of Soil Connection. The principles of this method of farming made absolute sense. We saw it as farming organically but with an increased focus on the soil biology and profitability. Farming for low costs, regenerating the soil and upmost animal and human health are fundamentals of this system. Biological farming is quite simply a common sense, basic approach to farming. Utilizing both resources of science and nature to work harmoniously together. It all starts with taking care of the soil life – nurturing it, feeding it a balanced diet, grazing at the right times and the appropriate use of tillage tools and methods to enhance soil life. (Zimmer 2000)

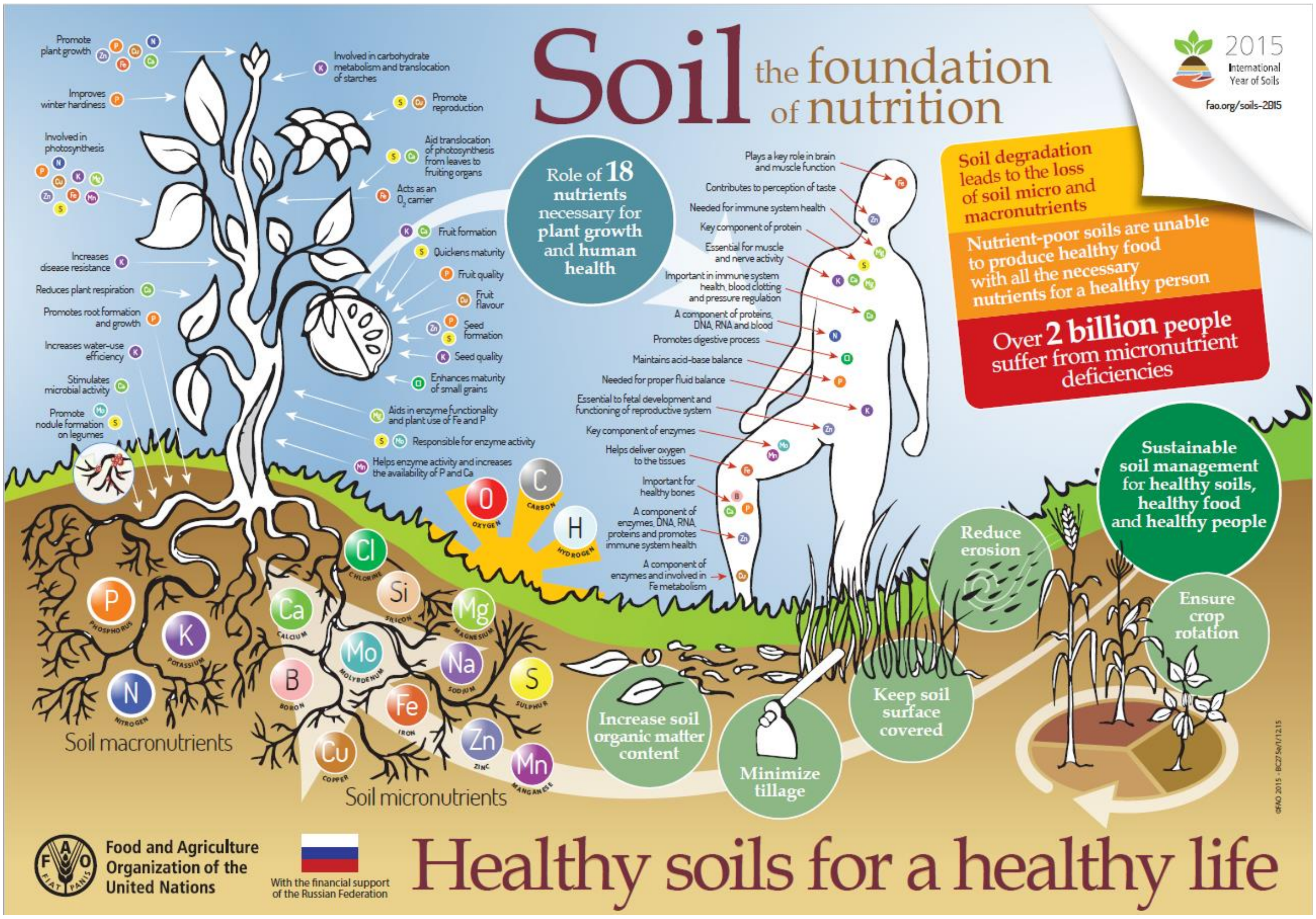


Figure 3 Food and Agriculture Organization of the United Nations Infograph, Healthy Soils for a Healthy life

(http://www.fao.org/resources/infographics/infographics-details/en/c/358223/)

More specifically working with Greg under this system the steps taken are :

1. test the soil to measure total extraction of 12 major elements, using very strong acids, this to see what exactly is available to access , then also use a weak acid test to mimic what soil biology would extract , this gives us a look to know what we need to add , and what is not there in sufficient volumes or to look at ways to extract what is already there .
2. Cell salts are needed, or building blocks for all cell reproduction, we find these mineral deposits from Ocean Sources, these to aid the loading of essential elements into the plant cell, such as Silica, Calcium and magnesium etc , and to create chlorophyll for effective sugar production , Essentially Energy.
3. Introducing new essential Bacteria and Fungi to the soil , these harvest atmospheric nitrogen and sulphur , and aide the extraction of minerals from the soil , also to provide insect pests control eg grass grub, clover flea etc . All soils have some forms of these already, but not necessarily ideal species.
4. We ensure we have 7+ plant species, summer autumn spring and winter grass species, legumes , Forbes and herbs , this provides the chance to get a complete diet for any mammal. This also provides the chance to provide to full range of sugars to the micro biology living in our soil, and allow the plant to provide the necessary carbon to store and fuel the system
5. We also need to manage our pastures well , longer rotations, 7-10 grazing's per year , understanding what is best for the plant to fully regenerate itself efficiently, an understanding also of moon cycles impact on seed germination , plant sugars and even animal behaviour.

(Soil Connection – Greg Barclay)

Practically under this system:

- We have dropped cow numbers to 300, across a 107ha milking platform with supplementary feed grown organically, replacements reared and cows wintered at a 80ha runoff block 12km away.
- The whole platform (107ha) and most the runoff receives two times a 5l per ha foliar application of a fish fertiliser Autumn and Spring and a single 500kg per ha of a lime based mineral mix. At a total cost of $30,000 per year.
- We have been over sowing approximately 20ha per year of pasture with a mixed species sword that costs approximately $350 per ha to do.

- And most importantly no paddock is grazed without at least a month rest and recovery period, stretching this out to 70 days in winter.

We are only 1.5 seasons following these fundamentals, so it is too early to make any absolute concrete claims with years of data to back, but what we are seeing on the ground we are extremely happy with. The farm is looking the healthiest Dad has seen it since it's been dairy. It is consistently growing extremely palatable grass, with the cows grazing paddocks the best they've ever grazed. The spring cows are producing 1.8 solids a day. Animal health problems are less than they've ever been, vet costs are a third of what they were. Empty rates have dropped significantly. And the cows are the most relaxed and settled they have ever been.

On the whole looking back at the regenerative principles I would say we are getting close to meeting all of these. However, we are still reliant on a 70ha runoff block that requires large amounts of fossil fuels to cut, transport and feed out food to the milking cows at home and we are still very much at the mercy of the global dairy milk price as we run less cows with less variable expenses but still similar overheads with only a 45c in conversion organic premium. We are also very much at the mercy of the climate with last year being the classic example of huge rainfalls all year totalling 1247mm by mid October and subsequently only 273mm over a 4 month period with scorching 30 degree temperatures and strong winds. It's hard to completely quantify the cost of this drought, but on a ballpark financial figure it was around $250,000. Resilience is certainly being built into our farming system with the changes so far, but again I don't think this is a complete solution just yet. There is still plenty of stress both environmentally and mentally with the vulnerabilities inherent to a largely homogenous system. Balance in all aspects is not quite found. Which is where the cows, the effluent pond, vegetable cropping and the nutrient cycle come into play.

Water Consumption in Dairy Farming

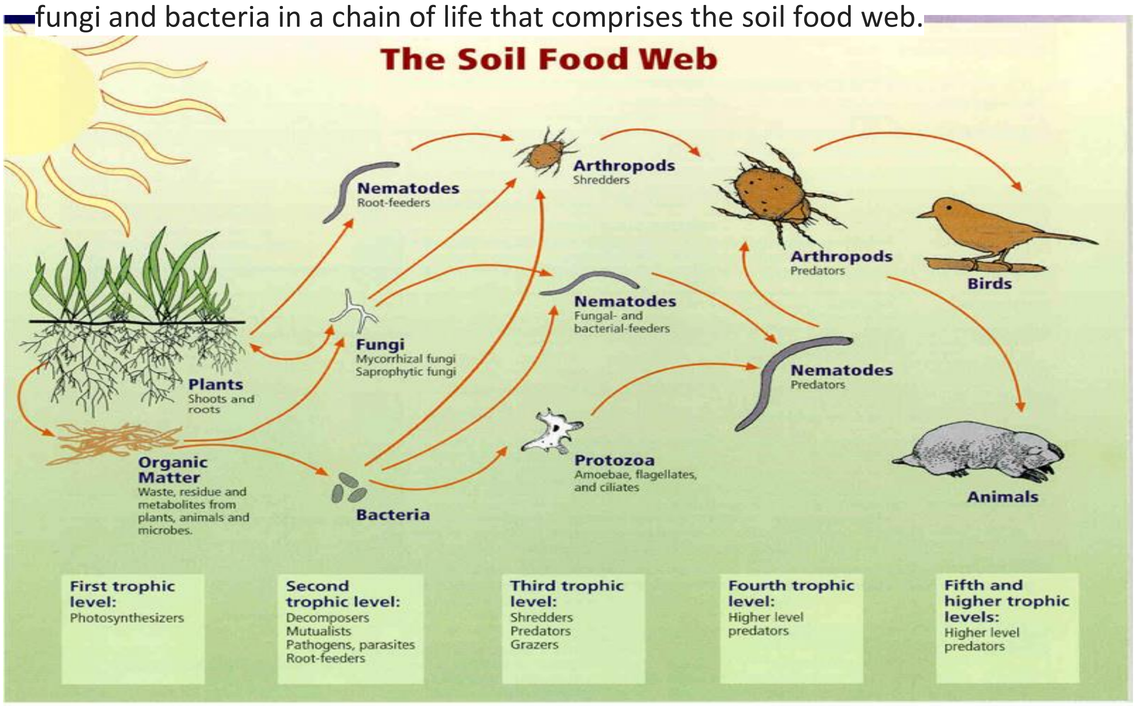
It just so happens that dairy farming requires a lot of water. Which is a bit of a problem. Water is not only for the cows to drink but in used in large quantities the washing up process of the cow shed and surrounding concrete. Over the month of May 2018, with 300 head of cows on our farm this equated to on average 67,000l per day. Assuming each cow drinks 70l of water each per day, this would mean both milking's equate to 46,000l of water essentially down the drain. However as most are all aware this is not lost, yes some may evaporate back into the water cycle, but for the most part it is collected into effluent storage ponds and spread back onto the ground, feeding these nutrients back into the soil.

Largely effluent has been considered a real issue in New Zealand because it's been deemed a waste product to get rid of in the cheapest manner possible. Typically only a few paddocks are set up to receive this effluent through various forms of irrigation. This can lead to a raft of problems such as nitrate leaching and nitrate poisoning as the soil and the plants can only uptake approximately 60-80kg of Nitrogen per hectare each application. Furthermore cow urine is very high in potassium which comprises a big part of effluent and which can cause issues in the soil, this should be applied at no more than 60kg per ha each application totalling no more than 120kg per ha in a year.(Dairy Australia)

So not only do you get these environmental toxicity issues around the irresponsible and uninformed application of effluent, but the huge nutrient potential of this effluent is also lost. It is all in the way we view our effluent. If seen as something to get rid of it can very easily cause more harm than good, however if seen as a valuable by-product of a dairy farming system it is treated with respect and when used effectively improves our soil and plants which is where farm health, animal health, human health and consequently farm success all begin.

Benefits of Animal Manure

Animals are essentially composting machines. They take organic material and compost it in a matter of hours, excreting out organic matter in a more nutrient soluble form which is then utilised by bacteria, fungi and other organisms in the soil. Higher organisms then feed on the fungi and bacteria in a chain of life that comprises the soil food web.



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

More specifically a study completed by ag research (Longhurst, R. D et al. 2017) on the nutrient content of liquid and solid effluents across multiple farms in NZ found:

Table 1. Physical and chemical properties of liquid FDE (%).

	%DM	N	P	K	S	Ca	Mg	Na
FDE - sumps								
Median	0.43	0.039	0.007	0.047	0.004	0.012	0.007	0.004
Mean	0.81	0.047	0.008	0.056	0.006	0.023	0.008	0.005
Count (n =)	63	77	77	77	39	39	39	39
FDE - ponds								
Median	0.28	0.019	0.003	0.029	0.003	0.007	0.004	0.011
Mean	0.40	0.025	0.004	0.032	0.004	0.008	0.005	0.011
Count (n =)	94	133	133	133	133	104	104	63

The pH was analysed on some FDE and median values were found to be 7.3 for sump samples (n =12) and 7.2 (6.8-8.1) for pond samples (n = 39). This shows that FDE is a slightly alkaline effluent and therefore regular application to dedicated blocks on a farm should see a rise in soil pH over time. Median carbon values were 0.46% for sumps (n=12) and 0.23% for ponds (n=12). Median mineral-N values were 0.014% for sumps (n=38) and 0.012% for ponds (n=56).

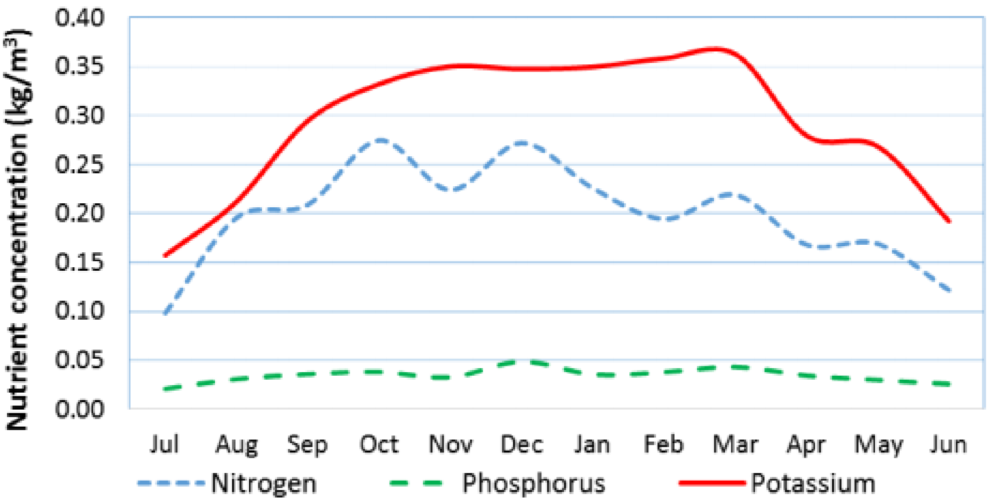


Figure 1: Mean nitrogen, phosphorus and potassium concentrations in pond effluent over year. Data over three years from three sites.

Although another study found that not all the nitrogen in the effluent is available to crops during the year of application as some of it is in the organic form and some is lost during application. Available nitrogen the year of application ranged from 30 – 80%, dependent on application method and type of effluent. However most the potassium and phosphorous are in an inorganic form, so 90% of potassium and phosphorous could be considered available the year of application.(Zhang H and Schroder J,2014)

Research has shown that land application of animal manures also significantly impacts soil, chemical, physical, and biological properties, therefore improving soil quality. Which is mostly down to the increases of soil organic matter following consistent manure application. (Risse et al. 2006)

Manure has also been found to increase soil ph on acidic soils (Tang et al. 2007) and to also increase infiltration (Roberts and Clanton 2000), porosity (Kirchmann and Gerzabek 1999), and water holding capacity of the soil (Mosaddeghi et al. 2000).

Lastly numerous studies have shown land application of manures will result in crop yields that are similar or even superior to those achieved with commercial fertilizers. (Xie and MacKenzie 1986; Motavalli et al. 1989; Zhang et al. 1998; Badaruddin et al. 1999; Lithourgidisa et al. 2007; Butler et al. 2008). Which have been credited to the natural nutrients from manure and improved soil conditions not provided by commercial fertilisers. (CAST 1996).

It seems the benefits of applying effluent or manure to your soil are huge, although caution does need to be exercised in application amounts, frequency of application and soil moisture during application. The old adage little and often rings very true in this and many instances. Now we should look to integrating the collection and application of effluent through dairy farming as a nutrient source for vegetable farming.

Mixed Cropping and Livestock Farming Overview

It is important to note that this is nothing new. Mixed cropping and livestock farming operations were once the backbone of all agricultural production systems. Before cheap synthetic fertilisers, crops were all reliant on animals as a source of fertility. (JA Kirkegaard) A combination of this and the economic efficiencies of specialising has separated each into their separate intensive system. Integrating a pasture and livestock component into a cropping rotation is based on long held agricultural principles of rest and rotation. Aiming to maintain soil structure and organic matter, create healthy soil biology, supress weed and disease pressures and extract water from the subsoil. (Bradley,R 2016)

It was in fact found in Canterbury that wheat yields following 6 years of rye grass and white clover are 30% higher than a continuous cropping rotation. This was due to measurable improvements in soil structural stability, organic matter and nitrogen fertility. (Francis G.S.2001) The longer the pasture phase it seems the better the yield. However short pasture phases still provide increased soil aggregate stability and soil binding agents, along with increasing the porosity and earth worm activity, but do not generally build significant amount of organic matter. (Francis G.S.2001)

Going one step further to a pasture phase is the growing to maturity and then incorporation of this ‘green manure’ into the soil pre-crop. This pasture phase could also be considered a cover crop as it is also used to protect the soil form erosion when it is not being cropped. Legumes such as clover and alfalfa have been found to fix between 18-36kg per ha per year.(Rosen and Eliason,2005) Grasses do not increase the nitrogen content of the soil, but they do trap residual nitrogen, reducing leaching and mine other nutrients from deep within the soil profile and bring them to the surface where they then can be available to the crop when incorporated into the soil and subsequently soil organic matter content increases. Decomposing organic matter also contributes P, K, S, Ca, and Mg to the soil nutrient pool. With a combination of legumes and grasses you get the benefits of both.

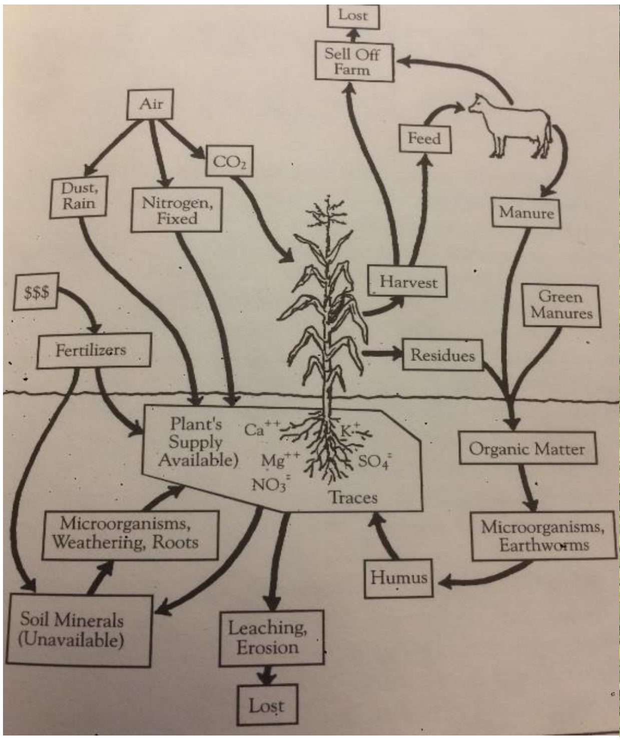


Figure 4 The Nutrient Cycle Zimmer, G.F. (2000)

Figure 5 Mixed Sword at Mingiroa Farm, 35 days rest In September 2018.

Mingiroa Farm Model of a Biologically Integrated Organic Dairy and Vegetable Cropping System

26 paddocks selected, 105.3ha - 7, 6, R1, R2, 5, 8, 4, 3, 2, 1, 9, 13, 14, 15, 16, 17, 18, D19, D20, 21, 22, 23, 24, 25, 26, 27

Figure 6 Potential Cropping ground highlighted blue and purple at Mingiroa Farm.

(https://360.agrimap.com/farms/view#bigmap/11524)

Soils, Climate and Vegetable Crops

Fortunately, at Mingiroa Farm we have been blessed with traditionally good cropping ground, a temperate climate and a decent yearly rainfall averaging 960mm. There are quite variable soils, with a mixture of clay, clay loam and silt loam. With such soils it gives us a variety of options in terms of crops to grow and timings of planting and harvesting. For now I will focus on 5 main crops for various reasons. Simplicity being the first reason. But also both broccoli and cauliflowers have been grown successfully in the past organically when the farm was direct selling vegetables. Currently we successfully grow organically about .5ha of New Potatoes for the farmers market and to sell at our roadside honesty stall. Although the yields aren't huge we direct sell these at a good price for all at $5 a kilo. Finally onions and carrots are staple vegetable which shouldn't be too difficult to grow or sell.

Crop Rotation

Assuming the runoff block is out of the equation, I will run a model with 15ha of vegetable each year with the rest as a dairy milking platform. Each crop will be 3ha. This means over a

105ha dairy platform, which are the blue and purple paddocks above that all have potential to be cropped there is a 7 year crop rotation. As stated earlier we are converting all our pastures into a mix sword comprising of 5 different grasses, chicory, plantain, red and white clover. With a combination of herb, legumes and grasses not only is this a varied diet for the cows but it should work really well as both a cover crop and eventual green manure once left to grow long and incorporated into the soil when the vegetable rotation comes around. Minimising tillage and the potential problems surrounding this and giving the plants ample chance to get their roots nice and deep over the seven years.

Effluent System

Currently we have over 100 days of storage across two effluent ponds so can stock pile effluent for the vegetable area if need be. We have a travelling irrigator set up which can cover 50ha at present and would require a further 1.2km of pipe to cover the next 65ha. The pump, an electric Ecopump has the capacity for this further elevation and distance with the capability to pump up to 80psi.

Machinery

In terms of machinery, we have a few bits and pieces from our previous history, so don't think we would initially have to outlay too much capital to gear up adequately.

Crop Nutrient Requirements

As most the farm has been in pasture under a dairy rotation for the last 11 years, there should be very few issues with natural fertility. You can see from the basic NPK analysis from our most recent soil test which came at the inception of the biological management the levels are pretty good.

Soil tests Mingiroa Farm May 2017		
	Home block	**Shed Block**
N (kg/ha)	36.8	27.3
P(kg/ha)	195.0	380.0
K(kg/ha)	101.0	226.0
PH	5.4	5.4

Soil tests from Brookside Laboratories Inc 11/5/2017

Looking at the nutrients removed by each crop and conservative yields based at the lower end of New Zealand organic vegetable growers averages, the additional basic nutrient requirement for the crops should not be great. The only issues may be with potassium and nitrogen levels in the carrots when grown on the home block. With a single 6mm application of effluent based off table 1 above and assuming 1L=1kg, it should equate to a further:

6000 x .025N x 30%(available N) = 45kg

6000 x .004P x 90%(available P) = 21.6kg

6000 x .032k x 90%(available K) = 172.8kg

Note that this rate of potassium is above the recommended rates stated above of 60kg/ha each application and yearly rate of 120kg/ha, but as the carrot crop should in theory uptake this excess potassium it should not be a problem.

Crops	Yield (kg/Ha)	Nutrient Content of Crop			KG Nutrient removed per ha		
		N %	P %	K %	N	P	K
Carrots	60,000	0.06%	0.04%	0.32%	36.0	26.4	193.8
Broccoli	12,000	0.18%	0.07%	0.33%	21.6	7.9	39.0
Cauliflower	12,000	0.18%	0.07%	0.33%	21.6	7.9	39.0
Potatoes	3,000	0.50%	0.06%	0.71%	15.0	1.8	21.2
Onions	25,000	0.07%	0.03%	0.16%	18.0	7.3	38.8

Estimates of nutrient content are adapted from Maynard and Hochmuth, 2007

The only slight issue is the current levels of acidity in our soils. Refer to table 4.8 in the Appendix. All the proposed crops except for potatoes prefer a soil above 5.5ph so we would have to make minor lime amendments to our cropping soil. We are already doing this as capital fertiliser on a yearly basis so it wouldn't require a lot extra.

Our current organic certifier BioGro, also allows, even encourages the use of dairy effluent as a source of nutrients for vegetable crops. (Biogro, 2009)

Dairy Stocking Rate

With 15ha of Vegetables this would allow for a 90ha dairy platform. By using Dairy NZ's Comparative Stocking Rate calculator assuming:

- 165 peak milking cows grazing on the 90ha platform all year except for 20 days on the river flats and tree paddocks
- Each platform paddock growing 13.3tonneDm per year
- No supplementary feed is bought in
- 25 dairy replacements grazed each year on our hill block, totalling 50 young stock at any one time.

Our Comparative stocking rate is 65kg of live weight per tonne of dry matter. Dairy Nz holds that at 74 kg or less the cows are offered a large amount of feed and there may be opportunities to increase the stocking rate.

Flexibility and Resilience

Much like a seven year crop rotation, at this stocking rate there is a lot of flexibility built into the system so that for instance in times of harsh weather conditions you shouldn't run out of feed, or very wet conditions it should allow you to look after the subsequent years vegetable cropping ground or avoid pugging typically wet paddocks. This surplus can always be managed with beef cattle also, which are extremely tradeable and cost nothing to purchase on a dairy farm, building further diversity and resilience into the system. Most importantly from a regenerative view is that all aspects to the system have flexibility and "fat" built into them and can as a result be balanced.

Financial Modelling

The following information demonstrates the financial impact of the cropping rotation coming onto the dairy platform. The "Status Quo" model is the dairy farm as it currently operates and the "Vegetable Cropping" model incorporates the crop rotation. These figures are in cash terms and are based on 12 months of operation. They exclude any payments of principal and interest (if applicable), income tax and GST.

The overall differences are as follows:

- A reduction in dairy cattle sales relative to the reduction in peak cow numbers.
- A reduction in milk production relative to the reduction in peak cows milked.
- Income coming in from the sale of vegetables.
- A corresponding total cost relating to cropping vegetables which is inclusive of labour to plant.
- There are also several reductions in operational expenditure on the dairy farm. They are:
    - An overall lower cost of labour in the dairy team.
    - Reduction in leased land required and the associated costs (including rates).
    - Reduction in feed and supplement.
    - Reduction of fertiliser costs due to smaller land are farmed (no lease block)
    - Reductions in vehicle expenses, administration, freight and electricity usage.
    - Significant reductions on animal health and breeding expenses.

In summary, the farm operating surplus is increased by 65% (an additional $275k) which could be directly contributed to servicing debt (if applicable) or further capital expenditure. There are also a significant (one off) cash proceeds from the sale of Fonterra shares and excess dairy cattle which could be used in the same fashion.

The table below should be read in conjunction with the list of assumptions in the attached appendices.

Profit & Loss (Cash Terms)	Status Quo	Vegetable Cropping	Variance	Variance %
Income				
Beef Cattle	$21,500	$21,500		
Dairy Cattle	$80,500	$40,250		
Milk Production	$867,297	$520,328		
Nursery	$85,000	$85,000		
Vegetable Income	$0	$1,011,000		
Total Income	**$1,054,297**	**$1,678,078**	**$623,781**	**59%**
FWE				
Vegetable Expenses	0	$507,000		
Wages and Salaries	$162,420	$149,178		
Leases	$79,520	$24,720		
Cropping (Dairy Feed)	$78,000	$54,600		
Rates & Insurance	$37,500	$30,750		
Nursery Expenses	$33,000	$33,000		
Repairs and Maintenance	$33,000	$33,000		
Vehicle Expenses	$32,000	$24,000		
Fertiliser	$28,000	$21,000		
Supplements & Concentrates	$27,000	$13,500		
Electricity	$27,000	$20,250		
Administration	$25,000	$18,750		
Breeding Expenses	$14,000	$7,000		
Animal Health	$12,000	$6,000		
Pasture Renewal	$12,000	$12,000		
Shed Expenses	$12,000	$10,200		
Freight	$10,000	$7,000		
Other	$7,500	$6,375		
FWE Total	**$629,940**	**$978,323**	**$348,383**	**55%**
Farm Surplus (EBITDA)	**$424,357**	**$699,755**	**$275,398**	**65%**
	40.25%	41.70%		
Capital Expenditure	$23,750	$47,500		
Operating Cash Flow	**$400,607**	**$652,255**	**$251,648**	**63%**
Extraordinary Items				
Sale of Excess Dairy Cattle	$0	$121,500		
Sale of Fonterra Shares	$0	$250,000		
Total Extraordinary Items	**$0**	**$371,500**		
Net Cash Flow	**$400,607**	**$1,023,755**	**$623,148**	**156%**

Alex Novak financial model 2018.

Benefits of this System

- The dairy animals through their effluent provide an easy, free, natural source of nutrients for the vegetables, no imported fertility needed. Nutrient balance is struck.

- Through the rotational grazing of pasture it remains in active state, mining nutrients from deep in the soil, adding carbon or organic matter to the soil, improving soil structure and harvesting sunlight to feed the soil biology who in turn provide invaluable minerals and nutrients to the plants growing in the soil. Contributing greatly to the nutrient flow cycle.

- Animals provide a solution to the issue vegetable crop residue or waste vegetables. Reducing the risk of disease and providing a cheap high quality source of food for the animals.

- Huge resilience is built into the soil through increased infiltration and water holding capacity.

- Soil is greatly regenerated but still feeding substantial amounts of people healthy, natural food.

- If we are regenerating and rebuilding soil we are sequestering carbon in it, posing an effective farming solution to mitigate excess carbon dioxide in the atmosphere or climate change.

- Resilience of the farm is substantially increased as the soil is more resilient so the plants also are more resilient too and income comes from multiple sources.

- Profit per hectare is greatly increased, with less stress.

- Dairy Farm provides cheap beef animals allowing for further diversification if feed surplus of this system is too great.

- Both operations are budgeted with fat around the edges, providing further resilience.

- Using a mixed species pasture as a cover crop and green crop greatly reduces tillage and potential soil erosion and compaction. Also reduces the energy footprint of this system.

- Harvest and weeding technologies are still limited for some vegetable crops, requiring larger amounts of labour bringing people and community back to farms.

Conclusions

There is huge disconnect throughout society when it comes to externalities and who pays for these. Specifically in agriculture, the common goods be it the air, water and soil are getting destroyed by modern farming methods. The caretakers of the earth are mining it to make a quick buck and die as 'rich' and 'successful' people. A prevailing attitude of 'taking' eventually catches up and we as a world are starting to see and feel these effects. Whether its climate change, desertification, loss of biodiversity or toxic waterways they're all symptoms of a deeper problem. Huge change is required on every level. The deeper the level the more lasting the change will be. In this report I'm advocating for a farm system change, but what's more important is a mindset and value shift. A system such as this may likely fall over if not aligned with the farmers mind and values. A mindset of giving, abundance, love, compassion, and regeneration must be adopted in order for 'it' to really work. Not just this system but for society to work as a whole.

Where this seemingly small but truly massive mindset shift comes from is a good question. A question of the chicken and the egg, which comes first? In a farming sense, does running a system as I've modelled above bring about this mindset shift in time? Or does the mindset shift need to happen before ever seeing the merits that are not just the financial ones of such a system? Yes financial rewards are handy carrots. But if people are motivated purely by these short cuts will be taken and the system will fall in on itself. Greed has no place in this system. This system focuses on the environment and the people first. Sure profit comes, but not at the expense of the people and planet. We are all products of our environment so potentially the system may bring about fundamental mindset shifts, but initially I feel it must align with at least some core values of the individuals for it to be successful.

Undoubtedly the opportunities in New Zealand for such a system are huge. And the opportunities for Mingiroa Farm are just as big. Most vegetables growers are seeking and paying for fertility and many dairy farmers are wasting precious fertility. Considered by many I've talked to as the "ultimate system", it has potential to solve many problems, not just the issue of fertility. Personally I look at it and say what's the catch? I must be missing something because it can't be this easy? The regenerative principles are well and truly met.

A primary concern with on farm diversification is that one person is running around like a headless chicken trying to be over everything, but here as you can see there is a substantial budget for wages so not one person is having to do this.

Luckily there is a groundswell of farmers not accepting the status quo and trying to find a 'better' way of doing things. This is a system to be seriously considered by them. Even if debt levels are high, it can certainly stack up and does so in our instance. As a farm we may have previous experience growing vegetables which certainly is of help but they're just plants much like grass. All require the same fundamentals and observance and care as a farmer are the most important things. And don't let the common preconception of organics stop you. The reality is certainly not a constant war on weeds and hamstrung production but a positive relationship with nature to produce the best outcome for both. Both look after each other and both are looked after by each other.

Lets start looking after and regenerating this beautiful planet we call home. No point in sh****ng on the very thing that makes us all we are and gives us everything we have.

Recommendations

- As a farm this looks like a very viable option and I highly recommend as a farm we make a move in this direction.
- Look at your farming operation and see what opportunities exist to cut costs, diversify and create a higher value product.
- Get your soils and effluent tested before attempting to grow vegetables in them.
- Look after the environment it is the very thing that your farming operation is built on.
- Seriously consider converting to organic farming, no marketing is required to sell this high value product, the label 'organic' is enough.
- Consider biological farming.
- Look into having multiple species of grasses, forbs, herbs and legumes as a grazing pasture.
- Use the regenerative principles to measure the success of your farming operation.
- Do the "right" thing because it is "right."

Appendix

TABLE 4.8. TOLERANCE OF VEGETABLES TO SOIL ACIDITY

Slightly Tolerant (pH 6.8–6.0)	Moderately Tolerant (pH 6.8–5.5)	Very Tolerant (pH 6.8–5.0)
Asparagus	Bean	Chicory
Beet	Bean, lima	Dandelion
Broccoli	Brussels sprouts	Endive
Cabbage	Carrot	Fennel
Cantaloupe	Collards	Potato
Cauliflower	Cucumber	Rhubarb
Celery	Eggplant	Shallot
Chard, Swiss	Garlic	Sorrel
Chinese cabbage	Gherkin	Sweet potato
Cress	Horseradish	Watermelon
Leek	Kale	
Lettuce	Kohlrabi	
New Zealand spinach	Mustard	
Okra	Parsley	
Onion	Pea	
Orach	Pepper	
Parsnip	Pumpkin	
Salsify	Radish	
Soybean	Rutabaga	
Spinach	Squash	
Watercress	Strawberry	
	Sweet corn	
	Tomato	
	Turnip	

Step Four: Divide KgLWT/tDM

Kg LWT/ha	891	(A)
tDM available/ha	13.7	(B)
Young stock grazing on farm adjustment	0.0	(C)
Net feed for dairy production (B – C)	13.7	(D)

Comparative Stocking Rate = (A ÷ D) ***65 kgLWT/tDM***

Financial Model Assumptions:

	Status Quo	Vegetable Cropping		
Platform				
Platform Size (Ha)	105	90		
Area Cropped (Ha)	0	15		
Total Area (Ha)	**105**	**105**		
Physical Metrics - Dairy				
Peak Cows Milked	300	165		
KGMS per Cow	371	371		
Total KGMS	111,300	61,215		
KGMS per Ha	1,060	583		
Price per KGMS (Organic)	$8.50	$8.50		
Vegetable Cropping				
Type	**Ha in Crop**	**T/Ha (Yield)**	**Price (KG)**	**Cost (KG)**
Carrots	3	60	$3.00	$1.50
Onions	3	25	$4.00	$2.50
New Potatoes	3	3	$5.00	$1.50
Type	**Ha in Crop**	**Heads per Ha**	**Price (Head)**	**Cost (Head)**
Broccoli	3	12,000	$1.50	$0.50
Cauliflower	3	12,000	$2.00	$0.50

- Growing costs sourced from a commercial organic vegetable grower.
- Organic produce prices sourced from Fresh Direct and Ceres.

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