Integrated Farming Systems

The past or the future?

A report for NUFFIELD AUSTRALIA FARMING SCHOLARS

by Robert Bradley

2009 Nuffield Scholar

August 2010

Nuffield Australia Project No 0915

Sponsored by: Rabobank Australia

Scholar Contact Details
Robert Bradley
Bradley Agriculture
461 Wilmores Lane Longford Tasmania Australia 7301

Phone: 0363912404
Fax: 0363912505
Email:robnjo4@bigpond.com

In submitting this report, the Scholar has agreed to Nuffield Australia publishing this material in its edited form.

Nuffield Australia Contact Details

Nuffield Australia
Telephone: (03) 54800755
Facsimile: (03) 54800233
Mobile: 0412696076
Email: enquiries@nuffield.com.au
PO Box 586 Moama NSW 2731

Foreword

My Nuffield journey started with one question. How to maintain and improve the sustainability of our intensive irrigated cropping soils in Northern Midlands of Tasmania?

Our farming system had changed rapidly from one of mixed crop and livestock to intensive irrigated crop and I wanted to examine the importance of integrating livestock/pasture into a cropping system to ensure the long term productivity of our land.

Examining sustainable practise and how leading farming businesses had pursued this objective lead me down many unexpected roads, from organics to integration with the market and value chain.

The traditional mixed crop and livestock enterprises that have served Tasmanian - farmers and dominated the Australian rural landscape are declining. Intensification of cropping has increased rapidly over the past decade driven by both drought, higher grain returns, the decline of the wool industry as well a generational change within the farm sector.

The gradual increase in scale of the family operation along with corporate- investment in agriculture has seen further specialisation occur. Single enterprise systems, be they livestock or cropping are both simpler to manage and measure for those that are investing. Similarly it meets many of the other business principals of scale, efficiency, specialist staff and systemised production. It removes the constant compromise and decision making between enterprises as well as provide an enhanced lifestyle to the operator.

This move toward specialised crop is occurring at the same time as we are facing increasing sustainability issues such as:

- herbicide Resistance
- declining soil structure (organic matter)
- falling soil fertility and increased investment in fertilizer
- continuing decline in our terms of trade
- increasing volatility in commodity markets
- climate change and government response to climate change

- changing consumer sentiment

What are the implications for southern Australia's-higher rainfall zones? What role do livestock and pasture have in dealing with these resource and economic challenges?

Ensuring the sustainability of our production systems will be required both from an economic perspective but also from community and consumer expectation as to how food is produced and land areas managed.

An integrated farming system allows us to use some of the advantages of nature, and ecology, as opposed to relying on chemistry to solve all our production issues. This report is not a push for organic production but rather a look at our reliance on a continuing supply of cheap fuel and agricultural inputs and what are the opportunities and consequences of a more integrated approach.

Key Findings:

- role of pastures in supporting crop rotation; needs revisiting and investment by our research organisations

- the contribution of pasture and livestock phases needs to be financially attributed in any benchmarking comparison of farming enterprises

- the increase in soil organic matter and nutrient building from pasture and livestock far exceeds any downside from soil compaction

- a move towards more integrated and sustainable production practises provides an opportunity to access a growing segment of the market wanting food with a good story
- sustainability is a powerful selling point, both for an industry and individual producers

- Australia, despite its many agricultural advantages doesn’t have vast areas of young resilient soils, cheap sources of labour, fuel or fertilizer. Hence many of the intensive agricultural systems from around the world are not transferable to southern Australia.

With the rapid land use changes occurring in Australia it is important to understand the consequences and opportunities these changes offer.

This research and scholarship has been undertaken with the generous support of Rabobank Australia.

Acknowledgements

My Nuffield experience would not have occurred without the invaluable contribution from my family, my wife Jo who not only managed the farm in my absence but has also been extremely supportive and encouraging of the whole process. Hugh and Ingrid, our children remained both interested and patient in my year of physical and mental absence.

Thanks to my in-law the Chilvers Family whom I have farmed with for many years for providing career opportunities and support before, during, and after my scholarship. Thanks to my parents for instilling a passion for agriculture and further education.

Rob Henry: For finally convincing me to muster the courage and have a second attempt at a Nuffield scholarship.

My personal travels have been aided and assisted by many people who committed time and resources to ensuring my learning experience were outstanding particularly: Alistair House, Emma Garrod, Brock Taylor, Nic Poole, Hope Pjesky, Carolyn Fuerth. Thanks also to the numerous people who gave me an hour or two of their time and through that changed the way I think and farm into the future.

Finally thanks to Jim Geltch, Rabobank, my fantastic sponsor and Nuffield Australia for all providing me with an opportunity of a lifetime.

Abbreviations

HRZ- High Rainfall Zone

GMO –Genetically Modified Organism

UK- United Kingdom

US- United States

EU- European Union

Contents

Executive Summary

Background

There is a rapid land use change that is occurring in Australian rural landscape. From mixed crop and livestock production systems to specialised and intensified crop production. This is driven in Tasmania by high value irrigated cropping options and across the sheep wheat belt by efficiencies and economics of broad acre cropping. There are many sustainability issues that are arising that threaten the long term viability of this move towards annual cropping on soils that have been historically maintained by long term pasture phases.

Farmers and industry organisations constantly balance economics and sustainability outcomes and gaining a greater understanding of the system we have created in such a short period of time is important to all those involved in managing agricultural resources.

Aims

To examine the viability of incorporating a livestock/pasture phase into an intensive cropping rotation. The role pastures play in resolving the long term sustainability issues such as declining soil fertility and structure, herbicide resistance, disease and weed control. To investigate the interface between crop and pasture and how it is best managed.

To understand the role sustainable farming practises play in leading farming businesses both now and into the future. Do "sustainable" farm businesses integrate beyond the farm gate as a means of improving their farm profits and sustainability out-comes?

Method:

The research was split into two main areas: firstly examining, continuous cropping/horticultural production and how they address sustainability; secondly, looking at integrated operations and what impact this was having on their farms economics and resource base. Over a period of ten weeks many researchers were interviewed including, agronomists, farmers, organic producers, sustainability officers, and quality assurance scheme administrators. This involved travelling extensively in US (Pacific North West, California, Oklahoma) as well as UK, Canada France and New Zealand. Research leads to many unexpected directions. It appears the theory of integrated farming systems is often well

researched but poorly practised. To find quality integrated operations with innovative solutions led to examining the organic industry as well as producers who where value adding.

Findings:

- The trend towards specialised and intensive cropping systems has been driven by efficiencies and cost structures, and is reliant on economies of scale to capture the small margins available.

- Tasmanian farming systems need to return a more integrated system that relies more on ecology and nature and less on chemistry and diesel**.**

- Markets, cost structures and resource depletion will drive a gradually move towards more integrated and sustainable production systems. The supply chain will force change in our production techniques to meet their desire for more "sustainable" food fibre and energy production. Sustainability is a powerful selling point, both for industry and individuals

- A profitable livestock/pasture phase is essential for the long term economic and resource sustainability of most cropping systems.

- Perennial plantings need to be incorporated into cropping system.

- The increase in the soil's structure, organic matter and fertility from a pasture ley phase far exceeds the downside of soil compaction from livestock

- The contribution of pasture and livestock needs to be financially attributed in any benchmarking comparison of business enterprises

- Research and Development needs to follow the lead from the organic industry and revisit the integrated system, the role of the pasture phases and green manure crops.

Introduction

I grew up on an irrigated and dry land cropping property in Gunnedah NSW. With a passion for cropping I obtained a Bachelor of Business in Agricultural Commerce from the then University of New England (Orange Agricultural College). Gaining experience outside the farm I worked in the cotton industry in grower services for a cotton merchant. I was then given the opportunity, through my wife's family, to begin a farming career in Northern Tasmania.

The original farm was a traditional mixed crop and livestock operation with small amounts of irrigated crop, dry land cereals and a self replacing merino flock. Grabbing the opportunities of available water, profitable cropping options (as the vegetable and poppy companies looked to expand their production base), we set about rapidly expanding our irrigated area and increasing our crop intensity, largely at the expense of the very low returning merino operation.

This change was replicated across the northern midlands of Tasmania. In a short period of time large amounts of land were converted from long term perennial pasture and extensive livestock production to intensive irrigated crop and horticulture. This transformation is continuing as current State and Federal Government policy is to further expand the irrigation capacity of Tasmania, particularly in the extensive grazing regions.

Initially we found excellent productivity and yields. Inputs remained relatively low, but the longer the irrigated system was in place, the greater the number of sustainability issues we began to face. Yields were being maintained with increased inputs, the soil structure began to decline, weed burdens increased along with herbicide resistance issues. These problems, topped with soil saturation issues, leading to drainage and salinity problems, began challenging our future productivity.

The cost of irrigation infrastructure is giving an economic imperative to farmers to adopt a cropping rotation that appears to be beyond the soil capabilities. Once infrastructure is in place intensive rotations generally follow. Similarly it is the economic imperatives that have driven cropping intensification across the Australian farming landscape.

Integrating a pasture / livestock component into this cropping rotation is seen as a solution based on the long held agricultural principals of rotation and rest, allowing for some natural soil rejuvenation. The crop / livestock rotation aims to maintain soil structure and organic matter, create health soil biology, suppress crop weed and disease and extract water from the subsoils.

Integrating crop and livestock creates many issues; agronomic, economic and social. The interface between the two enterprises creates constant compromise. But from a resource and ultimately economic sustainability perspective our understanding of spatially mixing crop and livestock will be important not only in Tasmania, but across the cropping landscape in Australia.

Objectives

Expansion of commodity crop production has been the economic saviour for many farming business in Tasmania and most of southern Australian. Is the expansion and intensification of this model our future or should we reassess the mixed farming system?

Challenged by decreasing yields and increased inputs in our intensive irrigated crop rotation, despite the adoption of best practise, led me to study integrated crop and livestock production. Worldwide many intensive agricultural production systems face sustainability issues. By examining how these remain productive and competitive in an environment of ever shrinking terms of trade, is vitally important not only to our business but most of southern Australia's cropping zone.

Southern Australia appears to be one of the last farming systems were you can still find livestock and crop sharing the same space (although rapidly changing). Why is this the case? Should we be heading down the specialised route like most first world agriculture production systems?

Businesses with a mix of crop and livestock create constant compromises. How best should we manage the:

- interface between pasture and crop,
- tillage practises to convert back to crop, and
- capture the soil building attributes of pasture phase?

Do integrated businesses offer greater resource and economic sustainability?

Sustainability, often linked to integrated farming systems, means many things to many people. With changing consumer sentiment and ever increasing scrutiny of our food production systems, what threats and opportunities does the word "sustainable" offer to us as commercial agriculturalists?

How should we integrate our farming businesses? Integration can not only occur from production perspective but also beyond the farm gate through engagement with the market place. Specialisation offers scale and efficiency in production. Integration and engagement

with the market place can offer increased margins. Is this type of integration an alternate route to overcome the constant need to expand production or perish?

Expanding and growing what we know best is always the easiest option to grow our business. We need to gain an understanding of the alternatives and whether they provide a viable option.

1. Mixed Farming Systems – Current Trends

The mixed farming system was once the backbone of all agricultural production systems. The twentieth century saw a gradual separation and specialisation of production systems in the western world. Almost all arable land through North America and Europe is now intensively and exclusively cropped and livestock production separated and intensified. The move to separation has two prime motivations; firstly the economic efficiency of specialisation and secondly the advent of cheap synthetic nitrogen fertilizer. No longer is cropping reliant on animals as a source of fertility. (JA Kirkegaard)

In general the complex ley farming system practised for centuries has been replaced by specialised and efficient cropping operations. These operations not only produce food products cheaply, but also support livestock units that are similarly specialized but spatially removed from the crop production unit. Mechanization and improvement in scale and efficiency of farm machinery has also added to the move towards intensive cropping.

The land use change in Australia and more specifically Tasmania has been more gradual and less pronounced. The wool industry provided a stable and reliable income for many decades. The variability in our soil types and rainfall patterns also lends itself to incorporation of livestock. In spite of this, there has been a gradual and more so over the past 15 years, rapid expansion of crop area to the expense of extensive livestock. The production data in Figure 1 clearly demonstrates this trend.

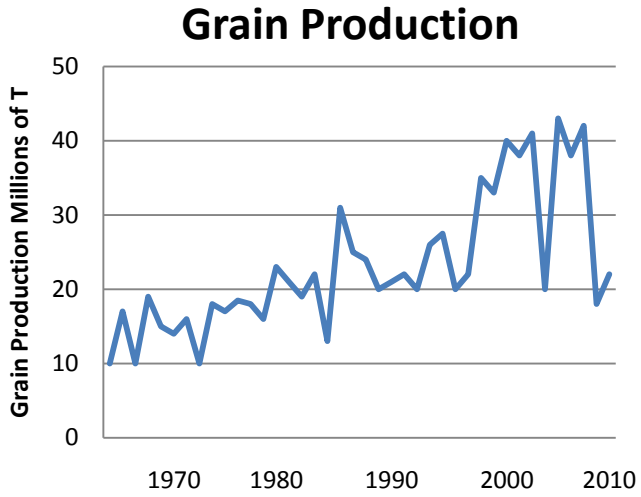

Figure 1. Australian Grain Production Source: ABARE 2008

This rise in grain production has occurred at the same time the sheep flock has fallen from 170 million in the 1960's to 70 million in 2008. (ABARE, 2008)

In the Tasmanian situation crop expansion has been driven by the economic demise of the wool industry, followed by irrigation development and expansion of the poppy industry. Poppies have provided the economic stimulus for change and development.

This background highlights that the current land usage patterns in Southern Australia are a relatively recent occurrence. These systems are still developing and evolving. This shift although being financially beneficial does expose individual business to both resource and economic risks, such as greater production variability from drought and frost, herbicide resistance, potential soil structure and fertility decline and larger cash flow requirements.

The adaptable mixed farming system, where the balance can be changed according to season and returns, is being changed irreversibly to intensive crop by factors such as the removal of fences, loss of breeding flock and pastures. The recent rise in sheep meats and lower grain prices highlights the advantages of adaptability.

Figure 2. Intensive Horticulture and Feed lot dairying on the same farming operation in California

1.1 Political, Social and Economic Drivers for Specialisation

Public policy in the United States strongly influences the diversity of crop and livestock production. The US farm bill is one of the key factors in determining land use (Reganold, 2009). Corn, cotton and soybeans receive three quarters of US crop subsidy and in turn they represent two thirds of the area under crop.

Similarly there has been a move away from mixed farming operations in the UK driven largely by the high cost of housing livestock over the winter months. The cost of labour and energy cost of preserving and feeding out, is driving a move to more arable production (Poole, 2010).

The advent of GMO crops likewise, has narrowed the field of enterprises farmers wish to pursue. At the same time there has been deterioration in the research applied to non GMO crops and cultivars.

Increased mechanisation in the cropping sector has seen annual labour requirements on farms fall. Seasonal labour and contractors are used and there is no longer a need to diversify to even out the work load across the year.

A further barrier to integration is the enhanced concern about food safety. In the United Kingdom, food crops cannot have exposure to animal manures and there is a withholding period of 12 months for many vegetable crops.

A new generation of farmers are expanding their mixed farming through cropping due to the ease of expansion, attracted to technology and lifestyle choices.

Adding to the motivations for specialised production are our research organisations and the manner in which research is funded. Individual commodities and industries are becoming increasingly responsible for funding research and there is less government sponsored generic and across industry research. A lack of research into the mixed farming systems is often created by the source of research funding. Generally both research bodies and individuals tend to specialise to meet funding criteria, and across industry research is often low on the list of priorities.

2: Sustainability: The New Driver

Economics have been the driver for specialised modern agricultural production. The farming community and the general consumer is increasingly questioning this industrialized production technique and asking questions about how their food is produced and if it is "sustainable" into the future?

2.1 What is Sustainability?

Defining sustainability and its implications to agricultural production systems is important in the context of this report.

Sustainability means many things to many people. Often it is a phrase that is strongly associated with the organic sector. It is much broader than this and is an issue most agricultural producers consider when making decisions. A sustainable system needs to be resilient, adaptable to change and not mining the resource base. Sustainable agricultural systems are those that make best economic use of available resources without damaging the under lying assets.

"Sustainable integrated farming systems" has many aspects: organics production, vertically integrated business, supply chain management and brand building can all have a role to play in creating a sustainable farming business. All these activities have one common thread and it is to build a viable business model capable of preserving and improving the assets managed in the business, be they soils, water and human capital.

2.2 What are the drivers for more sustainable agricultural production?

However sustainability is defined, like it or not aspects of sustainability are going to play an ever increasing role in agricultural production, due to increasing resource scarcity and changes in market perception.

Driving factors to change include;

- reduction in water allocation
- banning of more agricultural chemicals (particularly in the EU)
- increase consumer demand for eco friendly productions
- nutrient management on and off farm
- food retailer and manufactures looking for product differentiation
- animal welfare concerns
- climate change & government response to climate change

Consumers and the general public are being saturated with news and information regarding climate change and global warming. We should not under estimate the effect of this as a primer making people more sustainably and ecologically aware.

Forced Change:

The advent of quality assurance schemes within agriculture is now well accepted. Schemes such as Global Gap, Fresh Care are required to enter the market place. These schemes are starting to venture well beyond ensuring the safety of a product, to looking at the manner in which it is produced and the sustainability of the production system. This is being driven by consumer concerns and companies looking for a market differentiation. The following Case Study highlights these effects.

Case Study, McCain Food's Potato Producers:

McCain's potato producers in Washington State understand the influence the retailer of their products (MacDonalds, Burger King, Tim Hortons etc) have on their production system. McCain Foods is being forced to continually show improvement in their environmental and sustainability practises in the production of the raw material. Changes in farming production techniques are being driven by the market not economic returns at the farm gate. Eric Ritchie, Agricultural Manager of Farm Food Safety and Sustainability for McCains, explained that farming practise will continually be under scrutiny by their customers.

The potato growers have moved away from synthetic soil fumigation to using green manure mustard crops with high levels of glucosinilates to achieve disease control. This has been written into their quality assurance scheme. Increased water efficiency targets across the production of french fries are added to supply chain agreements.

Figure 3. McCains Potatoes Washington State

Eric Ritchie stated "That marketers of agricultural inputs clearly understand who now drives the production system and as a result they now try to sell new products and innovations that are perceived to be more sustainable directly to the consumer; McDonalds and Burger King, not the farmer or McCains etc. They expect change in the production system to be driven by the customer not the producer".

As producers of commodity products with limited pathways to markets most producers will be faced with such forced and difficult changes. The potato growers themselves saw it as extremely important that their customers fully understand the whole production system, as any changes need to have a positive effect across the entire supply chain. Eric pointed out that changes to fumigation practises has lead to increased losses in storage and processing, which in turn affects overall yield, increases waste and lowers efficiency.

Similarly international retailers are beginning to make strong and consistent statements regarding the products they wish to sell in the future. Justin Sherrard, Rabobank's General Manger of Food and Agricultural Research, points out that retailers, Walmart and Marks and Spencer's current policies both require by 2015 a major change in their supply chains.

- Wal-Mart will reduce greenhouse gas emissions by 20 million tons in the supply chain
- M & S aim to have 50% of their products with environmental or ethical attributes by 2015

Source : Walmart, Marks and Spencer

2.3 Sustainability Opportunities:

Increased consumer awareness regarding sustainability has created many market opportunities. “Organic”, “Food Miles”, “Local”, “Farm House”, “Free Range” are all statements that convey a message of sustainability to consumers. There clearly is a section of the market that is willing to pay for such attributes real or perceived.

Many businesses have successfully captured a section of the market, built brands and grown businesses based upon a sustainable image. Often seen to be for niche and for smaller producers, sustainability as a selling point can provide opportunities even for commodity producers. Educating consumers about farming practise has been a breakthrough for wheat producers in the Paulose region of Washington State. Shepherds Grain was established by two grain growers, Fred Flemming and Karl Kupers. It mills grain to flour and sells it into the growing “artisan” bakery market. Having their no-till production system certified by a third party, Portland Based Food Alliance, gave them credibility and from there they developed products and searched for viable markets.

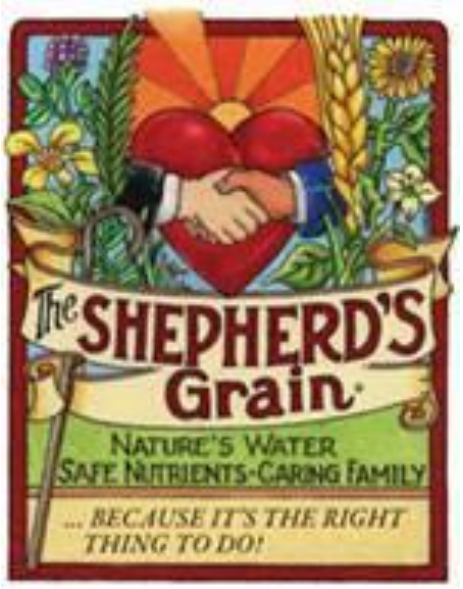

Figure 4. Shepherd's Grain Logo

Source: Shepherd's Grain

Now well establish and involving 20 other grain growers in the business, Shepherds Grain, the brand, gives consumers the opportunity to do "something" for the environment. In reality the farmers adopted no-till farming techniques for many reasons: cost saving, efficiency, increased scale in their operation, erosion control and moisture conservation. Marketing the environmental attributes of the system gives them a point of differentiation and in turn a premium price

3. Is Organic Production an Opportunity?

Organic production and sustainability are often linked together in the consumer's mind. Organic production in its purist form meets many of these sustainability ideals.

The market share of organic food currently ranges from 3.5% in the UK to 30% in Denmark. To my surprise, organic production has moved on from a cottage industry to one that is highly commercial and industrialized in nature. In the United States and the UK, organic production, particularly in horticulture, is often a division of large vertically integrated vegetable producing businesses.

Industrialised organic production is reliant upon the plough and cultivation based tillage systems. Fine seed bed preparation and repeated cultivation is used for weed control. This system is at serious risk of soil erosion and soil organic matter loss (Cannon, 2007). Reliant upon fossil fuels for all activities, the organic industry's claims of improved environmental outcomes are hard to quantify.

Of 76 studies reviewing the impacts of organic agriculture on biodiversity (assessing the effect on bacteria, earthworms, beetles, mammals and birds):

- 66 found organic farming to be of benefit,
- 8 concluded it was detrimental, and
- 25 produced mixed results or suggested no difference. (Cannon, 2007)

Conventional agriculture on the other hand, constantly struggles to convey an environmentally and sustainable image. The reality is that both systems have elements that have excellent sustainability outcomes. As often is the case, it is the middle ground that offers the most viable solution.

The market place bears some responsibility for the polarizing of production and marketing systems. Organics offer clear and defined product differentiation (Tomich, 2009). It is easy to differentiate extremes to a poorly informed consumer and much harder to market the middle ground.

An organic production system that incorporates the use of glyphosate would dramatically improve the soil management practise. It has the potential to improve soil structures, reduce the risk of soil loss and allow for greater incorporation of cover and green manure crops. Such a system could be argued as far more sustainable than the pure organics. Marketing a product that is produced using such a system is far more difficult as it is reliant on building trust with the public. The producer would be asking the consumer to trust them that they are doing the best for the environment and the resources at their disposal.

There is the emergence of certification bodies that aim to ratify good farming practice. LEAF (Linking Farmers and the Environment) in the UK is one such example. Aimed at bridging the gap between consumers and producers, it promotes integrated farm management and operates with a policy of "efficient and profitable production which is economically viable and environmentally responsible".

LEAF policies are based on:

- a commitment to good animal husbandry
- efficient soil management and appropriate cultivation techniques
- use of crop rotations

- minimum reliance on crop protection chemicals and fertilisers
- maintenance of the landscape and rural communities
- enhancement of wildlife habitats

This is an audited scheme and producers aim to demonstrate a far greater commitment to sustainable agriculture than simply an organic certification.

From discussion with producers many agree with the philosophy, but they are having difficulty extracting any significant economic gain.

Although of limited success I believe these are important steps in educating the general public about how their food, fibre and increasingly energy are produced.

Unlike urbanised Europe, Australian and Tasmanian agriculture is geographically disconnected from its markets both domestic and export, making it even more difficult to build trust and consumer empathy with farming practises. Where population is decentralised the linkage to agriculture is stronger, hence conveying a sustainable message is easier to sell, as consumers live and work in the same environment as producers.

4. Production Options- Many ways to produce a crop

Evidence from around the world clearly shows there are many ways to produce similar crops with positive economic returns. The primary difference between production systems is the cost structures that underlie them. The industrialized nations of the world have built agricultural production systems based upon cheap fossil fuels for energy and fertility. The sustainability of these systems relies on purchasing the plant and soil requirements.

These systems are built on “take aways and buy in’s”. Horticultural production from the central valley of California to Fenns in the UK is completely removed of livestock and pasture leys. They rely on purchased inputs for fertility and horsepower for soil conditioning. The system will keep working so long as cost structures remain the same or move parallel to commodity pricing.

In Australia and particularly Tasmania we have a comparative disadvantage in relation to input costs and in turn are vulnerable to a rise in fuel or fertiliser costs.

The following are some of the concepts and principals that are relevant to mixed cropping production system in addressing cost and sustainability issues.

4.1 Perennial Plants

"Large Scale Agriculture would become more sustainable if major crop plants lived for years and built deep root systems" (Glover). This quote comes from an advocate for developing perennial versions of our commonly cultivated food crops. Achieving this is a monumental hurdle for plant scientists and one which has a considerable timeframe.

Aimed at revolutionizing the way we farm, the desire to produce perennial food crops is based on the advantageous traits of perennial plants, with their deep roots, efficient water, carbon and nitrogen cycles. Perennial crop production is zero till by nature. Perennial plants are more adaptable to climate variation and far more competitive against weeds.

In addition perennials plants offer a more sustainable production system for marginal land which may be quickly depleted by a few years of intensive annual cropping.

Government and industry funded breeding programs in the US, Australia and Europe is underway but perennial wheat and corn is a long way off. However, there are many perennial plants that can be integrated into our current farming systems.

Long term research trials examining perennial plants show significant sustainability outcomes:

- timothy grass (a perennial hay crop) is 54 times more effective in maintaining top soil in comparison to annual crops

- lucerne crops can reduce nitrate loss by 35 times. Greater root depth and longer growing season boost soil organic matter and carbon sequestration by 50%. (Glover)

- perennial legumes play a significant role in maintaining a degree of soil structure but more importantly removing excess moisture from the profile in the intensively irrigated cropping ground

The perennial attributes of lucerne play a key role in maintaining a rotation in the central valley of California .The high value crop, processing tomatoes, is rotated with wheat and lucerne to extend the high value cropping period.

Similarly perennial seed crops on the Canterbury Plains of New Zealand, provide a resting phase in some very intensive horticultural rotations. These seed crops last on average 18-24 months, the perennial rye grass crops are planted in autumn, harvested for seed in the summer and then returned to dry matter production for livestock until the next spring. The system returns value from both seed and grazing enterprises and provides a sustainable backbone to intensive potato and onion rotations (Poole, 2010).

4.2 Restoring Effects of Perennial Pastures:

Wheat yields following 6 years of Ryegrass and White clover are 30% higher than a continuous cropping rotation (Francis G.S, 2001)**.** These significant increases in yield were found to occur on the Canterbury Plain in New Zealand. The interesting aspect of the research was the measurable improvement in soil structural stability, organic matter and nitrogen fertility showed significant improvement and it had a direct correlation to improved yields.

The general findings of most research in this area is that the yield difference depends on the age of the pasture and that the yield increases are driven by the combination of improved soil nitrogen and improved soil structure.

The down side is that the effect of the pasture regeneration phase in is relatively short lived. After three to four crops following pastures, yields have fallen to match those of a continuous cropping model.

In weakly structured soils, it would appear that a pasture phase the same length as the crop phase is required to at least maintain soil physical and chemical properties and at the same time provide an economic advantage to the cropping enterprise.

Short pasture phases provide increased soil aggregate stability and soil binding agents in the top soil as well as increasing soil porosity caused by pasture roots and increased earth worm activity. They generally don't build significant amounts of organic matter, (Francis G.S, 2001). Although they do build soil strength for cultivation and trafficking and the increased porosity improves drainage and infiltration rates of rainfall and irrigation.

The rise of bio fuels is further providing opportunities for perennial plants in our farming systems.
The use of perennial based pasture systems using grasses such as miscanthus and switch Grass are being researched and these are entering the early stages of commercial development.

Both species are long term producers of bio mass and offer soil rejuvenation opportunities. Miscanthus, sown as a rhizome, is harvestable after three year and remains a permanent planting for up to 20 years. Research from Guelph University, Ontario states the crop should produce 5-11 tonnes of bio mass per hectare and 120 mega joules of energy per ton. With one annual harvest soils are building organic matter and structure, similarly weeds are completely shaded out. (Dean, 2009)

The viability of biomass crops such as Miscanthus, increase and decrease in direct correlation to the oil price. At the moment like many new industries it is suffering growing pains, reliant on government programs (in the UK and US) and littered with entrepreneurs looking for a quick dollar. George Bush mentioned Switch Grass in a speech in 2008 and the industry was born over night.

An integrated livestock and cropping system provides many opportunities for the incorporation of perennial plantings. Lucerne, perennial ryegrass, fescue, phalaris, clover are all filling positions in intensive cropping rotations.

5. Lessons from the Organic Industry

The organic industry leads the way in integrated agriculture and has some excellent learning opportunities for the conventional production systems. The organic industry in the UK and to a lesser extent in the US has gone from cottage industry to industrialised production. Representing 4% of the UK food sales, the production system that supports these sales is becoming broad acre and very innovative in solving agronomic problems.

The price premium that most organic producers sustain (5-10%), allows them to have a slightly less efficient production system that often consumes a large time frame but less working capital.

The UK organic industry relies heavily on a grass clover ley phase. Typically rotations use 3 years of grass clover ley, followed by arable crop then a green manure, then crop again. The most efficient of these production systems often contain an integrated dairy unit. In some less efficient models the organic producer is itinerate. Often these are large horticultural businesses and they lease paddocks from farm to farm. They rely on organic subsidies to encourage landowners to have a low input pasture phase.

The first system is of most relevance to this report. In these systems the livestock component and producer is the key driver. As Peter Wastenage, organic dairy and vegetable producer puts it “the dairy unit actually means I’m being paid to build soil nutrient and organic matter into my soil, - it’s far better than paying for it”. (Peter Wastage)

The nutrient building capacity of pasture leys and green manures varies greatly with soil type and species used. The following table highlights the variability in species across soil conditions.

Table 5. Example of nitrogen fixation by various green manure

Crop	Mean (kg/ha/yr)	Minimum Kg/ha/yr	Maximum Kg/ha/yr	Number of Sites
White Clover	157	0	373	15
Red lover/grass	223	73	460	10
Sub Clover	142	4	320	8
Lucerne	211	2	550	12
Winter Vetch	121	40	208	2
Lupins	179	90	300	10

Source: (Francis, 2008)

The other factor is the timing of the release of nutrients particularly nitrogen which is influenced heavily by cultivation practises and soil condition (Francis, 2008).

The economics of green manures crops for stand-alone nutrient building is marginal due to the cost of establishment, incorporation and of the opportunity cost of missing a cash crop. When compared against synthetic fertilizers at today's prizing, it is an uneconomic source of nutrient, however, across an integrated farming system the green manure crop can offer a considerable advantage.

One particular advantage is the stopping of nitrate leaching. In intensive vegetable production, post crop nutrient levels are often quite high (50 to 80Kg soil N post onions). Leaching can be reduced by 95% with ryegrass green manures sown immediately post the high value crop. Early establishment is vital to ensure the roots systems are established to harvest the Nitrogen before soil saturation occurs in winter. The graph below highlights the considerable amounts of N that can be captured in an organic form.

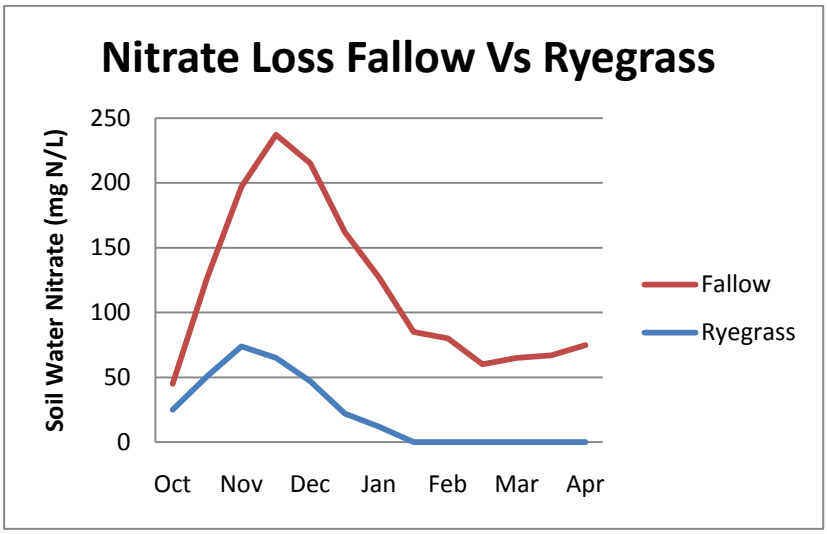

Figure 6. Nitrate Loss. Source: Green Manures HDC FV 299

Total Loss Rye grass 5kg/ha, Fallow (147kg/ha)

The capture of this nitrogen represents a significant economic and environmental advantage.

Direct seeding of the green manure crop is important in this system, since any cultivation will only stimulate the mineralisation of additional nitrogen.Turning the pasture/green manure phase into a profit centre as the following case study demonstrates is applicable to both organic and conventional production systems.

Figure 6: Peter Wastenage

5.1 Case Study: Peter Wastenage – Exmouth Somerset UK.

An organic vegetable, arable and dairy farming operation in Southern England. This is a completely integrated farming operation where the dairy unit was the primary enterprise. Vegetable production included broccoli and potatoes. Peter runs a simple system, 4 years of clover based pastures followed by one year of vegetable production, one year of cereal crop then returns to clover / grass pasture for the dairy unit.

The per cow performance was comparable to a similar grass based dairy units here in Australia at 25 litres per cow and vegetables were quite profitable once the organic premium was included at 10-15% at the farm gate. The organic milk premium was averaging around 8% over conventional production.

Crop weed control was cultivation based on the mouldboard plough specifically, followed by several surface cultivations to create a stale seed beds. Flame burners are used pre-sowing and in crop weed control relies on inter row cultivation and manual weeding. The production system appeared robust, with soils in good health. In keeping with organic industry requirements, Peter successfully relied solely on nutrient from the pasture rotation.

This organic operation demonstrates an efficient and industrialised production system. Operations such as this have many of the attributes of sustainable production be it organic or conventional. It is reliant on a profitable livestock operation to make good economic use of the pasture, soil and nutrient building phase.

Although the tillage sounded excessive, it is only twice in a 6 year rotation. The organic matter and soil structure built up over the pasture phase builds enough resilience to handle such practises.

5.2 Marrying old practises with new

The benefit of cover crop green manures was evident in both the organic and conventional sectors. The practise of under sowing cereal crops with pasture or legumes was often used in the past in mixed farming business in Australia. I saw many examples of this being re introduced with GPS technology to inter sow cereal crops with primarily clover but also pasture mixes. With the aim of capturing growing season temperature, under sowing took place at stem elongation in cereals. The under-sown crop remains dormant until the light hits after harvest. Data suggest considerable yield improvement in crops post the green manure red clover crops (Dean, 2009). In Ontario corn, wheat and soya bean producers were achieving a 9%, 8% and 7% yield improvement over the following three crops respectively, fixing 70 units of nitrogen. The yield improvement was far out weighing the cost of such practises.

6. Soils in an Integrated Farming System

When looking at sustainable farming systems in principal land managers are looking for systems that maintain and improve the most basic of our farming resources, soil. As managers we have the option to apply farming strategies that preserve or rejuvenate soil structure.

6.1 Soil Decline

Under a continuing cropping program of vegetables and cereals crops, there is ample evidence of gradual decline in soil structure and fertility (Cotching, 2009). Low fertility can be solved by imported product, until it reaches an economic threshold. Soil structure on the other hand requires management and time.

The following is an examination of soil management practise directly related to a mixed vegetable, cereal crop and livestock production system.

Tillage can be one of the major contributors of soil degradation. The advent of the minimum-till and no-till system has made an enormous impact on broad acre wheat, corn and soya bean production throughout the world. The drivers for this have been cost savings and moisture retention. The intensive horticulture sector has seen considerably less to almost nil adoption of this technology for numerous reasons:

- specific planting and harvest dates – paddock must be ready to sow for a calendar date rather than when the soil is in the right condition
- heavy harvest traffic – tillage after harvest is needed to nullify harvest soil compaction
- small seeds – require finely worked seedbed to germinate
- customer demands for perfectly clean produce- more risk of clods, straw, foreign matter

The optimum tillage practise witnessed in the horticulture sector was “rotational tillage”, where tillage is used only once in a four to five year rotation. No-till cereals and canola seed

rape were grown followed by heavy cultivation for horticultural crops such as potatoes and onions.

A similar management strategy was also being implemented in Ontario Canada in wheat, corn soya bean rotations. Tillage was used in this instance to create soil warmth and for disease control. Research from the University of Guelph Canada, showed no long term degradation of soil quality under a rotational tillage system, this included both mouldboard ploughing and surface tillage, when compared to a continuous no-till system. (Dean, 2009)

From a risk and economic perspective the heavy tillage to establish the highest value crop in the rotation can be justified so long as it is followed by a period of soil structure rebuilding. The practise of reverting to cultivation is often seen as detrimental. Large variances in soil type and cultivation practises makes locally adapted research into rotational tillage critical.

"**Tillage practises shouldn't be followed like religions they don't have to adhered to or expected to work every time in every situation"** (Godwin, 2009).

6.2 Compaction

The other major tillage motivator in vegetable production is to remove compaction which is often created by the harvest process. Crops such as processing peas and potatoes are harvested when soils are wet and have low soil strength. The size of machinery which is required for efficient and timely sowing and harvest has the potential to cause compaction to depths of .4 to .6 m (Ansorge, 2007). Prevention is seen as the best alternative as deep ripping to resolve the problem is both expensive and unpredictable as a solution.

There are many practises aimed at reducing compaction, tracked equipment, controlled traffic, reducing secondary tillage pass, all of which play a role. Vigorous pasture growth, although longer term solution, builds soil aggregate and works against compaction in two ways. Primarily it helps prevent soil compaction by creating stronger more stable soils and secondarily it can help rehabilitate compacted soils. A mix of both deep rooted and fibrous species has the effect of working the entire profile. (McCallum M.H, 2000)

The other major contributor to soil compaction is from livestock. This factor is seen as one of the major inhibitors to the integration livestock in arable situations. Grazing of pastures and

crop residues, even when dry have the ability to reduce the number of macropores in the soil surface.(Francis G.S, 2001). The effect of the damage is very much dependant on the clay content of the soil, soil moisture, organic matter content, tilled or untilled soil . Managed well the livestock compaction can be maintained as surface compaction and relieved by cultivation.

The detrimental effect of compaction from livestock needs to be balanced with the restoring effect of pasture. Ideally you need a system that ensures once the soil is opened up after conversion from pasture, all of the best no-till and minimum-till practices are implemented. This will ensure soil structure benefits are preserved and not lost quickly. Once in crop, a no-till system provides firmer soils reducing the impact of livestock damage if grazing occurs between crops.

7. Economics Impacts of Integrated and Specialised Farming Systems

Although there is a gradual investment in agriculture by corporate investors, farms remain predominantly family owned and operated around the world. The need for diversity in income streams for family operations is high. Single enterprise operations are vunerable to both price and production fluctuations. These risks are often outside the control of the operator, in turn an integrated system creates a buffer against economical and biological risks.

Economies of scale have been the key driver for specialisation. As terms of trade have tightened, the margin on each unit of product grown diminishes. Hence the need to lower production cost and increase turn over.

7.1 Out Sourced Enterprise Integration

There are examples of very large integrated and diversified operations but these are generally the exceptions. Most family operations have specialised to remain efficient and competitive. There is an increased practise of out sourcing components of a rotation or farming system.

Land managers (farm owners) are beginning to separate land ownership and the operational / trading enterprises.
Dairy and arable farmers in New Zealand do this quite commonly. Often arable farmers out source grazing, in the form of dairy cows, to graze green manure crops that are grown through the winter.

This provides several advantages:

- diversified income base
- financial incentive for a pasture phase in a cropping rotation
- importation of livestock skills on to the farm

Land sharing between operations is becoming common in vegetable production in the UK, Europe and New Zealand, with leases, joint ventures and profit share arrangements taking place between land owners and specialized vegetable producers. These systems provide crop and pasture rotations to both parties and provide a more sustainable rotation and economic diversification to the land owner. It shows that you don't need to be the expert in all fields and have all the plant and equipment or livestock to operate a diversified rotation.

7.2 Farm Resource Pooling

An excellent example of farm resource pooling was seen in Washington State where Eric Williams and his neighbour, shared land and swapped enterprises. One a sweet corn, processing pea and cattle producer, shared land with his neighbour, a potato grower. All four enterprises were conducted across the two farms. The two individual businesses provided specific equipment and expertise. Spreading the enterprises across the two business improved scale and efficiency and generated greater returns for both.

There is very little joint venturing / enterprise sharing in Australian agriculture. We remain to a large degree staunchly independent. The opportunities for across business integration are immense and offer considerable upside to both parties.

7.3 Financial Analysis of Integration:

Aside from the risk management benefits of diversity and enterprise integration, there are often direct financial benefits which tend to be overlooked in financial analysis of enterprises. There could be a strong argument put forward that standard economic and financial analysis of farming businesses is over too short a time frame. We are overlaying an annual financial recording system over a biological system without consideration that the biological system operates over a far longer time frame. (Weersink, 2009)

The economic contribution of rotations is almost never recorded in the annual financial returns. More often improved economic performance of the whole business is attributed to the benefiting enterprise not the contributing one. For example, in a mixed farming system the contribution of improved disease and weed control to a cereal crop from a pasture phase is in most instances recorded as a improved gross margin to the cereal crop.

Either beneficial or detrimental to a farm business overall performance, we need to place values on the activities that make an economic contribution over long period of time.

8. Integration beyond the farm gate

It seems that it is often those businesses that have lifted themselves beyond commodity production and engaged the market place directly that are more able and willing to change their farming systems. Businesses that are value adding and marketing have moved their profit drivers from yield to market share. The success of these businesses lies in their marketing success, but by having integrated farming systems where the profits from each individual enterprise are kept in house and finally realised at wholesale or retail levels, is quite powerful.

An excellent example of this is the following case study of Alvis Bros Ltd. Describing themselves as an "integrated west country farming business", they trade as "Lye Cross Farm" – West Country Farm House Cheese Makers.

Alvis Bros Ltd are dairy farmers, cheese makers, pork producers and arable farmers. All these enterprises are interrelated and depend on each other for a contribution. There are sales of products throughout the production system but as Nick Green (Operational Director) puts it, "the rubber hits the road when the cheese is sold".

Put simply the dairy produces milk, the factory cheese, the pigs consume the bi-products from the cheese making (mainly whey), the pig effluent is used as fertilizer for the arable operation, grain and straw is produced from the arable operation for both the dairies and the piggeries.
The focus of the business is to value add at each enterprise, and capture value along the way but primarily as cheese sales.

This has been an extremely successful formula for this family business but is not a strategy without risk. Although it is an integrated business, its income base is not significantly diversified.
Integrated marketing business such as this create margins two ways; from value adding production and by lowering the cost of production by making use of wasted resources from within the system (livestock manures, crop residues and factory bi-products).

Alvis Bros Ltd.

Dairy Operation

Cheese Making

Arable Farming

Alvis Bros Ltd

Pork Production

Source: Alvis Bros. Ltd

A market position has allowed them to integrate their operation and gain efficiency not available to those operating in the commodity market.

8.1 Collaboration

The alternative to value adding your product at the farm gate is capturing some of value up or down the commodity supply chain. There are many examples of farming businesses collaborating to establish scale in post and pre farm gate activities such as; grain storage, seed cleaning, vegetable processing and packing, dairy processing, cotton ginning, bio diesel plants etc.

For primary producers, extending their activities into areas of little expertise is often fraught with danger and there are many examples of failed attempts. The fact is there are often quite sound margins to be gained by extending further down the chain. Building capacity off farm often builds greater viability on farm.

The other major advantage for rural regions is the capturing of the value within your own community. Often these downstream processes provide employment both directly and indirectly to the local townships.

The integration is both at an enterprise level, but also at a personal level. Funding, managing and growing businesses with partners is difficult and often it is not the technical expertise but the corporate governance and interpersonal relationships that define the success or failure of the venture.

8.2 Case Study: Weyburn Inland Terminal

Weyburn Inland Terminal (WIT) is a farmer-owned and managed company operating an inland terminal and grain storage in Weyburn, Saskatchewan, Canada. The initial concept for WIT began in the early 1970's when a group of some 1,450 farmer/shareholders identified a need to improve the existing grain handling and transportation system. They decided that it was necessary to construct their own facility, keeping in mind the principles of economy of scale and leading edge technology.

Construction began in 1975 and operations commenced in 1976. With many teething problem in the early years the company survived and has grown into a successful service provider adding seed cleaning, drying, agricultural chemical and fertilizer supply and recently an ethanol plant.

One of the more innovative practises they have adopted is "Condo Grain Storage". In this instance individual farmers own storage space within the facility, much like strata titles for property, producers own specific tonnage that can be used throughout the facility. Farmers have storage that is flexible and with immediate access to drying, cleaning and rail facilities.

WIT is an excellent example of farmers joining together to solve a problem, build capacity and jobs within their regional community. Operations such as this have many lessons for regional communities like Tasmania to grasp the opportunity to service their own needs and add value to their farming operation.

This leads to discussion on the type of business structure used to achieve collaborative activities.

8.3 Co-operatives: Do they provide an integration opportunity that we have deserted?

The current farming generation in Australia seems to have an aversion to the co-operative structure. Australian co-operatives seem to suffer from poor press which often highlights poor corporate governance and constant pressure to demutualize and sell off to the corporate world. This is a generalisation but there has been a considerable exiting of farmer owned

cooperatives from the rural supply and processing industries (eg Pivot Fertilisers) over the past couple of decades.

Despite this, co-operatives seem to survive and prosper in other parts of the world, shining examples include Rabobank and Fonterra. Typically rural co-operatives are established to service the needs of farming communities. They provide primary producers with an opportunity to take ownership of their product further down the value chain and enjoy some of the returns captured at the export or wholesale price points.

In selling our product at the farm gate we are often dealing with huge multi-national firms that have considerable financial clout and shareholders to serve. The reality is that there will never be a level playing field. The constant consolidations, take-overs and mergers of companies that we sell our primary products to, only further highlights the need to take some control of our products ex farm gate.

Thriving co-operatives play a significant role in New Zealand Agriculture including; Fonterra the milk processor, CRT rural merchandiser, Ravensdown and Balance fertiliser suppliers, Silver Fern Farms meat processor just to name a few. With varying levels of success in providing benefits back to the commodity and producer, it appears our trans-tasman cousins are significantly better at banding together and overcoming the difficulties of working together beyond the farm.

There is a strong argument that our corporate law surrounding co-operatives needs reviewing and addressing to foster growth within this sector. Unlike in New Zealand for most states of Australia co-operative legislation requires one share one vote, whilst in New Zealand voting rights are generally based on your contribution to the co-operative, eg. tonnes of fertiliser used, litres of milk produced, or $ of product purchased. “This encourages your larger producers to participate building scale within the business and improves shareholder loyalty” (Howe, 2010).

Integrating our farming business beyond the farm gate is a difficult and time consuming exercise. Instead of our farm leader screaming about the injustices of the current supply chain system and looking for answers from government reviews into competition policy, maybe we should re-visiting the ground our farming forebears covered and team up a little. This may

take the form of co-operatives or other business structures but the reality is the commodity producer, regardless of business size, bears little influence on those that buy the product.

9. Recommendations

Every business, district, industry and country faces different production and business issues, but I think it is clear that we need to re-evaluate the direction in which modern agriculture is heading. Our farms are not factories. Monocultures service commodity markets well but not necessarily our farm's resources.

Production:

- perennial plantings need to be incorporated into our cropping systems
- green manure / pasture ley research from the organic industry needs adapting to conventional agriculture
- pasture phase needs to be of equal or greater length than the cropping phase
- "get over " soil compaction from livestock - the soil health, disease weed control benefit far exceed any downside

Economic:

- the contribution of a pasture and livestock phase needs to be financially attributed in any financial comparison of farm enterprises.
- desired farm enterprise integration can be achieved by partnering/joint venturing with specialist producers to out-source enterprise skills and equipment.

Marketing:

- embrace the growing demand for food with a story and move down the value chain
- be proactive in telling our sustainability stories to the market place
- gain product differentiation for sustainable production systems
- revisit co-operative "type" structures as a mechanism to engage the value chain and gain market strength
- support movements that raise the profile and importance of food

Research:

- increase the research into systems (integrated agriculture)
- move away from commodity and product based research
- adapt and share research outcomes with the organic industry

Conclusion:

The conventional cropping system will be forced to change by: increasing cost structures (fuel and fertiliser), consumer sentiment, increased regulation, climate change and governmental response to climate change.

"Sustainable practises" have the ability to service both our resource base and the market place.

There is a need to develop a middle ground of agricultural production a hybrid of conventional and organic farming that delivers positive resource and marketing outcomes at the same time meeting the need of producing quality food, fibre and energy for a growing population.

Mixed farming has a vital role to play in Australia's agricultural economic future.

References

ABARE. (2008). *Changes in Australain Grain and Livestock Industries, 1965-2008.* ABARE.

Ansorge, D. (2007). *Soil Reaction to heavily loaded rubber tracks and tyres.* Silsoe: Unpublished PhD Thesis Cranfield University, Silsoe, Bedford UK.

Cannon, N. (2007). *Sustainability in organic and conventional farming sectors.* Market Harborough: Nuffield Farming Scholarship Trust.

Cotching, B. (2009). *Soil Health for farming in Tasmania.* Devonport: Bill Cotching.

Dean, B. (2009, September 15th). Associate Professor. (R. Bradley, Interviewer)

Francis G.S, (2001). Soil Degradation under cropping influence on wheat yield on a weakly structured New Zealand silt loam. *Australain Journal Soil Res.* ,p 291-305.

Francis, R. (2008). *Green Manures- HDC Project FV299.* East Malling: Horticultural Developement Council.

Glover J. D, (2007). Future Farming: A return to the roots? *Scientific American* , p65-74.

Howe, T. (2010, March 14th). Mr. (R. Bradley, Interviewer)

JA Kirkegaard, M. P. Diversity and Evolution of Rainfed Farming Systems in Southern Australia. un published.

Marks and Spencer. (2010). *Marks and Spencers Plan A.* Retrieved June 12th, 2010, from M & S: www.planamarksand spencers.com

McCallum M.H, (2000). Contribution of nitrogen by field pea in a continuous cropping sequence comapred to lucerne based pasture ley in Victorian Wimmera. *Aust. Journal of Agricultural Res.* ,p13-22.

Poole, N. (2010, March 12th). (R. Bradley, Interviewer)

Reganold, J. P. (2009, August 24th). Regents Professor Soil Science Washington State University. (R. Bradley, Interviewer)

Richard, G. (2009, October 5th). Professor. (R. Bradley, Interviewer)

Tomich, T. (2009, September 8). Professor . (R. Bradley, Interviewer)

Walmart. (2010). *Walmart Corporate*. Retrieved June 12th, 2010, from Walmart stores Sustainability : http://www.walmartstores.com/sustainability/

Weersink, A. (2009, September 19th). Professor. (R. Bradley, Interviewer)

Plain English Compendium Summary

Project Title:	Integrated farming systems the past or the future
Nuffield Australia Project No.:	
Scholar:	Robert Bradley
Organisation:	Nuffield Australia and Bradley Agriculture
Phone:	0363912404, 0418276634
Fax:	0363912505
Email:	robnjo4@bigpond.com
Objectives	To investigate- the resource and economic sustainability of integrated (mixed) farming system. Why has there been a rapid movement towards specialised production system and is this the appropriate pathway for our agriculture sector in southern Australian agriculture?
Background	Decreasing yields, increased inputs in intensive irrigated crop rotation, and a rapid increase in the intensive crop production on soils previously managed with long pasture rotations. Declining importance of livestock in mixed enterprises.
Research	Interviews and literature reviews, and international travel, examining continuous cropping and horticulture and how they address sustainability, what role pastures play in intensive crop rotations. The effect on farm sustainability of integration beyond the farm gate.
Outcomes	The trend towards specialised cropping systems driven by efficiencies and cost structure, that is reliant on economies of scale to capture small margins To remain viable and sustainable our farming system in the future will need to rely less on chemistry and more on ecology and nature. Rising cost structures, resource depletion, changing consumer sentiment, climate change and government response will force change in our production techniques
Implications	Profitable livestock /pasture is essential for long term economic and resource sustainability of most southern Australia cropping systems More research and development into integrated farming system is essential, the organic industry leads the way in integrated research and adoption. Sustainability is a powerful selling point. Integration with the value chain leads to more profitable and sustainable farming business.
Publications	Nuffield Australia. Presented at ABARE Regional Conference Hobart May 2010, GRDC Update Campbell Town July 2010, Australian Association of Agricultural Consultants Conference August 2010 Hagley