Integrated Livestock Cropping Systems

How Diversity decreases risk and increases opportunity in agricultural enterprises

A report for

by Robert Egerton Warburton

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Forward

Integrated livestock cropping systems are an important part of farming in Australia and provide not only diversification as a risk management tool but also a means of coping with a changing environment.

Over the past 15 years Australian agriculture has seen many changes. Unsustainable livestock prices in the 1990's saw many farmers move from wool and meat enterprises into crops, such as canola and wheat.

Around this time, no-till farming began which brought about a change in the reliability of the cropping system, especially in low rainfall areas. Farmers no longer felt the need to have stock as part of their risk management strategy and focused on cropping only.

The pendulum had swung so far that by late 2009, many farms that had been an all sheep enterprises 10 years earlier were all crop. This also changed their risk. Ten years prior these farms had carried low debt and ran equities of more than 90%. By 2009 a series of poor seasons combined with high debt after years of machinery purchases, operating equities were down to 60%, with little income.

It is important that Australian agriculture runs a more balanced approach to its farm enterprises. With a variable climate and little or no support from government, the farming sector needs to manage its risk better than it currently does.

The key finding from my travel is, that as the diversity of enterprises increases on farm and between farms, so do the opportunities. It is through the synergies between enterprises that the next big leap in production will come.

Farmers have for too long relied on plant and livestock breeders and Research and Development Corporations to provide them with production growth. Instead, more focus needs to be placed on the interaction of the enterprises, both within the farm business and between farm businesses.

This report will highlight the three main integrated livestock cropping systems around the world and the opportunities these systems can bring to Australian agriculture.

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To the Nuffield Scholars I met in my travels, who would go to any length to find a contact and a place to stay or a car to borrow, thank you. The friendships made over the past year are some of the best I have and I look forward to returning the favour when you travel west.

Thank you to Dave, Graeme, Mardy, Al, Row, Kiwi and Balls for the fantastic adventure that was the Global Focus tour and all the other Nuffield Scholars that made my year so memorable.

Thank you to Grant who ran the show at home while I was away and many others including Brent, Dan, Helen and Kirsty for their assistance. The hard work and dedication they showed was evident in the harvest. Thankyou to my friends for their help and hard work in editing this report.

Finally, the biggest thank you goes to Jen and my girls Lucinda and Zara, for not only encouraging me to apply for the scholarship, but being so supportive during my time away.

When I was in Brazil in late March Jen and Grant started seeding canola and wheat on the back of a thunderstorm we received. 2010 was the driest year on record and these crops were not only the highest yielding but provided much of the winter feed for the livestock.

The Nuffield experience has provided a wonderful opportunity for both our family and our business. For this I am eternally grateful.

Abbreviations

GM – Genetically Modified

GRDC – Grain Research and Development Corporation

CPR – Pasture Crop Rotations

CAP –Common Agricultural Policy

ECL – External crop livestock

MLA – Meat and Livestock Australia

RDC – Rural Development Corporations

WSO – Winter Stocker Operation

EMBRAPA – Ministry of Agriculture Livestock and Food Supply (Brazil)

R&D – Research and Development

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Executive Summary

The study topic for my Nuffield scholarship was 'Integrated Livestock Cropping Systems'. However, in gaining international insight into this topic, my view of agriculture has altered to include other important factors, including the importance of risk, the relative tolerances of risk a business can take and importantly, the opportunity this can bring.

I travelled to Ireland, England, North America, Mexico, Brazil, Uruguay and Argentina, conferring with researchers, farmers, politicians, industry and business leaders.

I found three major integrated stock cropping systems.

The first system was the **Crop Pasture Rotation,** where pasture and crop alternate phases. This system is typically found in the southern hemisphere due to the unsubsidised nature of these countries that mainly export produce and don't have the ability to generate enough taxes to subsidise their farmers. The farmers use mixed farming as a form of income stabilisation. Another part to this is the importance farmers and governments place into the structure and longevity of the soils. Because income and in the case of governments, the ability to feed their nation, plays such an important role, 'landcare' is a structural part of R&D. In the case of Uruguay, it is written into legislation, and mandated that in some parts of the country, there is to be only three years of continuous cropping before a pasture phase is introduced. This is due to long term research showing there is a decline in soil structure after this time.

The second system was the **External Crop Livestock,** being the most common in the northern hemisphere. This is where farmers specialise in one enterprise only, such as corn production or hogs (pigs), but rely on other enterprises in the production system. One of the more interesting systems I saw was in Nebraska, where waste water from a dairy was being used to irrigate corn on adjacent property, which then sold corn and corn silage back to the dairy, two independent businesses working together. This system relies on the government backing the producer, with support through farm programs and crop insurance. The farmers can specialise because the chance of their system failing, or them not receiving enough income, is very low.

The third system was the **Winter Stocker Operation,** which is opportunistic. Farmers grow a crop such as wheat and then start grazing it. At a certain point in the season the farmer assesses the crop, season and prices and decides whether to continue grazing or run the wheat through to harvest. This system is found all over the world and is becoming increasingly popular due to the opportunistic nature it presents in volatile markets.

Regardless of where I travelled in the world, farmers develop systems that managed risk in their environment. Regardless of the amount of research showing them 'a better way', farmers manage risk by doing what produces the most reliable result. Whether this is GM corn grown for 25 years in the same paddock, or complex crop and pasture rotations; the result is the same.

My finding is that 'diversity decreases risk and increases opportunity'. If you look at innovation, conservation and agricultural growth as the drivers, then the southern hemisphere is doing all of these things well, and is in fact becoming the power house of agriculture. In the north, research facilities are providing lots of innovation, but due to the support the farmers receive, very few of them adopt the ideas because it has little effect on their bottom line.

Australia needs to relook at its research direction and make sure all the RDC's have a common vision. Gone are the days where the crop researchers don't talk to the sheep researchers and vice versa; because on the farm to two are inter linked and the future is the synergy between them.

As nations such as Basil, Uruguay and Argentina start increasing production beyond their current domestic requirements, they will become a major supplier to Australian markets. More than ever Australia needs to reinvigorate its research and development and create a new vision and outcome for agriculture. This will not only push new production limits, but focus on the prosperity of the rural landscape and its people.

Introduction

I farm in Kojonup, Western Australia, with my wife Jennifer and our two girls Lucinda and Zara. We farm Merino sheep for both wool and meat and grow canola, barley, wheat and Australian wildflowers. Our farm is situated in the south west corner of our state and we receive on average 550mm of rain between May and October. Our soils are classed as duplex, which consists of a few centimetres of top soil over 60cm of coarse sandy gravel over hard clay. Our summers are very hot (32-42C) with cold wet winters (3-14C).

My vision for my home farm is to create a farming system that maximises yield in both livestock and crops while constantly improving the soils and protecting and improving the flora and fauna. To achieve this we have started replacing annual pastures with perennials. These have improved the soils by cycling the nutrients and keeping the soils alive during the summer and providing out of season feed for livestock. This in turn has improved the crops following, by increasing water infiltration and rooting depth, leading to increased yields. Over the last few years we have been experimenting with over-sowing perennial pastures with crops, suppressing the pasture until the crop is finished, with the pasture system returning over the summer.

Over the past 15 years our farming system has moved away from all Merino sheep running at low debt and high equity, with the main expenditure being dog food and an old tractor. This system came under a lot of pressure in the mid nineties during extended periods of low prices for sheep and wool. With the purchase of more land we needed cashflow and the logical enterprise was cropping.

Now between 60-70% of the arable area is cropped, and with it, high debt levels and low equity has increased the risk of business failure. Spending more and more on machinery to keep up with the latest innovation, without the increase in yields has led me to question the direction of our mixed farming enterprise:

- Would we be better off specialising in one thing, such as all crop or sheep; or
- Should we continue to try and find a balance between the two?

Historically, mixed farming has been a successful way to manage risk, but with cropping technology increasing at a greater rate than livestock systems, and new generation farmers unwilling to take over traditional sheep enterprises due to the perceived hard work, all cropping has become the norm and risk management has become more about grain futures than cash flow. What is the rest of the world doing with mixed enterprises, and are they going down the same path?

I found three integrated farming systems during my travels; Crop Pasture Rotation, External Crop Rotations and Winter Stocker Operations. All three systems offer benefits, but it was the opportunity created when you put one or more of these systems together that was the standout.

Crop Pasture Rotation

Crop pasture rotation (CPR) is almost exclusively found in the southern hemisphere and is supported by three main premises:

- Large export nations;
- Risk Management;
- Food security.

Pasture crop rotations work on a system of land being returned to grass and for grazing or harvest for livestock feed. After a period of between one and three years, the land reverts back to grain production. This system was developed by farmers as a way of managing both risk of production and soil sustainability.

As soil qualities deplete after three years of growing crops such as wheat or barley (Fernando garcia-Prechac, 2004), the reintroduction of grazing and livestock reinvigorates soils so crops are able to grow again.

Brazil

Brazilian agriculture varies greatly due to climate variation including, a temperate climate in the south, a sub tropical savannah in the centre, a dry arid north-east and a wet tropical Amazon in the north-west. Throughout Brazil, CPR was typical in most farming areas.

Traditionally, tropical pastures in the north are grazed by Zebu cattle, the native breed in Brazil. Occasional crops of soy bean, corn and beans are grown to supplement incomes and provide for local communities.

In the last 15 years many of these systems have been replaced by continuous cropping of genetically-modified soy and corn, with cattle production pushed onto less-productive soils.

The replacement of livestock with intensive cropping on high quality land, is a trend that has been replicated in Australia, and one I saw in most agricultural communities I visited around the world. From what I have seen and experienced, it is not a system that supports either the

soils or farming communities particularly well. As a result, in the countries I visited, a more balanced system is being looked into.

EMBRAPA

EMBRAPA (Ministry of Agriculture Livestock and Food Supply) was established by the Brazilian government in 1973 to give focus and direction to Brazilian agriculture in a bid to combat low agricultural production and low yields. The country was suffering from a food supply crisis, as well as issues surrounding rural poverty and a lack of specific knowledge on tropical agriculture. It also had an institutional void in terms of poor agricultural research, education, marketing and media.

What most impressed me about EMBRAPA's aims was its focus on sustainable farms and communities, particularly its focus on social balance and family agriculture. One of the ways of achieving this was through the reintroduction of crop-livestock systems.

Dr Geraldo Bueno Martha of Embrapa Cerrados (Bioeconomic Performance of Pastoral Systems and Crop-Livestock Integration**)** headed a program of reintroducing livestock and crops into a mixed system, which also included treed and tropical fruit. As previously mentioned, many Brazilian farms are typically either entirely crop-based (growing continuous GM soy) or entirely cattle enterprises, grazing low-quality pastures.

Dr Martha's project aimed to produce family farms which grew a wider range of produce. The goal was to produce a stable economic environment through job creation for farming families and communities based on the thesis that diversifying production requires more diverse skills thus providing more employment opportunities.

In many EMBRAPA publications showing the results of the projects, I saw photos of rivers flowing with fresh clean water, native plants and trees flanking a mix of crops and livestock and plenty of houses for workers. This was in stark contrast to the millions of hectares of soy and sugarcane in large fields which were evident as I travelled through much of Brazil and the large cities comprising 300,000-600,000 people living in high-rise buildings.

Uruguay

Uruguay has also seen a dramatic change in its agricultural landscape over the past decade through the introduction of continuous cropping. Like most southern hemisphere countries, CPR was the most common system used in Uruguay. Wool, beef and dairy dominated the landscape, with 20% of the arable area planted to improve pastures and fodder crops. Much of the area was unsuitable to continuous cropping due to soil degradation under conventional cropping systems. (Figure 1)

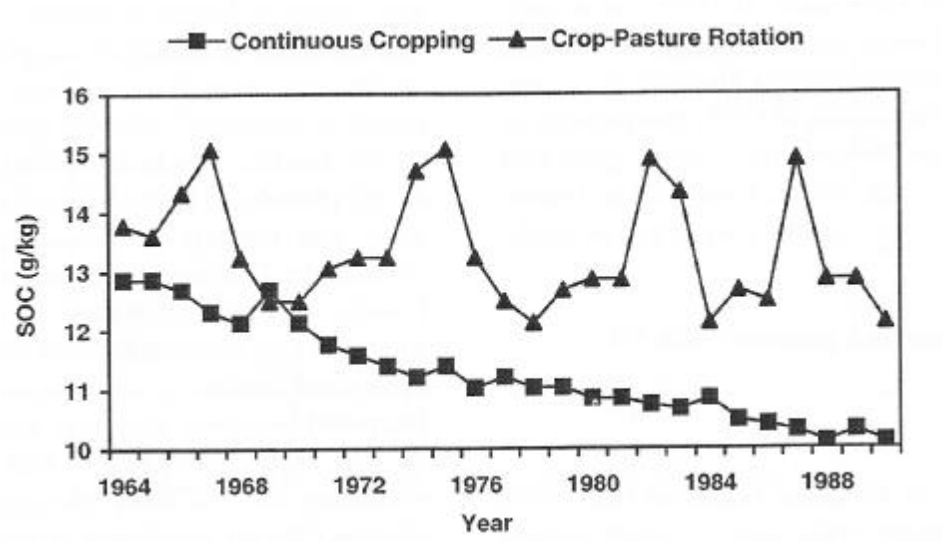

Figure 1 Change in soil organic carbon (Diaz-Rosello, 1992)

In the early 2000s the introduction of zero-till and GM soy beans changed all this, due to the low cost of establishment and low risk of crop failure from weed competition. Over a very short period continuous cropping came to dominate the landscape in the western quarter of the country from Colonia to Paysandú. This resulted in a decline in cattle and sheep numbers as livestock production was pushed to less-productive areas in the north and east.

Share Farming

The majority of farming in Uruguay is controlled by share-farming companies. One company in Dolores, western Uruguay is Agronegocios del Plata (ADP), run by general manager Marcos Guigou. ADP farm 50,000ha of corn, soy and wheat, employing 160 people. Mr

Guigou began farming in the year 2000, running cattle on a 1000ha farm in Dolores. Two years later, he seized on the opportunity to expand through renting land.

A typical rental agreement is on a tonnage basis, with a price fixed at harvest. A farmer rents his land for 0.7tonnes of soy beans per hectare and is paid at harvest that amount times the harvest price, of say, $400/tonne. The system has proved successful for Mr Guigou because he has been able to expand his cropping enterprise without the capital required to purchase land, and he has since expanded his business into Brazil, Argentina and Paraguay.

I also visited the farm of Lucas Gremminger in Soriano in north-west Uruguay, who has a contract agreement with ADP on 20% of his farm. Mr Gremminger grazes 2000 breeding Angus cattle and over 300 horses on his property and uses ADP as a form of supplementing the farm's income. Mr Gremminger did not have the skills and finances to implement his own cropping programme and instead decided to concentrate on the production systems he knew best. His relationship with ADP and the rental system worked well for him and he planned to plant more crops in rotation with pasture to fatten cattle. ADP would prefer Mr Gremminger to continue to crop land for up to 10 years, but Mr Gremminger's own experience in research at the University of Uruguay, has shown that even under zero till, a pasture phase is needed for long-term soil sustainability (Fernando garcia-Prechac, 2004).

One of the more interesting aspects of ADP's contracts with land-owners, is that it pledges to return the land in a better condition than before the contract was taken out through the use of best practice agronomy and no till farming methods. How the success of these projects is measured, and how accurate that measurement is, is not clear, but the pledge reassured the client that best-practice was being used.

Environmental effects

I visited the Faculty of Agronomy (Uruguay National University) in Paysandú, where I met Dr Oswaldo Ernst, who was running crop trials on the integration of no-till CPRs. Walking over the trial sites, we discussed the importance of crop rotation and no-till, and the effects of the change in the farming systems in Uruguay. Dr Ernst explained that even under the best continuous no-till systems, there was a loss of the amount of soil organic carbon compared to the CPR.

When compared in terms of $/ha, the value over a six-year period CPR was $260/ha, while continuous cropping systems had a value of $154/ha, based on the removal of nitrogen and the increased production through CPR (Fernandez, 1992).

While the financial benefits of CPR were clear, Dr Ernst's figures were based on a typical rotation system of corn-wheat-soy. However, from what I saw, the majority of farmers in the country did not work this way because soy beans returned twice as much profit as other crops, while production was far simpler, due to GM, glyphosphate resistant varieties. As a result, rotations were pushed in favour of soy beans.

The push towards continuous soy production had led to soil erosion, as there was little groundcover after soy beans were harvested, even in a no-till system. One of the most profitable systems for farmers was a straight soy rotation with winter fallow, but this left the soil exposed. Wheat was the usual winter crop, but due to long wet winters, it was not reliable. An emerging trend has been to plant grasses in the winter and bring livestock in to fatten; it is seen as a safer option than wheat and provides more stability to the soil.

As the best of the land in traditional cropping areas is being taken up, large farming companies, such as ADP, are pushing into areas not traditionally used for arable production. These areas in central Uruguay traditionally ran cattle and sheep for fattening, breeding and wool production however a global decline in wool and meat prices has meant farmers have seen the money offered by cropping countries as very attractive.

Government intervention

The shift has been so extreme that the Uruguay government has started to look at imposing restrictions on rotations. To gain a clearer view of the implementation of this, I spent time with farm consultant Roberto Roccar, of Delta Animal Production, Montevideo. He explained that the laws around soil conversion, management and erosion control had been in place in Uruguay for many years.

"According to this law, farmers can suffer a penalty for not doing what is right," he said.

He outlined that following the big increase in cropping in the last years, the government decided to update the law, to reform the rules that are included in that law, and to create a body that will act as a Department of the Ministry of Agriculture, Livestock and Fisheries.

Through this, they will define more strict rules, and probably the need of a document under the responsibility of a private agronomist, certifying a plan and control of a farm.

He also stated that this has not yet been clarified, but the general aim will be to have a more strict control on the land under cropping, in particular due to the fact that cropping will penetrate land which is not so appropriate for cropping. Continuous cropping is not possible in our conditions, in general, so some sort of rotation with cultivated pastures is and will be needed.

It was interesting from the point of view that when the science seems to be ignored by the farming community, then the government has seen fit to step in and enforce with legislation to protect the land. This has been seen in Australia, in terms of land-clearing and conservation, but not in general farming.

The overwhelming issue I found in both Brazil and Uruguay, was the government's primary concern for the environment and the proactive steps it took in not only trying to improve it, but at the same time trying to increase production.

Being large export nations there was no room for subsidies to compensate farmers for doing the right thing; instead they incentivise farmers by helping them increase production through research and development.

In Brazil, EMBRPA is looking to return 20-30% of existing farmland back to native vegetation, but at the same time its goal is to increase production on the remaining land by 4.5% per year to compensate. Unlike other nations, it also wants to diversify production away from monoculture for both social and economic reasons.

While many governments across the world are taking emphasis away from agriculture and focusing on issues affecting urban environments, countries in South America rely on agriculture for food security and economic stability.

In the opinion of some economists, Brazil and Australia have been two of the few nations to ride out the global financial crisis due to the stability of their agricultural sectors and the free market system they operate under, unlike the agricultural systems of the northern hemisphere, which were formed around a more structured monoculture and subsidised systems that does not have the same flexibility.

England

Steve Armstrong in Northampton, was one of the few mixed farmers I met on my travels though the UK and Ireland. The system in the UK has changed since the introduction of Common Agricultural Policy (CAP) as it pays for a farmer to specialise in one thing; either crop or livestock. In fact, the system discouraged farmers from being mixed. If a farmer uses arable land for pasture for more than two years, he has to apply to return it to crop. Often this is refused, so the land is continuously farmed in short rotation of mostly wheat and canola.

Steve is a first generation farmer who, in 1990, took a two generation lease on his property; meaning that he and any of his children can farm the land until the second generation can no longer. Steve uses all the available farming methods. He runs a mixed farming enterprise with sheep on pasture, winter and spring wheat, canola and linseed. But what makes Steve's enterprise different, is the way he uses environmental payments.

Steve allocates 10% of the property to wildflowers grown along the hedgerows. For this he receives £450/ha, but no single farm payment. His primary income earner is wheat, for which he receives £15/tonne more from the business he supplies, because of the amount of wildflowers he grows. This system also works for the sheep enterprise. As well as digging shallow ponds in the pasture for wading birds to breed; again a payment.

Figure 2 Steve Armstrong’s wildflower borders

In Steve’s calculations, mixed farming is far more profitable due to the flexibility and opportunity a diverse enterprise brings.

Crop pasture rotations are all about diversity

Diversity is the key to CPR success as it builds systems that lower costs while increasing production, profit and sustainability.

The diversity also allows for change. As environments and policies change, so can a CPR. Taking out one crop and replacing it with another, or moving between livestock enterprises and breeds, as markets change.

It is a system bred out of resilience, from countries with unsupported agriculture and tough environments.

External Crop Livestock

Within the External Crop Livestock system (ECL), each part of the system runs independently of every other. There is little or no interaction between enterprises within the farm, and more often than not the farmer specialises in only one enterprise.

This type of system is predominantly found in wealthier northern hemisphere counties, which consume most of what is produced, and have some form of subsidised agriculture.

Food production is at its most efficient, when one enterprise operates on one farm, as the farmer can specialise and become an expert in that field; but it comes at a cost. In this system there is a high chance of the single system failing, either due to market failure, disease or weather and it is without a backup enterprise, such as within the CPR. Governments are relied upon to support farming when times are tough.

This, of course, can only function when the majority of the food is consumed domestically, due to cross subsidisation. The consumer pays through taxes which are then given to the farmer, and in return the consumer gets consistently low-priced food. This is the case in both Europe and North America. It works well for both food security and affordability, but it does come at the price of sustainability and land tenure. There is little or no incentive to look to the long term, just the push for the most supported system. This can come at the cost of environmental sustainability and land tenure, due to the overly inflated price of land due to the subsidised agriculture it attracts.

North America

North America is entirely dominated by the ECL system. Travelling from Iowa through North Dakota and then down through the mid west to Texas I saw many great examples of ECL systems in play.

Iowa

In Iowa, I stayed with Tim Richter, a corn and soy grower from Lime Springs, who farms in partnership with his brother Randy, and business partner Jackson. They grow 3000 hectares of

GM corn and some soy bean, on mostly rented land. Almost 70% of the land in Iowa is rented, as the price of land is too high to purchase and make a return from farming.

Figure 3 Jackson & Tim

The corn they produce goes to three places. About 33% goes to ethanol production, with plants situated around the state so that it is no more than 50 miles to cart the corn. There are two main products that come from ethanol production; ethanol and brewers' grain. Brewers' grain now forms an important role in feedlotting cattle and pigs, as it tends to be cheaper, and is high in vitamins and other nutrients.

Another 33% of the corn crop is transported by barge down the Mississippi River and to other users, either as feed for cattle in other states, or export to China, also as feed. The remaining 33% is used in pig (hog) barns on the 300 hectares Tim owns. This is where the ECL starts to work so well.

The partnership owns the barns and the feed mill, but not the pigs. The barns are climate controlled so that they can operate at optimum performance all year, with all the waste stored in a pit under the pigs. This pit operates as both heating for the barn as it ferments, and as a year's storage for the manure before it is used for fertiliser. The outside air temperature ranges from minus 20° to 40°C.

The pigs are owned by a processor, with Mr Richter being paid for the barns' rent, management and feed. Mr Richter buys brewers' grain as part of the feed supplement, thus a

large percentage of what is grown, is used on farm. Mr Richter is really just growing and marketing corn as he has no real financial interest in the pigs. One of the big spinoffs is the manure the pigs' produce, which is pumped from the pits under the pig barns and injected into the soil as fertiliser reducing the inputs required for the crop.

In this system Mr Richter is wholly reliant on the corn price with no other diversification in income. So how does a system like this stand up to seasonal instability? There are two ways. Corn is indirectly subsidised by the ethanol industry due to it creating artificial demand for corn, this due to the ethanol mandate to produce 15 billion gallons of ethanol.

The second is GM corn. I visited Matt Lieberman, from Iowa State University, who is researching sustainable agriculture, in particular, crop rotations. The common crop rotation in Iowa is continuous corn. Mr Lieberman argues in his paper (Lieberman M, 2008) that a rotation of lucerne, conventional corn, soy and oats under sown with clover, produces the same margins as continuous corn, with the added benefit of increasing soil health, reducing fertiliser use and the amount of green house producing gases released to the atmosphere. So why then is 95% of the corn grown, GM triple-stack? Triple-stack product in corn combines Roundup Ready herbicide tolerance, YieldGard Corn Borer insect protection and YieldGard Rootworm insect protection.

Mr Richter grows continuous corn on most of the farms he operates, with some of the paddocks in their 25th successive year of production to corn. I put the research I had seen at Iowa State University to Mr Richter, and asked him why he used triple-stack corn which is expensive to buy and produces similar yields to conventional corn, and not implement a rotation to diversify his income as well as the other soil benefits seen in the research.

His response was simple. It was all due to risk. "Triple stack corn produces great yields every year; year in year out," he said. Previously, when he produced conventional corn, he faced greater risk as there were so many variables that could go wrong, and so many factors he could not control. "With the GM corn, you plant and fertilise it and then sit back and watch it grow".

Mr Richter now reliably grows 200 bushels per acre (12.5 tonnes per hectare), up from 140 bushels (8.8 tonnes per hectare) only 10 years ago; the yield improvement is mostly due to improvements in the GM technology, producing a more reliable system.

North Dakota

In North Dakota I visited Rocky Bateman who has moved away from a mixed farming enterprise comprising cattle and conventional crops. Mr Bateman now leases out pasture land he is unable to crop and grows a rotation of sunflowers, GM corn and GM canola. Mr Bateman says that the move away from cattle to zero till and GM crops has saved his farm. Specialising in cropping has given him reliable crops year in year out. By focusing on one rotation, and doing it well, he is making more money than he has in the past. For Mr Bateman, this means he can see a future in agriculture and can replace the old milking barn his grandfather built, with a more suitable undercover protection for his machinery.

Figure 4 Rocky Bateman explaining cover crops

In fact, the more I travelled through the mid west, the more common this story was. Yet at the research facilities I visited, the focus was on diverse systems of crop and livestock. All the facilities I visited had a common theme; switch grass production. The US has a mandate for 15 billion gallons of cellulose energy production, and switch grass is seen as something that can be grown as a crop to produce biomass, as well as pasture for grazing. But it is hard to see farmers growing switch grass for energy with the rapid advancement in yield offered by corn. In fact it is hard to imagine anything competing with corn for space at all.

This is one of the big problems a subsidised system faces - distortion of markets and the lack of diversity that brings impacts on both the environment and food supply.

Nebraska

In Nebraska I stayed with Bart Ruth, a corn and soy bean farmer who ran an ECL system in conjunction with his neighbouring dairy farm.

Mr Ruth uses no till in a soy and corn rotation, supplementing the water requirements with irrigation via centre pivot irrigators. While he has access to underground water, most of the water he uses comes from the neighbouring dairy farm, which pumps its waste water through underground pipes to the centre pivots; saving Mr Ruth both the expense of the water and the pumping.

The water coming from the dairy has good levels of nitrogen, phosphorus, potassium and other micro nutrients thus also allowing Mr Ruth to further reduce the amount of fertiliser he uses. So what does the dairy get out of this arrangement?

The neighbouring dairy milks 5000 cows, three times a day, over a 24 hour period. The cows are housed in barns with sand bedding and are fed a total mixed ration containing mostly corn silage with added brewers' grain, soy meal and whole corn, as well as other mixed feed sources found locally.

As part of the cleaning process, the dairy flushes the stalls twice daily with clean water pumped from the ground. The sand used as bedding is separated, and the water and faeces is

passed through filters to remove the solid waste, the nutrient charged water moving to the ponds where it settles until is ready to be pumped to the irrigators.

The water needs to be used and can not be pumped into the water course, so the most economical way to get rid of the water, is to provide it free to the local farmers. In return, the dairy has a good local supply of feed for its cows.

Mr Ruth produces three products on his farm: maize which is sold to the local silo or the ethanol plant about 30 miles away; corn cut as green chop for the dairy; and soy beans. All of these products find their way back to the local producers, with products such as milk, pork, cattle and ethanol sent interstate.

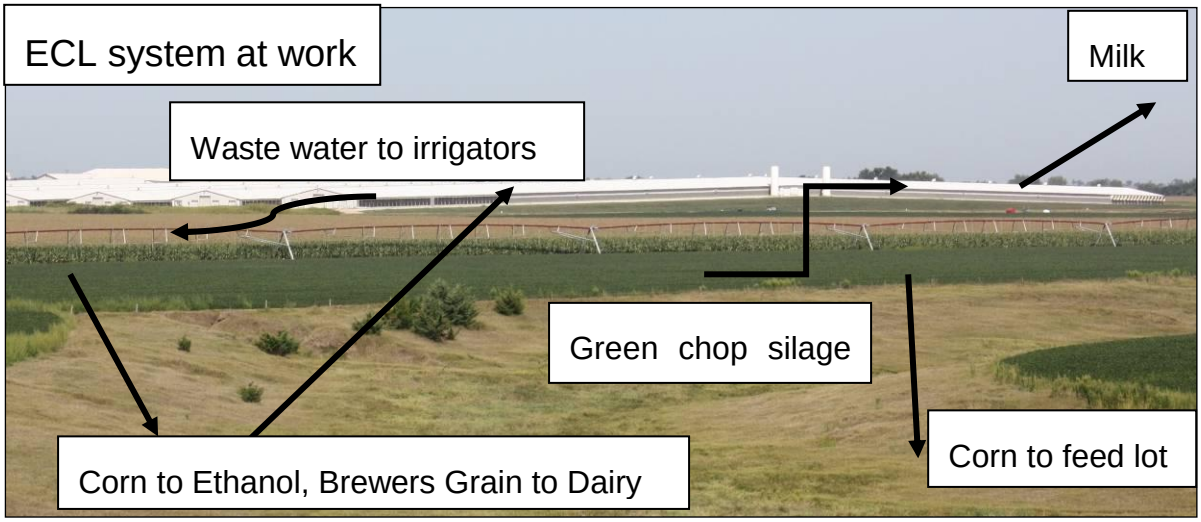

Figure 5 Dairy and corn farming interactions on Bart Ruths farm

What is different about the ECL system is that producers specialise in one enterprise, due to the protection and subsidisation of their commodities. This removes the need to spread themselves over many different enterprises.

It is easy to be reliant on other farmers within the system because they too are held up by the government's system of protecting a farmer's income. If you know the other partners in the system have a very low chance of going broke, then you can have the confidence to pursue a single commodity system.

External Crop Livestock is all about risk

Whether the farmer knows it or not, the external crop livestock system is all about risk. This system builds a reliance on each farmer doing his bit to make the system work. If one part of the system fails, then all of the other parts will falter. Having government support is so important, but would the system survive without it?

In terms of efficiency of production and output, this system wins. But in an ever changing world environment where the way food is produced is becoming as important as the cost, even this system could be under pressure.

Winter Stocker Operation

The Winter Stocker Operation (WSO) is the most opportunistic of the three systems. This system involves crops, such as wheat, being planted and then either grazed or let go to seed production, depending on the season outlook.

These systems are found in most agricultural industries around the world, but are often not recognised as a system on their own but as part of another.

There were three systems I investigated in Oklahoma, North Dakota and Uruguay.

Oklahoma

In Oklahoma hard red winter wheat is planted in the autumn, prior to the winter frost relying on either sub soil moisture or season opening rains. The aim is to get as much crop growth as possible prior to winter so the plant is strong enough to handle the cold and also to provide large quantities of feed to finish cattle.

Cattle come from all over the nation to fatten on the winter wheat in Oklahoma. It is said to be one of the largest migrations of cattle in the world. Cattle come from the coastal areas of the US where they are bred and raised on pasture then transported to Nebraska where a large percentage are agisted at feedlot utilising the large amount of corn grown in that state.

Cattle are required to be at a certain weight, depending on the finishing time required, before entering the feed lot. Wintering the cattle on wheat is one of the most cost effective methods.

There are two ways to operate a stocker operation. One method is for the wheat farmer to purchase cattle and finish them to the feedlots weight requirements. The farmer takes all of the risk in finishing the cattle but if the season is good they reap the profits.

The other way to have a stocker operation is to get paid on weight gain. An independent party owns the cattle and takes the bulk share of seasonal risk. The independent party can be the breeder of the cattle who takes ownership right through to the feedlot, or a trader who buys and sells cattle and makes his margin on the weight gain against the market price.

Oklahoma is seen as the meeting place for store cattle on their way to feedlots and thus has one of the largest stock yards in the country.

I visited the Oklahoma Stock Yards in Oklahoma City. It is one of the oldest stock trading yards in the US and operates 6 days a week, all year and is only 5 miles from the city's Central Business district. It is open to the public and has a restaurant and shopping district.

Figure 6 Oklahoma stock yards with Oklahoma city in distance

When so many cities are relocating agricultural facilities away from urban areas due to the smell and traffic, it was great to see the city embracing their heritage, much like many port towns.

Both methods have their pitfalls and benefits**.** I sat with some of the traders in the selling ring at the stock yards during the auction, and it did not take long before many of the pitfalls were realised.

One of the biggest, was when the farmer opted for weight gain payments and the trader dumped under condition cattle on the wheat farmer. These cattle take weeks to recover and gain condition and weight; thus the farmer loses out on payment for weight gain.

The other is the farmer buying the cattle in, and then the season going bad, and then having to dump the cattle back on the market. It seemed clear at the end of the discussion that like all farming systems, it requires great skill to manage the risk.

One of the most flexible parts of the system is the ability to play the season. If the price of wheat is high, farmers can opt to run the wheat through to harvest as normal. If either the price of wheat is low, or the cattle price is high, farmers will then continue to feed the cattle on the wheat, harvest no grain, but make the money from the cattle.

Overall, the system they run in Oklahoma is flexible and opportunistic which at the time of travelling was a far cry from the simple corn rotation I had seen in the northern states.

North Dakota

Rangeland Scientist, John Hendrickson hosted me for two days in and around Mandan in North Dakota at the USDA Agricultural Research Service. I had met Mr Hendrickson previously when he and some of his colleagues visited the research centre in Katanning Western Australia, which is about an hour from where I farm.

What caught my attention was his presentation on ‘integrated stock cropping systems’. As explained in external crop livestock systems, this type of system is not common in the US. Mr

Hendrickson and his team are trying to implement these systems to bring some sustainability to the soils and environment.

North Dakota is dominated by annual crops such as wheat and barley. The growing season is short with long, cold winters. There is a mix of enterprises, with cattle and some sheep (90,000) providing income from land that is not arable for cropping.

Mr Hendrickson's team is looking at two areas:

- Integrated cropping systems; and
- Winter stocker systems.

Integrated Cropping Systems

Integrated Cropping Systems (ICS) have three main elements. The first involves a modified crop matrix, where different cover crops are sown into a common residue to evaluate the above and below ground impact of cover crops on subsequent crops. Cover crops are becoming a popular way of restoring soils in North Dakota and I saw many examples of this as I travelled around with Mr Hendrickson.

Mr Bateman (as mentioned in ECL North Dakota) uses cover crops of sunflowers, peas, wheat, radish and turnips to break up the soils and restore fertility before commencing cropping. This process often takes 3-4 years, without any value from either grazing or grain. Mr Bateman and other farmers are having great success with cover crops not only to restore land for cropping, but also for pasture production, with many of the cover crops being planted to perennial pastures for cattle and sheep grazing.

The second element of ICS involves small plot techniques such as crop rotation, economic analysis and modelling techniques, to develop economically feasible management strategies for biofuels and an Eddy Covariance System to measure CO^2 flux as a surrogate for environmental impact of biomass crops. I saw very little biofuel production on any farms and

this will, in my opinion, remain that way until an effective harvesting and processing method is established. These systems are looking at grasses that can be grazed for part of the year and then locked up for biomass production.

Much like the Oklahoma winter stocker operations, if the price for biomass is low, grazing takes priority while if the price for biomass is high, the crop is destocked.

The element of ICS involves the performance comparison of livestock grazed on annual crops and perennial grasses in the fall. The integration of the pasture and cropping systems is seen as one of the biggest steps forward for agriculture in North Dakota. As in Australia, very few farmers will integrate the two systems, but there is a huge opportunity to remove livestock from pastures in the winter and graze crops on the same farm.

Winter Stocker Systems

North Dakota is covered in snow during its long winters, when little feed grows. One of the keys to the integration of livestock back into the farming system is developing better winter stocker systems.

One of the most interesting Winter Stocker Systems I saw was a trial managed by Dr Don Tanaka, at ARS Mandan (Drs. Don Tanaka, 2009). The trial was comparing a rotation of three crops;

1. Oats undersown with alfalfa, hairy vetch and red clover;
2. BMR sorghum x sudan undersown with sweet and red clover; and
3. Corn for grain and the crop residue grazed.

The oat crop was swathed at maturity, prior to the winter, with the cattle walking between the swaths and feeding on the oats, vetch and clover. The attraction of this system was its low cost, good nutrition and soil improvement from the nitrogen injected by the clover and vetch. Traditionally hay is rolled and stored in sheds and then taken out to the cattle as needed, but in this method the feeding is controlled by using moveable electric fencing which reduces both labour and preparation costs.

The sorghum and sudan crops are left standing for the cattle to graze, and like the oats, electric fencing is used to control feeding. One of the added benefits is the protection the crop gives to the cattle, as the height of the sorghum and sudan is greater than the cattle. This provides shelter from the cold wind, hence decreasing energy requirements and increasing weight gain.

The most interesting system was the corn which was planted in double skip rows with two rows planted one metre apart, and the next set of rows planted two metres away. The corn planting density is higher in the double skip rows and when cut with a conventional header front, instead of a corn front that leaves the stalk behind, just below the first cob, the trash, including the thrashed cobs and leaf and stalk residue, is dumped by the header into the double skip rows. This acts like a basket holding the corn residue (Figure 4).

The cattle then move up and down the rows, feeding at the ‘troughs’ of corn residue. I liked this system for its simplicity, as it would take very little to change a conventional system to enable the integration of livestock.

Figure 7 Dr Don Tanaka, winter stocker system

These systems offer a great opportunity to producers to be able to winter stock and thus find a better fit for them into the total farming system. Many producers I met had moved away from mixed enterprises, and are now focusing on single systems. So even if they do not want to continue with breeders, there is an opportunity as part of their cropping system, to make some money through the winter.

Uruguay

Like in Australia, waterlogging of crop and pastures is a common problem in Uruguay. While this makes winter cropping risky, winter crops provide cover to the soil, especially after soy beans crops which leave little biomass. With less that 10% ground cover after soy bean, soils are exposed and prone to erosion which has led to greater scrutiny of farm practices and crop rotation techniques. Due to the social perception, many farmers are looking to winter cropping alternatives for the answer.

Short term rye grass is one that is being trialled as a winter crop as it is easy to establish and not prone to establishment problems in the wet as wheat is. The grass is established and grown to production, and when the ground is firm enough, lambs are placed for fattening.

This system provides a more secure income for the farmer and better ground cover for the soil and the subsequent crop, as well as the much required feed for that time of year.

Winter Stocker Operations are all about opportunity

An opportunity is so often found in the cracks between enterprises, rather than in the enterprises themselves. By this I mean the opportunity in the winter stocker operation has come about as a by-product of trying to achieve a very different outcome.

In Oklahoma, it is the by-product of growing wheat, in North Dakota, it is the by-product of the long cold winters, and in Uruguay, it is the by-product of failing wheat crops.

Yet it is the synergies between the systems that so often becomes the profit driver, such as the ability of the farmer in Oklahoma to continue to graze his crops if the price of wheat falls, the ability of the farmer in North Dakota to use his corn crop to feed cattle through the winter, and the ability for the Uruguayan farmer to decrease his risk with forage crops instead of grain.

Recommendations

Wherever I travelled in the world, it was clear to see that farmers develop systems that manage risk in their environment. Regardless of the amount of research showing them "a better way", farmers manage risk by doing what produces the most reliable result. Whether this is GM corn being grown for 25 years in the same paddock or complex crop and pasture rotations, the result is the same - stable economic returns.

If you look at innovation, conservation and agricultural growth as the drivers, then the southern hemisphere is doing all of these things well and, in my opinion, are likely to become the power houses of agriculture. In the north, research facilities are providing lots of innovation, but due to the support the farmers receive, very few of them adopt the ideas because it has little effect on their bottom line.

My conclusion from my scholarship is that **diversity decreases risk and increases opportunity**.

Diversity

Diversity can be seen as either within a business or between businesses. Within a business, having both livestock and cropping offers two very different enterprises with different markets to manage risk. The synergy between the two gives each advantages, such as grazing of the crop stubbles in the summer months to help with the feed demand when feed supply is short, or grazing crops during the winter, such as in North Dakota and Oklahoma as an opportunistic income source or feed when pastured stop growing in a mixed farming system.

In Nebraska at Bart Ruth's farm, diversity can be between businesses creating opportunity. In this system sees up to four businesses being reliant on each other, each one operating independently but at the same time reliant on the others doing a good job. This creates good opportunities not only for the farmers themselves, but for the whole community because more diversity in a community brings more employment opportunities. This is shown in Brazil, where the government through - EMBRAPA - have a focus not only on production but on diversity of production, to sustain employment and prosperity in rural communities.

In Australia I believe the next big jump in productivity will be from exploiting the diversity of our farming enterprises. Working more on the synergies between farms could give large production boosts as well as managing risk and sustaining rural communities.

An example of this could be livestock supply chains. For example we could focus on breeding lambs on parts of the country that are not suitable for crop production, move them as store lambs to cropping areas during the winter for backgrounding and then finish them close to the processing works on grain. In this system the breeder can produce more lambs as there is no requirement to finish them and transport per lamb is cheaper as they are small. The crop producer has the opportunity for extra income from the live weight gain as well as a new grain markets with the lamb feeder market and income from grazing if the season fails due to no late rain and the processor receives a better grain fed product with a more constant supply. This system therefore produces three individual businesses with new opportunities.

Risk

Managing risk is becoming one of the most important aspects of the farming business.

Grazing cereals is one such method I think needs to be used more. As an example, a farmer could bring in lambs for agistment to graze his crops in the winter for four weeks at $0.5 per lamb per week at 30 lambs per hectare. This would bring in $60 per hectare in additional income, which is about the cost of the chemicals used to spray the average crop.

If the farmer were to buy in the stock he could expect, using my own experience, to grow lambs at 250 grams per day. Stocking at 30 lambs per hectare at a price of $2.50 per kilogram liveweight, this equates to $18.75 per day per hectare or over 30 days $562.50 per hectare.

In these two scenarios, by grazing the crops the exposure to a poor finish is lessened by the income generated mid-season, but in a good year the income is increased. Whether you choose to own the stock, agist or feed for weight gain, using the synergy between stock and crop has the potential to not only increase income but decrease loss.

Another example of risk management though synergies is attracting other intensive industries such as chicken, dairy and pigs to your farm, such as the examples I used from Iowa and

Nebraska. This gives the opportunity to sell grain direct and use the waste to fertilize the farming land, again decreasing risk and creating opportunity. I believe this could work well in Australia and it could also bring benefits of more local employment and stronger rural communities due to the diversity it would create.

The use of GM technology has a big potential to manage risk, as was evident in South America. As I travelled through small communities I was told of the huge change GM technologies has brought. The low cost of establishing the crops and the reliability of yield meant that even small farmers could move out of subsistence farming.

In Australia it can offer more consistent yields with better weed control and help reduce the cost price squeeze between inputs and outputs. If we look to the future and the possible effects of climate change, then GM is going to be a very useful tool to manage risk through its ability to breed in traits such as frost and drought tolerance.

Research and Industry

Australia needs to take a look at its research direction and make sure all the RDC's have a common vision. Gone are the days when the crop researchers don't talk to the sheep researchers and vice versa, because on the farm to two are interlinked and the future is the synergy between them.

I believe that the agricultural industry should contribute to an industry vision that is shared by all. As an example when GRDC and MLA write their own strategy for within their own industry it should refer to synergies in other industries. When research is needed on grazing cereals, then both the crop and livestock researchers need to be involved because the results affect both industries, not just one of them.

To facilitate this I suggest that the RDCs share facilities in one location. This would encourage more cooperation and possibly save duplication in many areas. I would also encourage Agribusiness to share the same space. As governments start to look at reducing funding for agricultural research and development, the agricultural industry needs to attract agribusiness in to take up the short fall in funding. This will also have the benefit of focusing

the results of research being more commercial and thus more focused on the farmer's bottom line.

But most importantly, research needs to have an outcome - not just a scientific one, but an outcome for the whole industry. If farm profitability is an outcome then you need to include all parts of the farming system and not just one. Focusing on just grain yield doesn't deliver better profitability alone, but increasing grain yield with good grazing tolerance and production could lift both production and profit while lowering the risk.

A way of implementing this in Australia could be to start a Cooperative Research Centre (CRC) for Agricultural Production and Sustainability. This could act as an umbrella organisation for all the RDCs to construct a common vision and outcome for industry and oversee the inter connectedness that these industries need.

More importantly, the CRC could look at the social and economical impact of agriculture on rural communities. The role R&D has to play in their health and look at ways and systems that not only increase production and profitability of the agricultural sector but that of the community as a whole.

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Plain English Compendium Summary

Project Title: Integrated Stock Cropping Systems	
Nuffield Australia Project No:	1107
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Objectives	To investigate the integration of livestock and cropping and their importance in Australian agriculture.
Background	There has been a change away from pasture crop rotations to all crops, with livestock becoming less important. This has increased to risk of the average farm and decreased the diversity.
Research	Research was conducted by visiting Agricultural institutions, farmers, politicians, industry leaders and research facilities throughout Ireland, England, USA, Mexico, Brazil, Uruguay and Argentina
Outcomes	Diversity decreases risk and increases opportunity. By moving to a more diverse agricultural system farmers are able to better adapt to adverse seasonal conditions, change enterprises as markets move and create opportunities from the synergies between the enterprises. Diversity also creates opportunities within the rural community and is a driver for healthier rural populations.
Implications	Research and Development organisations need to have a more united approach to research and work more closely together to create better outcomes for farmers.
Publications	