New Zealand Nuffield Farming Scholarship Trust Award

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Sustainable Farming Systems

Minimum Tillage / Direct drilling practices and management systems

Irrigation water use efficiency

Irrigation water allocation systems

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DECLARATION

The comments and opinions in this paper are based on my personal findings. No responsibility for the comments can be attributed to the Nuffield Farming Scholarship Trust or any affiliated party.

ACKNOWLEDGMENTS

I would like to thank from the outset the trust for the opportunity to take the trip and the learning experience. The name of Nuffield is held in high regard and opened many doors in all the countries I travelled to. To the nine other scholars in the group, and Doug, Sean and Andrew for a great time together and again the information shared.

The contacts and hosts that gave freely of their time and information to make the trip as rewarding as it was. My host family, Anthony and Rosemary Hopkins, were a huge information source and home base away from home. To all the company representatives and private people that added to my trip, a sincere thank you and I look forward to ongoing contact.

Finally to my family, friends and staff who worked incredibly hard and helped keep the whole operation ticking along during my absence.

INTRODUCTION

Having completed a degree in agriculture I am aware of the importance of soil health and had started modifying the way we approached crop establishment, mainly with direct drilling autumn forage crops, and then moving into the cash crops. We had also invested in irrigation.

I had become involved in setting up a sustainable cropping group, with which the regional council were also involved. The group was concerned over wind erosion, water use and trying to sow into peat and timber to establish crops without ploughing. LandWISE was formed and successful in gaining a Sustainable Farming Fund grant.

The three study topics were all major concerns of the group with a focus on vegetable crops and maintaining profitability if the production system was changed. We had already experienced difficulty with establishing super sweet sweet-corn under reduced tillage systems yet knew the benefits gained by the soil from reduced tillage farming practices was well documented and proved by many. With world leading technology available in NZ for use in this area my main aim was to look at management issues and systems.

The water issues were also of concern, with the public perception about irrigators wasting water on windy days. What constitutes an efficient system? How do we allocate water to irrigation in limited reserve areas? All of these are critical issues when water is seen as a limited resource.

World Situation

The increasing demand for food is going to put ever-increasing demands on our food production systems. More people, urban spread and production land lost to climate change and other events means we are expecting more produce from a diminishing resource, the soil! Great advances have been made in genetic improvement and crop husbandry issues, but have we gained the full potential of these advances or have we had negative influences at work as well?

Countries with longer histories in crop production than NZ have learnt lessons, many of which have been well documented (dust bowls). What has been learnt and more importantly how can it be adapted to work in our situation while maintaining profitability for the producer.

Water use will also increase and the debate between water users and environmental concerns will grow in intensity while trying to decide who gets what. This limited resource needs to be used in the most efficient way possible and allocated to all users in a fair and equitable way.

AIMS and OBJECTIVES

The primary aim would be to provide some answers to the questions raised. Providing solutions or options for the questions poised. The experience of countries with more extreme problems and climates would be a great learning ground.

Secondly I was determined from the outset that this report would be a useful and readable document that would provide new ideas for future use and new ways of doing things for many sectors of New Zealand farming.

The successful transfer of the ideas into practice would also mean that the scholarship had been successful and that New Zealand agriculture had gained.

TRIP ROUTE

The group, two New Zealanders, five Australians and Sean Beer from the UK, met in Singapore and spent two weeks in Asia, learning a general overview of their market systems and culture. This time proved to be very interesting, a chance to make friends within the group and visit places I would never had expected to see. This time in Asia also showed the heavy demands on the land and water resources and reinforced the need to use the best methods possible.

The next leg was a week spent in London looking at the political and lobby groups that operate in the English system. A fair amount of time was spent learning about the Common Agricultural Policy (C.A.P.) and European parliament. We then moved to Brussels and saw European parliament first hand and had discussions on the implications of this system to our respective countries, how it worked and future changes. The next leg was a brief look at the French farming area near Lyon. The focus was on small innovative companies netch marketing. Examples were a wicker manufacturer, the oldest in France, a winery, organic sunflower oil production, village market pork supplier and also some standard farmers. This was very informative, providing for plenty of stimulating discussions with Frederic our guide and host managing to get some culture into the group!

Leaving the continent we moved to the Lincoln and Yorkshire area. This was a change to look at UK agriculture in an overview situation with the local Nuffield's hosted us. They did a wonderful job considering the Foot and Mouth outbreak was very serious and limited the programme. The close of this time was the end of the group tour, and the study topics became the main focus.

The next six weeks I spent in the UK. The foot and mouth out break meant that many areas in the UK were no go zones especially if you wished to move around. Consequently the study area was confined to the East Anglia, Norwich, York, Lincoln and a brief visit to Southern England. I visited the main equipment manufactures and

farmers using various systems. There were also many private research companies doing trial work and evaluations. I departed England in May and headed to the United States and Canada. I elected to drive this leg of my trip and after landing in Chicago I drove though the Midwest, down to Nebraska, up thought the Dakotas and up into Canada. From Souris I headed across to Calgary and then down into Washington. From here the focus was on Irrigation and I moved down to California, attended Cal Poly to complete an irrigation audit course and then down to Arizona. From here I drove via Denver and Kansas back to Chicago and started for New Zealand. Concluding the study time in Early July.

Group In Asia: Adrian Gault, Sean Beer, Mr Pradoldej (host), Andrew Fowler, Marc Jackson, Neil Smith, John Foss, Mrs Pradoldej, (host) Ben Bootle, Hugh Ritchie, Sandy Forbes.
Absent; Steve Hicks Canada, Jeff Kockett Zimbabwe, Patrice Pobel France

THE STUDY

Due to the fact that I visited several sites and countries to research three different topics I will present the findings under country headings, drawing conclusions while remembering there is no one right answer.

United Kingdom

There are three main establishment practices:

1. Traditional plough - Ploughing is considered to be the mainstream and has problems with weed control, slugs and cost. I make mention of that just to be aware that there is no perfect system.
2. Minimum-tillage - Minimum-tillage or reduced-tillage is the next biggest segment. This system is based around discs and presses and then drill. The best variant being the Solo system manufactured by Simba.
3. Direct drill - Direct drilling is by far the smallest group.

Minimum-tillage

Minimum-tillage was a considered new technology in the 1970's and 30% of the winter wheat was planted using this method of establishment. It lost ground to more traditional methods due to herbicide resistance and other weed management issues. The last 3 years with the high value of the pound making market competition for UK farmers hard there has been a resurgence of new ideas to look at cost reduction and profit maximization. Unfortunately the foot and mouth (F&M) outbreak meant that my area of study was a little limited but I still feel that I was able to visit most cropping areas.

Strengths:	Reduced use of the plough, lower time required for planting season
	Large output machine, reduced labour requirements
	Simple operation, less operator skill required
	Easy to run 24/7 for high output
	Better weed control as longer stale seed bed time

Weakness: Very high capital cost, large-scale farm or contractor
Very high horse power requirement
Short work period and then idle capital for main equipment
Can lead to herbicide resistance

Opportunities: Still large areas using traditional method
Due to farm mergers right type of equipment for fewer staff

Threats: Herbicide resistance, Black –grass
Deep compaction due to heavy gear in a damp season
Soil degradation due to cultivation

Direct-Drilling

Strength: Large time saver, machine and Labour
Reduction in cost compared with eco-tillage
Increase in soil carbon levels bioactivity

Weaknesses: Weed control, no cultivation to germinate weed seed
Slug's perception to be worse but not proven
System perception looks rough /untidy

Opportunities: Create better soil and lift yield
Large area
Working in unploughable areas.

Threats: The memory of the systems failure in the 70's
Still learning and seen as a big jump of faith
UK economic pressure is such that seen as a higher risk

These two systems both work and their supporters were good operators producing good crops. The key to their success was their systems approach and integrated management to eliminate problems. The direct drill operators were using spring

sowing more to give better weed control which might be needed in the future for some of the other systems.

The over all impression was that farmers had tried reduced-tillage technology in the 70's. Weed control problems meant that by 1996 only 6% of winter wheat was minimum-till drilled down from 30%, enough to stop them trying again. The feeling was also that the economic conditions meant that the farming system employed had to maximize yield and so any threat to this was not an option. As a consequence I only meet two operators that were employing direct-drill techniques. There was however a large move to non-inversion reduced cultivation practices.

This system seemed to be working well with good crop establishment. However even in the Simba promotional material ploughing was still required in some situations. The system was dependant on low residue levels with cereal stubble cut short and straw fine chopped and well spread. The problem weed in the UK is Black grass, so time after harvest to allow new growth is important or waiting after first working to allow germination and subsequent spraying. To date this did not seem to be improving the situation and so the plough was an option to bury the worst weed areas. Slugs were another major problem and with the very wet autumn and Spring 2000 –2001 all establishment systems faced a problem. A cost/ time comparison of the non-inversion system compared with the old follows.

Andrew Ward, Roy Ward (Farms) Ltd

Cost Analysis / Cultivation Systems

CURRENT	OLD
HEAVY LAND (1st WHEAT)	
Disc & Press x 1	Plough & Furrow press
Sub soil	Disc & Press x 1
Cultipress & Roll x 1	Spray
Spray (Sting Eco or papaquat)	Powerharrow
Freeflow drill	Drill (MF 30)
Roll (only after rape)	Roll
Mins./£ to establish 1ha:105 / £71	Mins./ £ to establish 1 ha: 186 / £103
HEAVY LAND (FOR RAPE)	

Disc & Press x 2
Spray (Sting Eco)
Freeflow drill
(Cultipress & Roll)
Mins./£ to establish 1 ha:56 / £71

Disc & Press x 2
Subsoiled
Disc & Press x 1
Spray
Powerharrow
Drill (MF 30)
Roll
Mins./ £ to establish 1 ha:181 / £109

Summary

"With a certain amount of thought, experimenting and admittedly expenditure over the last four years, we have managed to significantly reduce the cost per hectare and the time needed to establish not only cereals, but all our crops. If we has still been using the old system on this cropping we would of needed another 31 days and spent an extra £5840 just to establish our cereals" (Ward, A, undated).

This raised a question about rotation of either crop or sowing time. Crop rotation was an option but generally there was either financial or access restrictions to planting large areas of different crop. The problem around second cereals was still there. Rotations of sowing time were an option and moving to spring sowing alternatively gave a good chance to control black grass and slugs.

Case Study

Michael Boydell, Hayton Farm, Leeds

Michael was one of the two people I visited using a direct drill. He was using a triple disc technology and had been for 10 years. Soil type was very hard clay and in the early time penetration was a problem. Ten years down the track the problem reversed and this is due to the vastly improved and softer soil. Yield has not been affected with an average of 12 ton/ha of autumn sown wheat. However the wet Autumn (2000) and continuing wet weather resulted in huge slug problems, after three treatments and re-sows he let the crop fail and started again in the spring. This gave a good opportunity to control the black grass and also the slugs. The crops established well and he believed that a 7-ton/ha yield was needed under the spring-sown system to make it stack up against an autumn sow. This rotation between seasons and some other break crops was now part of the farm system. He was growing 200ha of crop and only doing 50 hours on the tractor a year!

The soils and bio activity within was also startling. The residue on the surface after a 12-ton/ha crop was almost gone by the end of April. Worm tents were pulling the entire residue down with root development and the length of roots being very good. Once again dispelling a popular belief that direct drill crops suffered in this area.

Other Research

The research arms in the UK arable scene were doing plenty of work on side-by-side trials of different sowing systems with both Morley and the Arable Research Centre responding to the interest. However many of the benefits from direct drilling are cumulative and need time to reach full potential. Equally management systems are different and so by same day sowing some of the advantages of the various systems are lost. Another limit to the introduction of minimum-tillage is the visual look, clean brown soil with straight new green rows of crop is the norm and anything else is "untidy"

Other Equipment

The Vaderstad Rapid and the Horash drills also have a following in some areas but usually in conjunction with some cultivation. There are also some Canadian influenced drill types but they seemed to struggle with the residue levels.

USA

The first visit I made was to the Conservation Technology Information Centre (CTIC). CTIC had just completed an audit of tillage practices for the US. From the 290 million acres planted conservation tillage accounted for 36.7 %. Conventional tillage accounted for 42.7 % and the rest was a combination of other tillage types. Conservation tillage is defined as leaving 30% cover on the ground post planting, conventional 0 -15% other 15-30%. Looking at the conservation tillage area true no-tillage one pass had stayed constant from the 1990 figure 6%. The big move was in

other types of tillage the main one being Strip-tillage. With this in mind I spent a great deal of time looking at strip-tillage. As previously mentioned the benefits of reduced tillage are common between UK/USA and NZ so I will not dwell on them.

Strip-tillage

This system is a two pass operation the first being to use a shank and closing disc system to create a zone of tillage 100mm wide and 125mm deep. This operation usually includes the placement of fertilizer as well and is completed in the autumn in the USA. The following spring conventional planters travel down the same rows sowing into the loosened tilled zone. This system works mainly with wide row crops like Maize and corn. The exponents of the system cite four main advantages over one-pass systems while maintaining the benefit of those same systems. Those reasons are:

1. Uniform soil temperature along rows up to 10 degrees farenheight above surrounding soil.
2. Loosening and slight raising of the row allows for moisture movement and quicker germination in wet situations
3. Fertilizer can be put in during the first pass leaving the planter able to operate longer with less risk of fertilizer burn or ammonia gassing
4. Soil disturbance prior to planting allows weed control before plant emergence.

Strip-tilled maize

As you can see the residue for erosion control and organic matter build up is still present but the plants establish vigorously.

This system was certainly very encouraging as it answered a lot of the questions that I was struggling with in New Zealand. Certainly the yield results in the US showed an advantage to strip-tillage compared to no-tillage and conventional results here in New Zealand but we still have to exactly copy their system.

The main disadvantage is that it relies heavily on the operators' ability to follow exactly the rows of the pass before. For this reason Global Positioning System use might become a future add on.

Dakota Lakes Research Centre

The Dakota Lakes Research Centre in Pierre run by Dwayne Beck has been at the forefront of zero-tillage and problems associated with it. The use of a Corn /Soya rotation in the Corn Belt has lead to a build up of diseases that have caused problems for long term zero-tillage crop production.

Stacked Rotations

Beck's research was based around the idea that weeds and pests had preferential hosts and so by only having to survive one year without a preferred host was an easy challenge. The move to stack rotations, (running two or more crops of the same family in a row), begun. This results in pests having to survive for up to 4 years without a preferred host and has resulted in reduction in pest pressure.

Another weapon to fight weed build up is to rotate chemicals used and in their case they can use a chemical family only once every six years, making chemical resistance very hard.

Dwayne Beck was also very positive about high residue farming and was removing no residues at all. By using his concept seeder (drill) he was planting all crops with a form of zero-tillage and had lifted the area average yields on his research farm and

surrounding properties by around 30%. This management technique also lead to other advantages, mainly in water infiltration rates, which meant that when rain did come it was able to enter the soil profile and not run off to waste. This concept was to become apparent in other areas as well.

The final point to note about Dakota Lakes was the concept of University, government and private farmer contributing to the funding of a commercial research farm and that the ideas discovered were put into practice and used by the surrounding district. This type of extension system worked very well.

Canada

The Canadian system was very similar to the Australian, and hence a lot of equipment was common to both countries. This tended to be wide large tool bars of 20 metre plus with single operators expected to sow 1000-1400 acres per day. However in these systems there were changes happening. Most of the crops were planted using some form of knife-point or tine drill with one-pass operations. These openers, however, had higher soil disturbance than disk openers. This system was slowly building organic matter and lifting crop yields. However it also increased the residue levels, which needed to go though the drills. As the soils' organic level changed so did the knife type and also the row spacing to allow the residue to pass though. Research was being done on how far the row width could be moved before the canopy closure became to slow allowing weeds to become more of a problem.

Conservapak owner and farmer Jim Haliford was conducting trials to see how wide row spacing could be before yield was affected. The government research station in conjunction was looking at the resultant effects on weed populations. Again this showed how when changing production techniques the system had to evolve as the soil changed. This is a very important point to note.

Jim Halford inspecting row width trials.

This was leading to a move to disc type openers that would handle the higher levels of residue and as the soil condition was better due to increased organic matter these opener types were working well.

Morris Opener used in heavy residue areas

Research being done at Indian Head Research farm continues to focus on the relationship between tillage practice, soil temperature and weed control. This is an area specific relationship, but what can be learnt is that there is no one answer. With

zero-tillage the soil takes longer to warm so slower emergence of crop weeds have more time to compete. However the slight soil disturbance in the seed row warms faster than surrounding soil so weeds inter row would be slower due to the cooler soil. The management that needs to be adopted is therefore a very flexible to handle seasonal change.

Minimum-Tillage and the effect on Water Infiltration

At this stage I was in Palouse country, which is a cereal growing area in Eastern Washington State. Typically it is steep hillsides, up to forty-five degree slope, with an annual rainfall of 15-20 inches. The typical system was to conventionally cultivate the ground post harvest weed for the next year and then sow a wheat crop one year after harvest to be harvested the following year, i.e. one crop every two years. This time frame was to allow enough water to build up in the soil to grow a crop. The biggest failure of this system was the loss of water due to run-off and the loss of soil due to erosion. The move to direct seeding occurred over a 12-year period as the system was learnt. The result was a better soil structure and increased organic matter, but the major benefit of this move was the water infiltration rate into the soil which increased so much they are now able to grow a crop every year effectively doubling their output. This result dovetailed with the Dakota Lakes work as well. Once again weed control is an issue and at the beginning they went winter wheat to winter wheat causing a grass weed problem. Again as in England a move was made to rotational sowing time e.g. spring and winter. There were still problems to face up to and more challenges ahead but they were convinced that it was the right move.

This was an extremely interesting visit as the country was where we would finish lambs or run sheep not plant wheat! However all the principals were relevant to New Zealand. These are two quotes from John Aeschliman the owner, “ We don’t claim to be experts. We must remain humble, remembering that we are merely stewards of the land. The credit for any success belongs to the creator. Also about the time you think that you have it all figured out, you find out that you don’t. We never stop learning.” And “ Don’t quit until you succeed”

Insert yielder drill and combine shot page 3 and 7 of Aeschilman farm case study

Minimum-tillage conclusions

- Reducing cultivation of soils has a positive impact on the soil. The organic matter that builds in the soil lifts the bioactivity in the soil and also increases the water holding capacity of the soil.

- Reducing cultivation will use less fuel and labour resources consequently reducing the cost of the system and the demand on resources. This move also reduces carbon loss due to cultivation and with ratification of the Kyoto protocol in the future, technology like this will become important to reach targets.

- Increases in bioactivity will lift water infiltration rates causing fewer run-offs. This will lift water use efficiency and lower irrigation demands. There will also be a reduction in erosion and waterway contamination, both of which impact heavily on the Resource Management Act.

- There are technologies that could be successfully used in New Zealand. Strip-tillage is one such idea, which would be especially useful in increasing soil health in degraded soils without impacting on profitability. This system will be used in Hawkes Bay 2002 in Squash, Maize and Sweetcorn.

- Management systems will have to change to suit the new technologies, as it is not just a case of changing the planting system and leaving everything else the same.

- As time progresses there will be new challenges to meet. Weed and pest control, residue management that will potentially impact the systems used. Stack rotations are one such tool to be considered.

- An attitude change is important, it will be different from the neighbours and there will be a learning curve, but the long benefits are worth working toward.

Photo page 17 extention bulletins include caption under photo

Water Use Study

The focus of this part of the study was to use water efficiently and allocate the resource fairly. New Zealand has an ever-expanding demand for water and it is becoming more and more apparent that it is a limited resource. The hydro levels, and the Auckland water supply being the most news worthy of the cases to date.

England

I did not expect to find much to do with irrigation in England, but what water was being used in Agriculture was under extreme pressure from environmental groups. There were however some very good ideas happening in coordinating the water use.

The first was a countrywide assessment of water use efficiency and resource management, analysing current use and forecasting twenty-five years into the future under different strategies.

This map shows the current ground water use, areas in red show where over extraction is occurring, and the chart beside shows the 4 different plans for the next 25 years. The solid colour at the top of the columns is that water used in irrigation.

This type of planning focuses on the supply and demand of water and if used here would have many benefits. Regional plans do some of this on a catchment basis. In some areas in Hawkes Bay only 2% ground water is allocated. A proactive approach to putting community water schemes into the public arena, giving an alternative to a private scheme could see water use efficiency gains and make the limited supply go further. Once a water user spends money on a private scheme there is less incentive to join a community scheme and so cost per user or critical mass of a scheme comes into question. Forward planning like this would stop the problem faced by the users in the red areas on the above map; as they need to reduce the draw but how does this occur? This is where the system started to loose support as it was being done far to late. First and foremost the environmental lobby groups had huge power and support and could object the consents. Leaving the proving of their concern on the door of the extractor who would then have to prove he was not having the stated effect, all at his own cost. There were thirty recommendations to save water in the UK; eight of these were directed at farmers with more at down stream businesses. When farmers use

only 20% of the public pipe leakage in irrigation it would seem an unreasonable level of targeting.

The next interesting visit was to Norwich University where they had been working with irrigation in developing countries, water had been allocated on a proportional basis rather than actual quantities. This idea has some merit as all users will have water and it enables prioritising water on farm rather than the current all and then nothing system when trigger points are hit. This is obviously applicable to surface extraction but was a different way of looking at the problem. Tradable rights was just coming into play, but as in NZ if you allow trading of a natural resource then you have to apply that resource to all potential users then let the trading happen. To allow trading with only those who hold current extraction licences gives them a huge advantage.

The Users

Water is expensive in the UK with all extraction being paid for, including the run off from your own paddocks in winter. This saw extractors using their water very carefully, simple things like permanent pipe structures and good monitoring, had resulted in one potato grower using the same water and growing twice the area. There was also a move to drip tape irrigation, this again was producing 30% lift in yield for the same quantity of water used. This drip system was complex in that it has manifolds and sectional control to allow flushing and checking. These drip systems also allow for fertilizer placement and even pesticide application.

Diagram and Cost of Drip System (appendix 1)

Drip filter station

The roll of the market place is also important in the overall water use picture. The skin finish on potatoes required by the supermarket was estimated to increase water use

per crop by up to 50%, with no additional yield but a smooth skin. By awareness and a change of contract there could be a large saving of resource.

Awareness by the whole community of the issues is critical and also actions taken by consumers, e.g. surveys on potato quality expectations, have a consequence. Consumer surveys where the questions asked have no resource or cost consequence associated with the answers are leading to this type of problem in all the food categories. It has the potential to affect New Zealand as well, if uninformed public are allowed to form production standards for local or export markets.

USA & Canada

Washington State is the home of Nelson Irrigation a major supplier of all irrigation hardware with a focus on nozzles and control. It was an interesting company as it supplied to all major manufacturers of irrigators showing an unbiased view in the market place.

Their main thrust of research was into uniform application and was focused in many fronts. There were the nozzle research sprays, rotators and wobblers. Coupled to this was an incredible quality assurance programme to ensure that all components operated to their prescribed range. There was a lot of work being put into a system design programme to ensure that the right system was used in the correct application. Thirdly they were working on drip irrigation systems. This is not a Nelson benefit but these three areas are the main new ideas or focus in the USA with regard to irrigation.

The use of drip irrigation, be it temporary or permanent instillation, deep or shallow burial, was hugely increasing. Some farms growing onions were using pivots for germination and then buried drip for main crop irrigation. This was due to control of water, ability to add pesticide, fertilizer and also soil conditioners. There was also the ability to automate all functions and save water at the same time.

This system and Nelsons approach showed that the key to good irrigation was uniform application.

Onions grown with drip irrigation

Automated permanent filter station

Following this idea I moved to California Polytechnic and attended the Irrigation Training and Research Centre (ITRC) course.

The Irrigation evaluation course was directed at large water users to create awareness to the fundamentals of efficient water use. The key message was that if water application was not uniform, i.e. more water was being applied to one area then compared to other areas, water would be wasted. This was due to the depth of wetting idea; if water is applied to below the root zone then it is ineffective. A damaged nozzle or some such fault could cause this or poor system performance. Having a simple but reliable way to check and evaluate this was the main aim of the course.

I wont go into the details of how the systems check works but it takes about a day to complete, with half the time in the field and the other half writing up of the report. The cost is covered to a large degree by the water authority bodies but there was a trend to direct charging as a shift in uniform efficiency could cause a serious reduction in water use and as water was charged it paid to be efficient. The outcome of this for New Zealand is a new MAF sustainable farming fund to adapt this system for use in New Zealand and then train the industry. In August 2002 Dan Bloomer attended this course and started the initiative off. A Page Bloomer report on this system is included in the appendix's 2

Water Allocation

California was a great area to study this and the main the lesson was how not to do it! The allocation from the water authorities was run at a district level and appeared to work very well with the main function to distribute the water as fairly as was allowed. The main problem was legislation. The various rights and unfinished schemes, and competition for water resulted in some horror stories.

The first unfinished schemes were the big irrigation projects in California. The main unfinished part was a water return canal back to the ocean to allow salty water to be

returned to the sea. It is no longer possible to build these canals so any salty water has to be dealt with on farm creating mess and waste saline areas.

The use of grandfather rights means that some users have 100% of their water before anyone else has any and can lead to very large wastage by these users. Next to desert areas you have flood irrigated rice fields while the neighbours get nothing or grow crops on drip irrigation. This certainly led to less than good feelings toward administration of the water resource. The last example is that of deals reached being broken. Water flows in rivers were to be increased in line with environmental concerns with the extra water being gained by lowering dam levels. All sides agreed to the compromise and it was passed into Law. However, it was successfully stopped by the environmental lobby due to the water in the dams being colder at lower depths. Consequently the river flows were now increased yet there was no increase in the release of the total water available and irrigation was halved over night.

The key message here is that the rules have to be applied evenly and there has to be a trust that having invested heavily for the use of water that the resource is going to be managed in a credible way. Arizona has a system where the water is allocated on a per acre basis and if you don't use all the allocated water you gained water credits. In some situations in water short areas some farms that had no more water credits where being sold and brought by more efficient users of water who had gained credits on other farms. This system seemed very fair in a water short area and certainly had a focus on efficient use of the resource. The key point with this system is that all areas had water allocated and then how well it was used was up to the individual.

In Arizona the scarcity of water meant that the most water efficient systems were employed enabling the accumulation of water credits. Sun Dance farms were one of the innovators in creating drip irrigation systems with a focus on permanently buried drip tape, the oldest beds being 20 years. The crops grown were mainly melons in rotation with cotton as a break crop. They developed the permanent bed farming system and manufactured equipment to suit this system's requirements. The drip technology has continually been upgraded, so to have long-term beds with old technology shows the success of the filtration and management systems controlling

the drip tape. The use of fungicides, soil fumigants, fertilizer, soil conditioners, and water make's the system very similar to hydroponics except it is outside and uses soil as a medium.

Water Study Conclusions

- The uniform distribution of water is the most important factor in efficient irrigation
- Considerable water saving can be gained by checking uniformity of irrigation systems
- As water costs rise so does the willingness of users to pay for advise on conserving water
- Drip irrigation systems provide a very uniform application and generally produce more product per unit of water used
- Water rights need to be uniform in allowances and enforcement
- All schemes must be finished so expectation will meet reality.
- The strength of water preservation groups is growing and can potentially cause significant restrictions
- Water rights on an volume per area basis allowing for credits to use at discretion has merit for subsurface takes
- Water allocation on a proportional basis for surface extraction rights has potential merit

POST TRIP ENDEAVOURS

At the outset of this award I felt that the true value to Farming in New Zealand would be what results or ideas could be adapted to the industry here. The creation of LandWise prior to my departure was always going to be a potential vehicle for the new ideas; this has proved to be the case. Last season landWise ran five trial sites and used strip-tillage technology on three of them. This coming season that has number been predicted to increase to 8 and be spread up the east coast.

Upon return from the USA I imported equipment and built a strip-tillage planter, which was the machine used in the LandWise trails and also for a fair amount of contracting.

Results were mixed and on investigation with some outside assistance it was believed that there was potentially a problem with ammonia gas around the seed due to planting seed and applying the fertilizer at the same time. In the USA these two processes are separate and so 2003 season will aim to change this.

'Drumpeel Special'.
Offset fertilizer knife, followed by "mole knife tm" with closing disc, residue manager and then conventional John Deere planter unit.

End result – seed planted straight into mulched maize stubble

Generally the outcomes were encouraging especially as the season was a difficult one LandWise has run seminars and a conference on strip-tillage with attendees from all over the North Island. These have resulted in inquires for work and information right across the country. The Commercial Grower magazine has also featured this work and MAF's monitoring reports.

With this support, a contractor and myself have imported a designer built row unit and not a Drumpeel Special! This will separate the two processes into 1. Strip creation and fertilizer placement ,2 Planting. This will hopefully remove some of the variation and there is already work booked.

Strip creation for squash in Gisbourne with the purpose built unit

Resultant squash crop

The second major happening was in the irrigation field. Having attended the Cal-Poly course the LandWise group thought it was worth trying it here. To ensure this work was focused we looked at setting up a separate group and applied for funding from MAF SFF. This was successful and we have just started on the full programme. The aim is to adapt the system to New Zealand in terms of the equipment used and figures that we understand. There will be a training program developed to enable the assessing of irrigators.

Drumpeel Lateral being tested for uniform distribution

To give an example of the benefits of this we used our new linear move lateral irrigator to see if there was a benefit. As expected the uniformity was high catching from the pipes in the order of 96% then when catching on the ground catch cans it was poor down to 80%. The reason seems to be in that spray patterns are clashing, similarly another new pivot irrigator was checked and similar problems found. This demonstrated how even new systems seen as being good can require adjustment that is not visible to the eye. The remedy for this particular problem is to shorten every second drop pipe by 100mm.

I include in the appendix two and three reports by Page Bloomer, one is the Irrigation Audit report that will outline where this SFF project will head and the second looking at another form of strip tillage. The point to note is that these reports have stemmed from the opportunity I had in completing this Nuffield Trip.

Prior to completing this report I visited Australia, during the 2002 drought. While visiting Ben Bootle I noted a strip of wheat that had not grown. When inquiring if that was a drill problem I was surprised by the answer. The reason there was a miss was the spray during the summer fallow missed a run and weeds grew, the moisture the weeds used then depleted soil moisture so the crop would not grow. The surrounding crop had an estimated yield of half a ton to the acre. This was a classic demonstration of the need to conserve moisture. The second example was where conventional-

tillage was used and the moisture loss was far greater so crop yield was down compared to zero–tillage planting.

Conclusion

The one over riding conclusion is there is no one answer. There are huge research efforts spread over many different types of system, they all have merit and are aimed at a more sustainable way of using the resources available and creating a profit. This report presents and explains some new ideas for New Zealand agriculture, which I believe, have merit and value.

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