Cost Efficiencies in No-till Cropping Systems

A report for

by Paul Adam

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Foreword

Much has changed in the Australian Grains Industry in the last 100 years. We have seen mechanisation, the use of synthetic fertilizers and the introduction of semi- dwarf genes in cereals help to revolutionise production to make the Australian grains industry a world leader.

In recent times we have seen change of another kind with the evolution from conventional tillage system, minimum tillage, direct drill and then to no-tillage. This change has also seen the introduction of controlled traffic farming with farmers leaving permanent wheel tracks through every paddock for all machinery to follow, in an attempt to limit compaction caused by multiple passes of heavy machinery. This journey has seen various design and technology challenges, which have allowed many farmers to rationalize machinery and reduce other variable costs. The overall impact has been to reduce costs, increase profit margins and has added to the sustainability of the farm business and the fragile soils many of us farm.

With so much change and so many gains the questions had to be posed, "*What is next?* ". Where will our next big efficiency gain come from, and is it possible to be more efficient than we already are, or will our ever increasing costs continue to eat into our profits?

My Nuffield Journey would take me 16 weeks, through 10 countries, trying to gain as much knowledge on this subject as possible, with the view of driving down input costs further than has been done before.

Acknowledgements

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- To Nuffield Australia, for the work that goes into keeping the program going and allowing me the privilege of joining such an amazing network of scholars worldwide.
- To my sponsor, Macquarie Agricultural Funds Management for their support of the Nuffield program and allowing farmers like myself the opportunity to experience so much.
- To all the people, who gave up their time to allow me the opportunity to gain an insight into world agriculture. A special thank you to those of you who have opened up your houses and allowed me the privilege of being a part of your lives.
- To my parents, for their encouragement, support and for helping to keep things at home running with some sort of normality.
- Finally, to Meg, Robert, Caitlin and Bree. Thank you for the love, support and sacrifices that you have all made, allowing me to have the opportunity to undertake this life altering journey.

Abbreviations

ha - hectare

CTF- Controlled Traffic Farming

No-till - No tillage

GRDC - Grains Research and Development Corporation

mm - Millimetres

GST - Goods and Services Tax

RBA - Reserve Bank of Australia

UK – United Kingdom

FSWC – Full Season Weather Certificate

ABARES- Australian Bureau of Agricultural & Resource Economics & Sciences

GM-Genetic Modification

Definitions

No-tillage is using knife point or disc seeding with 5-20% topsoil disturbance.

Zero-tillage is disc seeding with less than 5% topsoil disturbance.

Reduced-tillage is one pass prior to seeding with a full cut-out of the topsoil.

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Executive Summary

The challenge to increase efficiency is one that all industries face and agriculture is no different. Increasing productivity in a cost-effective manner is even more difficult to achieve.

One of the aims of my studies was to find cost efficiencies that progress our no-till system further than before. Technology and design was always going to be key to this goal, offering the biggest gains if our seeding system could be developed to a true one pass system. The reality is that many growers around the world are more advanced in their techniques than machinery manufacturers have machinery to cater for their needs. This market is yet to reach critical mass where the companies see the returns nedessary to allow them to alter machinery design and ultimately to drive new assembly lines. Some companies have variants that are coming close to reflecting our needs but are just not quite there yet with many design aspects still focused at the broader market.

What is evident is that risk has been a key driver in the pursuit of efficiency and one method of risk aversion is to minimise the excess cost in business. This principle was common in every facet of agriculture studied and it really stood out in highly supported countries with efficiency being much lower on the list of priorities of growers that were visited. In these areas there is total focus on yield above anything else and costs are not considered in the equation as much as the areas with the greatest risk exposure caused by either environmental conditions or less favourable governmental policies.

What was unexpected was to find a risk management tool that could have the potential to smooth out some of the financial pain severe weather events often cause to the average farm business without having a detrimental effect on the desire to pursue cost efficiencies in no-till enterprises. The use of insurance-based supports appeared to be an excellent compromise between a farmer’s risk exposure and the need to drive as much efficiency as is possible into the system.

Introduction

To some of us farming is not just a job that you just stumbled into; for others it is a profession that runs deep in your veins. For many it is something you aspire to do right from childhood.

After completing secondary school at Tottenham Central School age 16, I made the move north to start an Advanced Certificate in Pastoral Production at Longreach Pastoral College. This was an interesting time in my life, a chance to break away from my small town and see what this big world has to offer. It was the opportunity to learn and experience another area that was different to my own and to experience so many different points of view. After completing college I returned to Tottenham where I worked in various roles for four years until joining my parents back on the family farm "Dysart" in 1999.

Much has changed since then with the business evolving from a traditional mixed farm through to one that is continuously cropping, using no-till and controlled traffic technologies. The business has in this time seen our machinery requirements change with each alteration to the system, eventually culminating in a mass rationalization with the adoption of no- tillage. It is this final change that lead me to really again question everything, to not be afraid to challenge those long held beliefs and apply long used business objectives to remove as much excess as possible from the business.

If as businesses we refuse to chase big productivity gains and just rely on varietal breeding alone we will quickly see any gains eroded by inflation.

Objectives

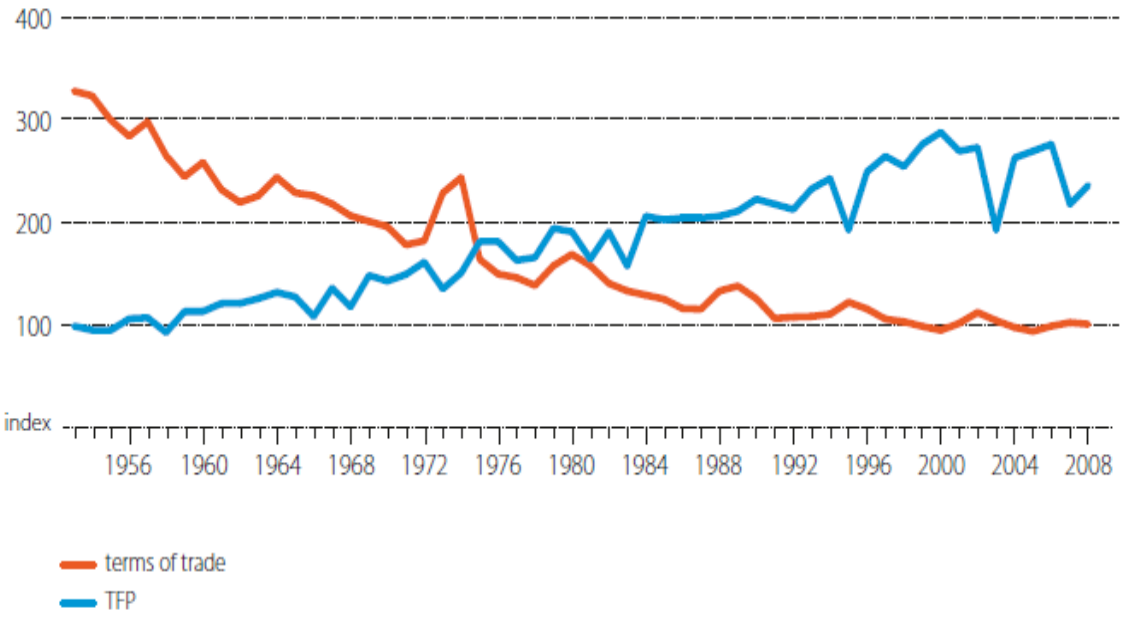
The key objectives of my Nuffield Scholarship were:

- To investigate potential efficiency gains from breeding of better traits into common crops.
- To investigate load-carrying tractor variants which might offer efficiency gains by having design adaptations that better suit the range of tasks carried out in a no-till cropping operation.
- To develop the current no-till seeding system into a true one-pass operation by incorporating a herbicide application.
- To find any products that may help with the overall profitability of the average no-till farm business.

Chapter 1: Cost Efficiencies in No-till Cropping Systems

Cost efficiencies in no-till cropping systems is a very broad topic which could cover many aspects of the day-to-day running of a modern grain producing business. With the adoption of no-till, grain growers were able to make much needed productivity gains. Large efficiency gains like those experienced from the adoption of no-till are not all that common, but without them we see our profits quickly eroded by inflation of our inputs. The graph below shows the trend of declining terms of trade of Australian broadacre farms against the total factor productivity (TFP) growth in the broadacre sector.

Total factor productivity on Australian broadacre farms



Notes: The terms of trade is the ratio of an index of prices received by farmers to an index of prices paid by farmers (ABARE 2009). TFP is the ratio of a quantity index of aggregate output to a quantity index of aggregate input (Gray et al. 2010).

Not long after commencing my studies it became apparent that the terminologies and definitions used in Australia differed from those in the countries visited.

The topic needs to be defined to give a clear understanding of terminology used.

- What is meant by cost efficiencies?
- What is a no-till cropping system?

Cost Efficiencies

Cost efficiencies are defined in the Oxford Dictionary as an amount that has to be paid or spent to buy or obtain a product: the effort, loss or sacrifice necessary to achieve or obtain that product; and the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in. In other words having the most effect, for the least amount of effort or input.

No-till Cropping Systems

No-till cropping systems are defined in the Oxford Dictionary as designating a method of planting in which soil is not tilled but instead is planted by insertion of seeds in small slits, weeds being controlled by other means. That is seeding directly into the field without preparing the seedbed other than with a knock-down herbicide.

Efficient Crops

Increasing cropping efficiencies to keep in front of inflation is going to be a major task, with gains from varietal breeding having slowed in recent times. These efficiencies can only be achieved by increasing production whilst decreasing inputs or vice versa.

At the John Innes Centre based in Norwich, scientists (Griffiths, 2011) are using gene marker technology to better identify genes that are beneficial in breeding. They are using the mapped genome of the small weed Arabidopsis which can be found in a variety of climates, to shed light on beneficial genes. It has been discovered that Arabidopsis shares many genes with our major crops, including wheat, rice, maize and canola. As the genome of these crop species are so complex and as yet have not been mapped, scientists are using the Arabidopsis as a substitute for the holes in the data. By isolating the desirable genes in the Arabidopsis, scientists are able then to select for the like genes in the crop species being worked on. This allows them to increase the rate of genetic gain by being able to select only the desirable genes and not have to correct so many of the unwanted traits that often get carried over to the next generation when using standard breeding practices.

Arabidopsis (BBSRC, January 2009)

This has the potential to rapidly increase production by being able to indentify traits that lead to increases in production or decreases in inputs. These traits range from frost tolerance to fertilizer efficiency or even cereals that have the ability to fix nitrogen in a similar way to legumes.

The efficiency gains from some of these traits have massive potential to take our farm productivity to a whole new level. Imagine the impact to our profitability of grain crops that require little or no fertilizer without having a detrimental impact on the soils we farm. The benefits seem endless, but we still have a wait to see some of these traits come to fruition.

GM (Genetic Modification) may also lead to crop traits that improve many aspects of our farm businesses. The experience of the cotton industry is a prime example of some of the gains that could be achieved. With the introduction of the Bollgard trait into cotton breeding the need to do multiple passes with strong insecticides like endosulfan has been greatly reduced. The economic effect of this has been profound on the industry, but the environmental benefits have been equally impressive. Traits that were to have a similar impact on the grains industry could provide much needed efficiency gains.

What drives the machinery investment on farms around the World?

It seems in every country there is a reason for having sheds full of expensive toys.
The most common reasons given were:

- timeliness of application
- labour costs
- crop rotations
- soil constraints
- marginal production
- competitiveness between growers

Timeliness of application

Timeliness of application was the most common reason for the levels of capitalisation in machinery and always due to climate issues within the specific farmed areas. These climatic challenges are different for every country and for even regions within those countries. Take Alberta in Canada for instance; due to the short growing season and wet conditions at seeding growers are very highly capitalized to take advantage of any window of opportunity they get, as the impacts on yields from missed opportunities can be massive. This is almost the opposite to much of Australia's conditions where a lack of soil moisture usually constrains growers' opportunities to sow seed and only giving growers very narrow windows for seeding. These narrow windows tend to lead to higher levels of capitalization in machinery with growers having their own machinery rather than using contractors or entering into machinery sharing arrangements with partners.

Labour costs

The world's labour market and its effects on machinery levels is an interesting topic as the results were quite profound. It seems that the cheaper and more readily available the labour supply, the smaller the capitalization on modern machinery. In countries with a cheap labour market the trend when scaling up is to add smaller, low technology machines rather than expand the size and capability of the machines used. This was very evident in Brazil where

vast fleets of smaller tractors and implements often undertake the same role that would be done in the North America or Australia with one larger machine. This is purely a response to the economics of the situation. It is much more cost-effective for Brazilian farmer to invest in this low technology system than to invest in the high end of the market.

Crop Rotations

Crop Rotations can pose many challenges to growers around the world. Whilst it is often best practice from an agronomic perspective, it often gives growers challenges in dealing with so much specialised equipment. It is amazing that as growers we often get caught up in the rotation and forget to question whether it is truly profitable when all this specialist equipment is taken into account. In many cases much of the cropping system is built around one small aspect of the rotation rather than building it around the most profitable system. This was the case with a UK farmer visited with sugar beet dictating much of his system. At the time of my visit this particular farmer was questioning whether to dump sugar beet from his rotation and replace it with another crop type. In this particular grower's case it would allow him to get out of the specialist equipment he owned, and also to remove the multiple passes of cultivation associated with the production of sugar beet that were not necessary with some other crop types.

Potato Harvester operating at Norwich, Norfolk, United Kingdom (Abrey, 2011) showing how specialised some of this equipment is.

Soil Constraints

Soil constraints are an issue that tend to polarize farmers reasons for undertaking the practices they do and can determine the machines they need. As part of my studies the focus was not just on farms operating no-till systems, it was also what drove the level of machinery in cropping systems. Soil constraints were an area that affected conventional farmers more than ones running no-till systems on controlled traffic. It is astonishing to think that farmers in many countries have sheds full of machinery dedicated to soil amelioration to rectify issues they have created.

Soil compaction was the one issue that was really contentious with most farmers willing to blame a clay soil for this instead of showing a willingness to acknowledge they are contributing to the problem with the practices they undertake. What can also take some grasping is the solution offered by machinery manufactures, which is to generally increase the tyre size and roll more of the field down. The farmer is left with only one solution, which is to dig up the field. This requires large amounts of time, fuel and machinery to bring the field up to standard, so it can again be seeded. This whole process only compounds the problem by destroying soil structure and in many cases depleting valuable soil carbon and ground cover. This all has cost associated to it, which is always borne by the farmer.

The problem could be simply overcome much earlier by controlling traffic on the field and matching implement widths. It will be interesting to see what the effects of higher energy costs have on these conventional systems and see whether the results are practical change across a vast area.

Marginal production areas

Marginal production areas in the regions visited always showed an increase of operating scale and focussed producers on the costs of production rather than just yield. The risks to production these areas regularly face tends to make their operations much leaner with little to no excess, as in most cases the businesses are unable to support this level of investment during poorer seasons. Interestingly this marginality has the opposite effect on change within the system. It seems risk is a key driver of innovation and without risk the desire to change and progress the system greatly diminishes. The more reliable the income is of the growers within the area the less the willingness to alter the system and the levels of capitalisation in machinery on the farm quite often increases with this safety.

This effect was more evident in countries with very safe climatic conditions and ones with very generous support programs.

Airseeder being operated by the Swindler family (Swindler, 2011) in the more marginal cropping area of North Dakota, United States of America

Competition between growers

Competition between growers is alive and well in every country visited, but in many cases it is for the wrong reasons. This competition is often focused on material wealth rather than profitability and efficiency. In many cases it is more important in the farmers mind to have machinery with the latest bells and whistles, than focusing on the efficiency levels that can be achieved by that machine and whether this is the most cost effective path for the business.
It is interesting to think that as farmers we are often critical of our city cousins and the consumerism in which drives much of their lives, yet partake in this practice on a much greater scale than we are often willing to recognise. This consumerism and desire to have the latest model is almost counter-productive to our business goals, as in many cases the latest machine offers very little in the way of efficiency gains. It is also interesting to look at the effect this has had on design of machinery. The reluctance of manufactures to radically alter design, but rather make minor design changes surely stems from having this captive market.

This halt to major design changes is most evident in modern tractors with the design principles behind the tractor barely altering, yet many of the practices it is used for have altered greatly.

Tractor Design

Tractor design really hasn't altered a great deal in the last 60 years. There are a few more creature comforts but the core design principles haven't really varied. The design concept leans very much to high-draft hauling of implements either by three point linkage or drawbar. In contrast our no-tillage system no longer has the high horsepower requirements previously needed and has moved to much lighter spray and disc seeded applications. The late tractor designer and manufacturer Harry Ferguson once said "a tractor without an implement is like pen without ink" (Thorne, 2006), yet some 60 years on we really haven't been willing to progress the tractor design principle to suit the implements now used in our no- tillage systems.

So what is the alternative? A move to a load-carrier may provide some of the solutions needed. We need a tractor platform that adapts to the tasks that we do now, rather than being stuck in the past. Something like a self-propelled sprayer that has the ability to still pull a seeder or chaser bin at harvest. Developing a true one-pass seeding option remains a primary objective. These tractor concepts are already available and being produced by two manufacturers, mainly for the European market.

Multidrive

Multidrive Tractors Limited is a division Kelland's Agriculture Ltd., based at Birdlip, Gloucestershire in the United Kingdom. They produce the Agribuggy sprayers and Multidrive range of load carriers locally, sourcing supplies from major component suppliers from around the world. Multidrive's moto is "Justifiably Different", which gives an idea of how they view their design and the tasks the tractor is capable doing. The concept seemed to be very sound and went a long way to addressing the flaws in the current tractor design in regards to the requirements of no-till system. It is very much specialist load carrier, but still retained the functionality of being able to haul equipment. It also has the option to be fitted with three point linkage which increases its functionality. The only weakness that could be seen was it is slightly too small in regards to horsepower requirements for no-till farmers operating wider systems and it had lost a lot of its ability to do heavier tasks. The design had moved too far toward a dedicated sprayer rather than something in the middle. It also posed some challenges, such as to how to give this tractor the ability to go to a one-pass seeding system.

Multidrive tractor in Birdlip, Gloucester, United Kingdom (Pashley, 2011)

Claas Xerion Saddle-Trac

The Claas Xerion Saddle Trac is manufactured the Claas Harswinkel plant in Germany. This would have to be the most interesting tractor concepts ever developed. This design was instigated by Helmut Claas on 19th September 1978, with the first prototype produced in 1979.

After many trials and tribulations it took till the autumn of 2004 for the first series production to be released (Horst-Dieter Gorg, 2006). It is an amazing design concept that has retained all the functionality of the modern tractor, but has been given the ability to carry large loads either trailing or on the area left free by placing the cab front-mounted over the engine bay. This gives this tractor the ability to be fitted with tanks up to 15cubic metres. It has three point linkage front and rear giving the ability to attach a vast array of implements and has the potential to do a series of tasks at once. This platform offers the greatest design potential in my view to take our current seeding system through to true one-pass system.

Class Xerion Saddle-Trac set up for slurry application and seeding of rape at Dorpen, Germany (Konken, 2011)

With the ability to carry such large weights and still pull an existing seeder, with a small spray boom front-mounted on the linkage should allow the goal of developing a true one-pass system to be achieved. The cost savings from being able to achieve such a task could be quite substantial. In our own case that would amount to 20% of our spray time being incorporated into an existing pass.

After spending time at Claas headquarters in Harsewinkel Germany, spent talking to Jan Wollenschlager, Product Manager for Tractors (Wollenschlager, 2011), I discovered that the biggest difficulty would be getting the wheel spacing to three metre centres and the impact this was likely to have on the tractor's ability to carry large loads. The inability to get the wide wheel spacing is detrimental to the whole system as it would be almost certainly a step backwards from our current position. The Claas Xerion Saddle-Trac certainly gives a wonderful insight into what impacts design could have on cost efficiency, but also highlights the impact being such small market has on our ability to source machinery that fits the farming system we now operate. It has proved to be the most comprehensive package, which came the closest to achieving the objectives set.

Fuel Efficiency

Fuel efficiency within agriculture in many of countries visited did not rate as highly on growers concerns as had been expected. The expectation was that with many other sectors within these economies already moving to highly efficient energy usage, the agricultural sector would have followed closely. This was not the case, as most growers visited were more focused on yield than costs, so as result fuel efficiency rated very low as a priority. This might be in part to the cost of fuel for growers being much more stable than experienced in Australia. Fuel prices in Australia follow the market with excise and GST claimed back as tax credit post-purchase rather than pre-purchase. The pre-purchase model used by many countries has the tax removed at the point of sale and in many cases the price is also set by the relevant government body in that country. This has two effects;

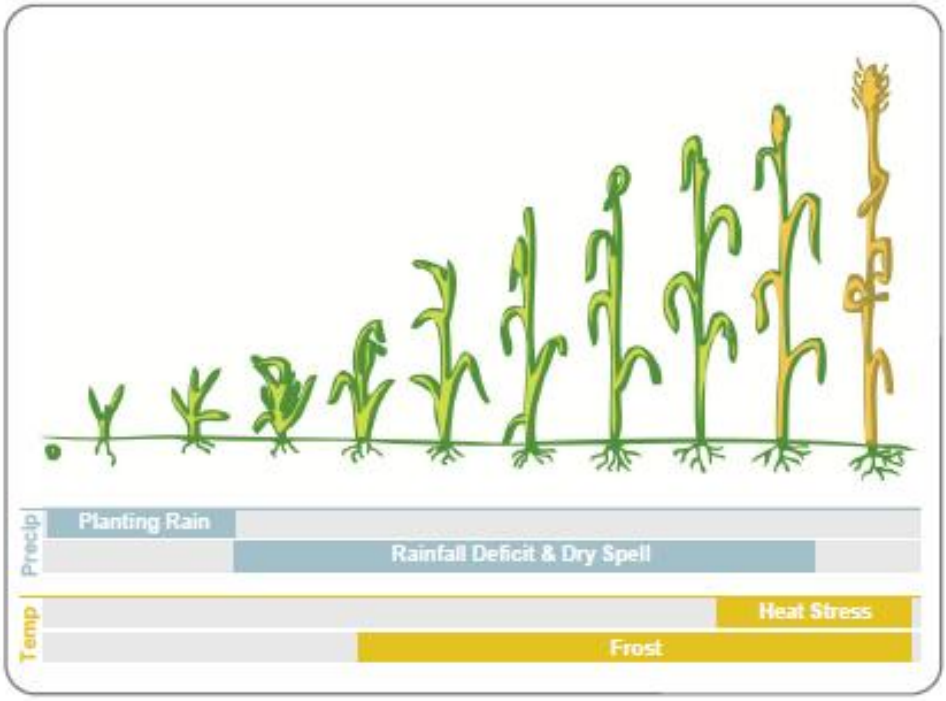
- firstly of reducing the initial capital outlay of the purchase by the farmer, and
- secondly, the market exposure to the ever fluctuating price of fuel.

This buffer really doesn't give growers the incentive to change as the exposure to reduced margins is decreased.

Weather Derivatives

It was during my travels through the Netherlands with Henk Smith (Smith, 2011) that he mentioned the use of weather derivatives (CelsiusPro, 2011) as a risk management tool. Until this time my focus had been on reducing cost as a means of risk management, not on being able to hedge against that risk by insuring against the weather. After more research on the topic it soon became apparent that this was a tool used not just by the agricultural sector but many other industries exposed to variability of the weather. It is a product that is not just limited to Europe but covers most parts of the world. It gives producers the ability to insure against a wide range of perils (snow, frost, wind, rain and temperature).The payout of weather derivatives is based on a weather index which is derived from measurements at an official weather station. The buyer of a weather derivative can gain an amount as high as the contractual maximum payout, with the loss limited to the full premium amount. One of the weather certificates that is most applicable to most of Australia's grain growing regions is called a Dry Season Certificate. As the direct correlation between rainfall and yield is so great in Australia it has got the real potential to reduce the risk associated with grain growing in many parts of Australia. This Certificate works with the client able to receive the payout amount for every millimetre of rain that the cumulative rainfall is below the strike. The strike is a predetermined cut=in point in mm, up to the maximum payout during the purchased cover period.

Another certificate now being offered is the Full Season Weather Certificate (FSWC). This Certificate is a multi-peril certificate and offers risk protection over the entire growing season of a range of crop types. The FSWC is based on plant biology and local climatology. It uses the weather needs of the crop in that region as a starting point and still uses an official weather station to take all measurements with payouts derived from these measurements.



The above picture represents an Australian wheat crop and shows the potential weather risks that a FSWC would cover. (CelsiusPro, 2011)

Both products have a minimum 20 days before they commence and payouts are not made on a claims basis, but instead paid automatically at the expiry of the certificate calculated on the weather data provided by the official weather station. The risk aversion provided by both products offer Australian grain growers an opportunity to build more sustainable farm business with much of the financial pain severe weather events cause being hedged.

Land values

Land values have had a major effect on efficiency in many parts of the world with growers unable to expand their operating scale as better technology becomes available. With land in many parts of the world being just classed as real estate and price of that land totally separated from the production that can be achieved, it is difficult for farmers to increase their operating scale and spread their costs over more area. The inability to do this and continually place downward pressure on their costs per hectare places growers in the very vulnerable position of being unable to mitigate some of the cost inflation they experience.

The other effect of land holdings on efficiency is the restrictions placed on it by government legislation. Environmental legislation is impacting farmers in many countries by not allowing them to alter field characteristics. This was very evident in the UK with farmers unable to alter or remove hedgerows and pursue field designs that allow better efficiencies to be achieved.

Whilst we need to protect some of these environmental and cultural aspects of our land there also has to be mechanisms that allow growers to pursue efficient farming systems. This is not limited to the UK with similar scenarios in most countries. This is a major source of discontent within the farming community within Australia as in many cases most of the cost associated with this environmental stewardship is born by the farmer with very little recognition by government or the wider community.

Recommendations

It is the adoption of new technology and change of practices that has led to the biggest efficiency gains within our industry. This does not mean we should just neglect plant breeding to focus on technology alone. Plant breeding will always play an important role as a means in improving productivity and when combined with new technologies they have the potential to speed up the genetic gains achieved and offer some very valuable advances for the future. But nevertheless it is farm machinery that offers some of the biggest gains here and now. The difficultly is changing the focus of machinery manufacturers away from the number of different pieces of machinery that can be sold to one that is producing machinery for modern farm practices. This won't be easy, but without it is difficult for farmers operating no-till systems are able to make any significant gains on efficiency. It is not about reinventing the wheel as most of the technology is there and currently in use. It is more combining it into a package that allows farmers to get much more out of the valuable capital they have purchased. There needs to be more research into on-farm efficiency with the findings evaluated and published so as to give other growers a true picture of what can be achieved and what is possible into the future.

As more of the world's valuable resources come under supply pressure it seems likely that there will be more of a shift away from multiple passes with multiple machines and there will be more of a need to combine tasks as much as possible or use more efficient systems as part of any farming practice. The limitation to this is the role governments want to play with polices that directly affect the pricing structure of energy and the energy intensive products that the agricultural sector needs on a day-to-day basis. As with all government intervention it will come at a cost and if the support is too generous and does not contain some element of market exposure then it is likely to send the wrong signals and stifle efficiency.

Risk management for Australian growers need not only be about reducing cost as there are tools out there to place growers in a position to hedge their production risk and allow some sort of a safety net in poorer seasons.

Australian growers, whilst being some of the most efficient in the world, need to continue to search for efficiency gains that provide them with the most cost effective means of progressing the current no-till system further than has been done before.

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Plain English Compendium Summary

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Objectives	To search for cost efficiencies for no-till cropping systems that improves the profitability of Australian farmers.
Background	The adoption of no-tillage and controlled traffic has provided much needed efficiency gains to many farm businesses by allowing the reduction of variable expenses and the better use of capital invested in machinery. These gains and the productivity gains from varietal breeding have slowed providing major challenges for farm businesses as profits are eroded by ever increasing costs. Technology is likely to be key to the reversal of this trend and has historically provided our largest efficiency gains.
Research	This work is based on my travels to Brazil, Mexico, the USA, Canada, the UK, the Netherlands and Germany. It is also based upon my own experiences of owning and operating a farm business practising no-till on controlled traffic in central NSW.
Outcomes	Efficiency gains from plant breeding are only running at about 1% per year, but much larger gains could become a reality if some of the traits being highlighted using gene marker technology come to fruition. Australian no-till farmers lead the world with their systems being vastly more cost efficient than in many parts of the world. Much of this efficiency stems from their exposure to risk. Risk seems to be one of the key drivers toward efficiency and without it the drive to change is greatly diminished. Insurance based supports didn't impact as greatly on the need to be more efficient when compared with government policies that are more direct and regular in their distribution. Such subsidies result in farmers having less incentive to change. Machinery manufactures are still focussed on the broader market and no-till farmers using controlled traffic will find it difficult to source machinery that provides the large efficiency gains needed. This scenario is unlikely to change until we reach a critical mass that forces these companies to cater for segments of the market that are striving to be as efficient as possible.
Implications	Cost efficiencies that provide major gains are becoming more difficult to find and without them farmers will see their profits continue to be eroded by inflation.
Publications	Nil