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An Alternative to Border Check Irrigation

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Comparison of border check to drop tube centre pivot irrigation for lucerne irrigated with saline water

by *James De Barro*

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An Alternative to Border Check Irrigation: ***Comparison of border check to drop tube centre pivot irrigation for lucerne irrigated with*** **saline water**

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Foreword

The Australian lucerne seed industry is estimated to be valued over A$100 million to the Australian economy with the majority of seed produced under irrigation. Border check is the principal method of irrigation. This method is used extensively in Australia's main production area, around the township of Keith, South Australia, where 90% of Australia's seed is produced.

The majority of Australian lucerne seed is irrigated from saline ground water systems. In the South East of South Australia, this resource is declining in availability and quality. Coupled with this are changes to water policy and licensing, stimulating the lucerne seed industry to evaluate alternative irrigation practices and delivery systems. Producers also need to manage the negative impact of saline water on lucerne seed production.

This research aimed to qualify and quantify the drop tube irrigation system as an alternative and significantly more efficient ground water irrigation system for the production of lucerne seed and hay. Success of a drop tube system could revolutionise irrigation application methods for the irrigated lucerne seed industry in Australia where both fresh and saline water is used. The research also aimed to quantify reductions in the volume of saline water pumped and applied for lucerne seed and hay production whilst maintaining profitable yields in comparison to existing border check irrigation.

The research shows that the drop tube centre pivot pumped 50-68% less water and provided a 50% increase in return per megalitre pumped.

The research determined that irrigation via the drop tube system on non wetting sandy soil is best applied in large applications (75-125 mm/irrigation event), which reflects the traditional success of the border check system. The project findings supported anecdotal experience that at the commencement of irrigation using the drop tube system, saline water can be immediately applied successfully to seed crops. In addition, the drop tube system fits in favourably with proposed water management policy to reduce ground water extractions, and in doing so, does not reduce the opportunity to maintain lucerne seed yields.

This project is funded by De Barro Agricultural Consulting, South East Natural Resource Management Board and industry revenue that is matched by funds provided by the Australian Government.

This report is an addition to RIRDC's diverse range of over 1700 research publications, forms part of our Pasture Seeds R&D sub-program, which aims to facilitate the growth of a profitable and sustainable pasture seeds industry based on a reputation for the reliable supply, domestically and internationally, of a range of pasture species.

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- downloads at www.rirdc.gov.au/fullreports/index.html
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Peter O'Brien
Managing Director
Rural Industries Research and Development Corporation

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Special mention is made to Mark Wenzel who is the pioneer of the drop tube in the Australian lucerne seed industry.

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About the author

James De Barro owns and manages De Barro Agricultural Consulting. James has an honours degree in Agricultural Science and a Graduate Diploma of Business and was awarded a Churchill Fellowship in 1999. James is an inaugural member of the Lucerne Australia executive committee. James resides in Keith in South Australia and specialises in consulting to lucerne seed producers and industry regarding all facets of seed production in dryland and irrigated systems. James is responsible for the ongoing research focus of the business that finances several projects. James is involved in industry policy development and promoting the lucerne seed industry through membership of Lucerne Australia.

It's OK to ask dumb questions. It's easier than facing up to dumb mistakes.

Anon

Abbreviations

EC	Electrical conductivity
TPWA	Tatiara Prescribed Wells Area
SECWMB	South East Catchment Water Management Board
SENRMB	South East Natural Resource Management Board
ppm	parts per million

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Where there is an open mind, there will always be a frontier.
Charles Kettering

Background
It is estimated that 95% of Australia's lucerne seed is produced from irrigated crops. The availability of water for production is under threat due primarily to ongoing dry conditions across the production areas of Australia over the past 20 years. Australia's river systems support only a small degree of lucerne seed production. The lack of available water coupled with competitive forces driving up the value of water may place the security of surface water for lucerne seed production in jeopardy due to the lower margins with lucerne seed production compared to higher value irrigated crops.

Who is the report targeted at?
At least 90% of Australia's lucerne seed production is from the Keith district of South Australia from crops irrigated with ground water. The availability and quality of this ground water is declining due to a combination of dry seasons and over allocation of the resource. The licencing system for the resource is currently being changed to a volumetric system similar to that used in the Murray Darling Basin. Irrigators will have a licence for an allocated volume of water and within the renewed Water Allocation Plan under direction from the Federal Government's National Water Initiative a water trading framework will be established. Irrigator's allocations are also likely to be reduced as part of a strategy to sustain the quality and quantity of the ground water system. Consequently the Australian lucerne seed industry needs research such as this project to assess irrigation options that may assist in maintaining and strengthening the production base.

'At least 90% of Australia's lucerne seed production is from the Keith district of South Australia from crops irrigated with ground water. The availability and quality of this ground water is declining due to a combination of dry seasons and over allocation of the resource.'

What the report is about
The majority of lucerne seed produced in Australia and in particular the major production area of South Australia, traditionally use border check irrigation as the established irrigation system. Through the 1970's and 80's border check irrigation increased in the Keith region due in part to the technology at the time, the flat terrain, free draining soil type and the salinity of the ground water. Until recently, the notion of irrigating lucerne seed crops with water with salinities from 4000 – 8000 ppm with anything other than border check irrigation has not been evaluated. With the impending changes of water policy, advances in seed production and irrigation delivery technology the use of alternative irrigation systems is now a necessary consideration for irrigated lucerne seed producers. The report examines a comparison of lucerne seed and hay production between a drop tube irrigation system and a border check irrigation system.

Methodology
The research examined the income and expenditure of lucerne seed and hay production from drop tube and a border check irrigation systems over two consecutive seasons. Management of each system was recorded and the net profit/ML pumped was calculated.

Aims and key findings
The research evaluated a comparison of border check and drop tube centre pivot irrigation systems for the production of lucerne seed. The cost of production and the net profit for each system was assessed and the return per megalitre pumped was calculated. The key findings of the research were that there was no discernible difference between either irrigation system in the production and net profit. Most importantly the research determined that drop tube irrigation returned 55% more profit per ML pumped. In the context of changes to water allocation policy this is a critical finding.

'Until recently, the notion of irrigating lucerne seed crops with water with salinities from 4000 – 8000 ppm with anything other than border check irrigation has not been evaluated. With the impending changes of water policy, advances in seed production and irrigation delivery technology the use of alternative irrigation systems is now a viable and necessary consideration for irrigated lucerne seed producers.'

Implications for relevant stakeholders

Border check irrigated lucerne seed producers will benefit from the research findings in terms of investing capital into changes to their irrigation systems or the development of new irrigation enterprises. The results of this research will allow irrigated producers to evaluate their irrigation methods in the context of maintaining or increasing their production as well as the profitability of their businesses and how they operate in the developing water market. Irrigators have the prospect of improving their efficiency by utilising aspects of this research including the use of soil moisture monitoring technology to advance any alterations to their irrigation systems.

Recommendations

Irrigated lucerne seed producers and the lucerne seed industry as a whole are reliant on the availability of water to maximise production. If the industry aims to retain its share of water use for production and maintain or increase its current production levels it needs to embrace the concept of alternative methods of irrigation delivery to both conserve water and enhance the sustainability of the water resources as well as maximise the return for every ML of water pumped and applied.

'If the industry aims to retain its share of water use for production and maintain or increase its current production levels it needs to embrace the concept of alternative methods of irrigation delivery to both conserve water and enhance the sustainability of the water resources as well as maximise the return for every ML of water pumped and applied.'

1. Introduction

1.1 General overview

The Australian lucerne seed industry produces approximately 6-7000 tonnes of seed each financial year, of which over 90% is produced in South Australia (SA), in this project's research region, Keith, SA. Approximately 8,000 ha of irrigated lucerne is harvested annually for lucerne seed in the Upper South East of SA. Other established but significantly smaller irrigated production areas in Australia include the Lachlan Valley region in Forbes, NSW and new areas around Deniliquin, NSW, Shepparton, Victoria and more recently Tasmania. The export value of lucerne seed exceeds A$25 million and the value of the lucerne seed industry is estimated to be over $A100 million. The increasing value of lucerne seed to the Australian pasture seed industry, as well as to the rural economy, defines it as a commodity that requires research designed to maintain and improve yields, as well as sustain the industry and grower returns. As an intensive high input crop there is a requirement for sustainable practices that suitably respond to the environmental issues impacting on the lucerne seed industry. This research was required to assist in developing qualitative and quantitative information aimed at preserving the production base of the Australian lucerne seed industry.

1.2 Research area

Lucerne seed production is the Keith district's key crop. By virtue of the natural saline ground water, lucerne is the most reliable perennial crop. The highly permeable sandy limestone soil profiles of the region generally provide a suitable medium for lucerne seed production under irrigation as they are free draining, enabling lucerne to persist and provide profitable seed yields under saline water irrigation. The irrigation of lucerne for seed production is a major key for the economic and social stability for the local communities.

1.3 Water resource management – local history

Across most of the South East of SA, the ground water resource exists in unconfined and confined aquifers. The majority of Australian lucerne seed is produced by irrigation water extracted from the saline unconfined aquifer system. The South East of South Australia is divided into regional Prescribed Wells Areas and the common source of border check irrigation water for lucerne seed production is in the Tatiara Prescribed Wells Area (TPWA). Salinity in aquifers in this area ranges from 2000-8000 ppm (3600-14400 electrical conductivity (EC)). This is the water source central to this research.

In 1984, the Tatiara region (incorporating the Keith area) was prescribed due to concerns regarding increasing water salinity. An area based volumetric water allocation system developed from estimated crop water requirements was instituted in 1988. The ground water allocation plan was an Irrigation Equivalent System where the allowable area of any irrigated crop to be grown was relative to the water use of a "standard area and type" of pasture referred to as the 'reference crop'. This system operates on an estimation of the water use of the crop. The system is currently in use across the Upper South East of South Australia. The licence provides no limit on the volume of water that can be pumped from the aquifer to irrigate lucerne for seed production, however, specifies the area upon which any volume of irrigation can be applied. The licence is administered by the Department of Water Land and Biodiversity Conservation (DWLBC) and costs approximately $12/irrigation equivalent.

Historically, land in South Australia has been divided into Hundreds for the purposes of simplifying government management. Within the TPWA, the Hundred of Stirling is Australia's biggest lucerne seed production area and as a result is a highly concentrated area of border check irrigation. In 1997, detailed crop area ratios were created in the Hundred of Stirling by proactive irrigators concerned that water withdrawal was greater than the annual recharge of the aquifer system which was associated with a noted rise in water salinity and decline in the water table. Allocation reductions were instituted and new crop area ratios created to allow producers to best use their reduced allocation for production. This was the first exhibited licence change, organised by irrigators and State Government water resource representatives, that was directly in response to the notion of the importance of water quantities pumped and the impact it had on the ground water system.

The *Water Resource Act 1997* was created to permit specific water resource management where deemed necessary, with the aim of sustainability of the water resource. The TPWA is one of five management areas in the South East where the *Water Resource Act* required a water allocation plan to be created. A State Government Select Committee Report on Water Allocations in the South East was released in August 1999 and created the framework for the South East Catchment Water Management Board (SECWMB), which was formed under *the Act*, to be empowered in consultation with the community to produce water allocation plans to replace existing water allocation policies. In 2006, the SECWMB was incorporated into the South East Natural Resource Management Board (SENRMB) as part of the South Australian Government overhaul of natural resource management.

1.4 Water resource management – the future

In 2008, the format for water allocations for irrigators will change. Licences for all the Prescribed Wells Areas will convert from the current area based format to a volumetric format. Such licences will provide the irrigator with a set volume of water (megalitres (ML)) that will be permitted to be pumped from the aquifer in any given year. The water allocation plans governing water resource management are currently under review and there is a high probability that water extraction licences will be reduced with the aim of balancing irrigation activities with the projected needs of the aquifers sustainability. It is not known whether the licenced irrigator will be restricted in the area permitted to be irrigated but with the need to develop water policy that promotes efficiency and a water trading framework, it would appear an unlikely scenario.

The research was conducted in the Hundred of Laffer, which is adjacent to the Hundred of Stirling. At the commencement of the research the Hundred of Laffer was the only remaining irrigation area in the South Australia’s South East not in a Prescribed Wells Area. In February 2007, the Minister for the SA Government’s Department of Water, Land and Biodiversity Conservation declared intent to prescribe the Hundred of Laffer. It is predicted that within the next two years the Hundred of Laffer will be within the TPWA.

2. Objectives

2.1 Purpose of research

In reference to the RIRDC research – Dividing the Droplet (RIRDC Publication No. 05/116) and The Invisible Reality of Groundwater Salinity (RIRDC Publication No. 06/053) border check irrigators needed research to be undertaken so that when licences are converted they will have a quantified understanding of the potential of an alternative irrigation delivery system such as drop tube irrigation. The irrigation supply for the majority of Australia's lucerne seed production area is under pressure due in part to 20 years of declining winter and spring rainfall in the recharge areas of the groundwater system. This has resulted in lowering water tables and water availability as well as increases in water salinity. In addition, other contributing factors include land use changes, increased irrigation water demand, over allocation, inappropriate water policy, a lack of the true value of irrigation water and the resulting lack of efficiency in irrigation delivery systems.

This research provides irrigators with an understanding of the volumes of water pumped by two forms of irrigation - border check irrigation and an alternative, drop tube pivot irrigation. A result of the research would be that irrigators would be able to evaluate if bore water with salinities in excess of 4000 ppm could be applied via a drop tube system with no adverse impacts on the lucerne seed crop. The technology of the drop tube system is known to be tolerant of water with salinities of at least 9000 ppm which is highest salinity known to be used for border check irrigation in the Keith district. In addition, the research calculated the cost of production and the financial returns per megalitre of both irrigation systems.

Capital investment by irrigators to establish any form of irrigation system is significant. It has been calculated that to install a fixed drop tube pivot (including bore drilling, pump, pipe work and pivot structure) would cost between $4000-5000/ha for a 50 ha area. Border check irrigation establishment for the same area is estimated to cost between $1500-2000/ha. For an existing border check irrigator to covert an irrigation system to drop tube pivot the cost would be in excess of the quoted figure due to the need to remove the current system prior to replacement. Consequently, there is a need for a quantified understanding of the benefits of changing irrigation systems in terms of production potential. Production potential includes the potential to increase acreage of production, crop management efficiency, increasing returns per ML pumped and, of paramount importance, sustainability of ground water system. This research focuses on the crop efficiency and returns per megalitre pumped for two irrigation systems, drop tube pivot and border check.

With the impending changes to allocations there is a likely impact on the socioeconomic structure of Australia's key lucerne seed production region. Declining water allocations may impact on the area of irrigated lucerne seed production and hence the gross production. This research was required to aid producers in their review of irrigation delivery systems and in the context of the Australian lucerne seed production base it could assist in maintaining the volume and area. Maintenance of yields and area of production will provide a steady socioeconomic environment for the local communities as well as for the network of suppliers and buyers of lucerne seed throughout Australia and the world. The research will provide the catalyst for positive change in irrigation management supporting the Australian lucerne seed industry and sustaining the invaluable ground water resource.

3. Methodology

3.1 Research location

The research was conducted 17 km west of Keith on the property of Wayne and Lindy Lehmann. The research compared the production of 30 ha of 17 year old border check irrigation with 30 ha of drop tube centre pivot irrigation established in 2004. The border check irrigation was sown to certified Aurora in 2002 and the drop tube irrigation was originally a dryland paddock of Flairdale sown in 2001. The paddocks are adjacent to each other and the soil type is sandy loam over limestone rubble and marl.

The irrigation water for the border check irrigation was 4000 ppm in March 2005 and 4700 ppm at the same time for the drop tube irrigation. At the time of research commencement in July 2005, as was still the case in September 2007, the location was the only site that provided the opportunity to compare the two irrigation systems in adjacent paddocks with the same soil type (non wetting sands) and using similar irrigation water. The salinity of the water is unsuitable for traditional centre pivot spray irrigation (different from drop centre pivot irrigation) of lucerne seed crops due to the adverse impact on seed and forage yields. At least 70% of the lucerne seed produced in the region is from border check irrigation currently irrigated with water unsuitable for traditional pivot irrigation technology.

3.2 Irrigation application management

A Valley® poly lined galvanised towable pivot fitted with two types of irrigation emitters was used as the drop tube system. ¾ of the emitters were Senninger® LDN bubbler pads and the remaining were Senninger® Quadspray emitters. (Photos 5-11). The border check system used was representative of 1000's of hectares of irrigated lucerne crops in the research area (Photos 1-4). Water was pumped into a delivery channel and sluice gates were opened in the wall of the channel to release water into the irrigation bay. The gates were closed when the water had sufficiently travelled down the bay and there was enough water at the head of the bay to push water to the bay's end.

In both sites, the timing of irrigation events was determined by assessment of soil moisture recording data. Soil moisture data from a continual logging C-probe was referred to through the season. Appropriate refill points were established for each site and irrigation events were timed to be when the soil moisture content approached the refill point. A prescribed volume of application was recommended for each irrigation of the drop tube site however only the timing of irrigation could be recommended for the border check site as water volume applied cannot be varied.

Irrigation was only applied through the second half of the second hay crop as well as the seed crop. This is representative of typical management in the district in an average season. In 2005, oats were over sown into the drop tube site to increase hay production for the initial hay cut.

3.3 Data collection

The pump output from both pumps was measured with a RotoFlo® paddle meter marketed by MACE. It was decided to compare the total volumes pumped for each system and not conduct a full water balance on the systems as the aim of the project was to compare the baseline water requirements of the existing systems and their associated production costs and returns. It is accepted that the border check system's efficiency (defined as $ return/ML pumped) can be improved in several ways. Examples of this are piping the water to the flood bays rather than using an earthen delivery channel and changing bay sizes to get an optimum flow that mitigates drainage losses in respect to the available flow rate.
All activities for each paddock and their associated costs were recorded. Such activities included mowing, hay baling, irrigation and harvest. The production off the paddocks, such as hay and seed was also recorded along with the value.

3.4 Data assessment

The collated data was assessed to calculate a cost per ML pumped for each system. It was decided not to incorporate any percentages of infrastructure payments (e.g. pivot payments such as interest) with either system as this would confound the results. The final calculation of efficiency expressed as $ return/ML pumped would give an individual seed producer the opportunity to evaluate the actual system cost/return over which any individual finance scenario can be placed.

3.5 Crop management

Lucerne hay and seed production was managed under long standing management practices commonly used in the research region. Frequent crop inspections through the seed production phase determined pest control application timing as well as irrigation and harvest management.

4. Summary of Results

4.1 Season 2005/2006

Table 1 presents the activities undertaken on the two research crops as well as the production and water pumped. The expenditure and income of all activities are presented.

Table 1: Income/expenditure of lucerne seed production off drop tube and border check irrigation in season 2005/06.

Action Taken	Drop Tube ($/ha)	Border Check ($/ha)
2/6/05: Echidna oats seeded @ 70 kg/ha	$40.00	
25/7/05: Broadleaf weed control: Buttress 1.2 l/ha	$24.50	
25/7/05: Broadleaf weed control: Diuron 1.0 l/ha + Sprayseed 1.8 l/ha		$30.00
7/8/05: Plain super @ 150 kg/ha	$36.00	$36.00
20/9/05: Copper manganese 4.0 l/ha + wetter 0.1%	$11.50	$11.50
6/10/05: Lorsban 280 ml/ha	$11.50	
10/10/05: Lorsban 280 ml/ha		$11.50
1-20/11/05: Cut, rake, bale, cart hay	$202.00	$108.00
7-15/12/05: Cut, rake, bale, cart hay	$85.00	$99.00
23/12/05: Copper manganese 4.0 l/ha + wetter 0.1%	$11.50	$11.50
2/1/06: Fastac 140 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%	$13.20	$13.20
24/1/06: Fastac 140 ml/ha + Lorsban 300 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%	$17.20	
24/1/06: Fastac 140 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%		$13.20
3/4/06: Sprayseed 2.5 l/ha	$32.50	
5/4/06: Windrowed		$38.50
10/4/06: Harvest	$60.00	$60.00
Certification/Phytosanitary requirements	$53.00	$43.00
Seed cleaning	$85.00	$70.00
Crop advising/Irrigation scheduling	$84.00	$84.00
Fuel (irrigation pumps)	$187.50	$157.00
Labour (irrigation management, mowing, raking, carting)	$80.00	$217.00
TOTAL EXPENDITURE ($/ha)	**$1034.40**	**$1003.40**
Production		
First hay cut	4.2 t/ha = $630.00	2.3 t/ha = $420.00
Second hay cut	1.4 t/ha =$252.00	2.0 t/ha = $360.00
Drop tube seed crop ($3.00/kg) - Clean	713 kg/ha = $2139.00	
Border check seed crop ($3.40/kg) - Clean		587 kg/ha = $1995.80
TOTAL INCOME ($/ha)	**$3021.00**	**$2775.00**
NET PROFIT ($/ha)	**$1986.40**	**$1771.60**
Water pumped (entire irrigation season)	4.16 ML/ha	8.26 ML/ha
EFFICIENCY ($ return/ML pumped)	**$477.50/ML**	**$214.48/ML**

4.2 Season 2006/2007

Table 2 presents the activities undertaken on the two research crops as well as the production and water pumped. The expenditure and income of all activities are presented.

<u>Table 2:</u> Income/expenditure of lucerne seed production off drop tube and border check irrigation in season 2006/07.

Action Taken	**Drop Tube ($/ha)**	**Border Check ($/ha)**
1/5/06-30/9/06: Hard Grazing		
10/9/06: Plain super @ 150 kg/ha	$41.00	$41.00
5/10/06: Broadleaf weed control: Sprayseed 2.5 l/ha	$32.50	
5/10/06: Broadleaf weed control: Bromoxynil 1.2 l/ha + Sprayseed 2.0 l/ha		$38.00
5/11/06: Copper manganese 4.0 l/ha + Fastac 70 ml/ha + wetter 0.1%	$12.35	$12.35
10-20/12/06: Cut, rake, bale, cart hay	$75.35	$82.25
6/1/06: Fastac 140 ml/ha + Lorsban 300 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%	$17.20	$17.20
25/1/07: Fastac 140 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%	$13.20	$13.20
16/2/07: Fastac 140 ml/ha + Copper manganese 4.0 l/ha + wetter 0.1%	$13.20	$13.20
24/3/07: Sprayseed 2.5 l/ha	$32.50	
27/3/07: Windrowed		$38.50
1/4/07: Harvest	$60.00	$60.00
Certification/Phytosanitary requirements	$35.00	$39.00
Seed cleaning	$38.00	$56.00
Crop advising/Irrigation scheduling	$84.00	$84.00
Fuel (irrigation pumps)	$311.25	$297.00
Labour (irrigation management, mowing, raking, carting)	$55.00	$266.00
TOTAL EXPENDITURE ($/ha)	**$820.55**	**$1057.70**
Production		
One hay cut	0.93 t/ha = $280.00	1.15 t/ha = $344.00
Drop tube seed crop ($5.00/kg) - Clean	318 kg/ha = $1590.00	
Border check seed crop ($5.00/kg) - Clean		437 kg/ha = $2185.00
TOTAL INCOME ($/ha)	**$1870.00**	**$2529.00**
NET PROFIT ($/ha)	**$1049.45**	**$1471.30**
Water pumped (entire irrigation season)	5.32 ML/ha	16.5 ML/ha
EFFICIENCY ($ return/ML pumped)	**$197.27/ML**	**$89.17/ML**

5. Discussion of results

5.1 Variety differences

In assessing the results, it is necessary to consider the status of the two lucerne crops. The border check site was sown to Aurora in 2002 and the drop tube site was sown to Flairdale in 2001. Both varieties are semi winter active varieties with similar world activity ratings of 6. Flairdale has not been widely grown for seed and has been a consistent mid-range seed yielding variety. Aurora has been grown widely in Australia's seed producing region and, whilst a noted high yielding variety in the Forbes region in NSW, it has been a highly variable yielder in the Keith region. It is not appropriate to directly compare the two varieties seed yield ability by a direct comparison of district data due to greatly significant differences in sample pool generating the averages. Aurora has been a reliable yielder at the research site with yields ranging from 400-950 kg/ha of clean seed over 17 years of production. Flairdale has had a similar yield history and for the purpose of the research it is accepted that there is not a significant difference between the varieties in hay or seed potential.

Prior to the establishment of the drop tube system, the Flairdale paddock was a certified dryland lucerne crop that was harvested annually. Being a dryland paddock the grazing management was different to the Aurora crop as it was grazed more often and much harder. At the commencement of the project, both crops had similar plant populations with the border check having 23.8 plants/m^2 and the drop tube 23.2 plants/m^2. The border check site was laser levelled in 1988 when it was established. The drop tube site has never been laser levelled and this dictated the irrigation application strategy.

5.2 Irrigation application management

The drop tube site's grazing history together with a non-wetting (water repellent) uneven sand soil surface required the need for the irrigation to be applied in a form of quasi flood irrigation. Non-wetting sand causes water to run off in a similar way water runs off a car's bonnet. Quasi flood irrigation with the drop tube system has proven to be the best method of irrigating on these soils, both at the research site and other pivots equipped with similar drop tube systems. By applying irrigation events of 75-125 mm/ha, the non-wetting effect is negated and irrigation water more evenly infiltrates the soil. Consequently, this method displays more even plant production, similar to border check irrigation systems.

In the border check system, water was applied to the lucerne crop via a channel with the water being confined between two check banks approximately 30 metres apart. In consideration of delivery channel and evaporative losses, each irrigation event applied an average of approximately 120 mm/ha. In real terms, the application volume would be a range of volumes decreasing from the head end of the irrigation bay to the tail end.

5.3 2005/2006 & 2006/2007 season results

Tables 1 and 2 indicate that season 2005/06 was more productive than the 2006/07 season. The principal reason for this was the drought effect in 2006/07. Both research sites were grazed hard with sheep prior to closing the paddocks for hay production in October 2006. Lucerne does not respond well to continuous hard grazing and the sites were both grazed too hard between May and October 2006. Due to the grazing and the dry weather before irrigation commenced, the lucerne growth was significantly affected in the seed production phase in both the pivot system and the border check system. In addition, the lack of rainfall removed a vital source of growth promotion that irrigation with saline water cannot replace. Whilst the plant population remained relatively static in the two years of the project the production was significantly reduced in the 2006/07 season. In 2005/06, the season was representative of an average season with adequate rainfall through winter and spring to permit good lucerne growth and avoid over grazing by sheep.

In 2005/06 (Table1), the overall expenditure for both forms of irrigation were also similar, although there were variances in the components of the totals. In the pivot system, extra expenditure was incurred in hay production due to oats being sown. There was more cost required to produce 44% more hay compared to the border check paddock. The labour requirement for the border check irrigation (i.e. irrigation gate changes) was greater than the drop tube system.. Net profit was similar for both forms of irrigation in 2005/06 indicating that neither system had an agronomic advantage.

In 2006/07, production conditions were much tougher than the previous year. The total expenditure (Table 2) was greater for the border check irrigation due to the higher labour requirement for irrigation management and in particular irrigation gate changes through the irrigation season. The hay yields and returns were similar and the net profit was greater for the border check system due to higher seed yield. In difference to the 05/06 season the seed yield off the border check system was higher in 06/07 due to greater lucerne vigour and production. This was a consequence of the management leading up to the seed crop phase.

In 2006/07, 20% more water was pumped in the drop tube system and 50% more was pumped in the border check system than in 2005/06 due to dry weather conditions. Regardless of more water being pumped in both systems, the net profits were less than the previous year, indicating the importance of rainfall and more moderate grazing systems.

6. Implications of research

The research findings indicate that drop tube centre pivot systems are a suitable alternative to irrigating lucerne for seed and hay with saline ground water. In the two years of the research, no discernable difference can be determined between the net profit of either system. On the basis of this research, lucerne seed producers irrigating with saline ground water could confidently investigate the establishment of drop tube centre pivot systems as an alternative or replacement to the standard border check method. However, establishment of centre pivot systems are more costly than border check irrigation and there are logistical issues such as the presence of power lines and fences, as well as environmental considerations such as established trees.

Irrigating with centre pivots, and in particular with saline water, may create issues with salt build up in the root zone. Research is inconclusive at this stage as to the detriment of this, particularly in average rainfall seasons. DWLBC[1] indicated that areas with long histories of spray irrigation (e.g. centre pivot) with saline water have been sustainable to date, but it is not clear of the longer term sustainability of such practices. The DWLBC research suggests that border check irrigation has a more immediate negative impact on groundwater quality and that a drop tube pivot system may aid in improving the sustainability of the aquifer system.

With the impending changes to water allocation in the form of metered/volumetric allocations as well as allocation reductions, the efficiency findings of the research are of great value. The new regional water allocation plans governed by the Australian Governments National Water Initiative strongly invoke a water trading aspect to water management. As this eventuates water will begin to develop a significant value – a fact that has not existed to date with the water used for irrigating lucerne seed under the current water allocation policy. In a future with declining water availability and rising water values the need to refine the water applied to lucerne seed crops and maximize the value returned per ML pumped is real. With use of drop tube pivot systems, irrigated lucerne seed producers may be able to maintain their level of seed production, improve returns per ML and take part in a developing water market that permits lucerne seed producers to remain viable and productive.

The efficiency, where efficiency is defined as the $ return per ML pumped, was 55% higher in the drop tube system than the border check system for both years of the project. The drop tube system exhibited itself as a more water efficient system in the two season studied. These findings are very pertinent to the future of irrigated lucerne seed crops both in the research region and elsewhere. The gross margin analyses presented in Tables 1 and 2 indicate that the drop tube system was more profitable per ML pumped and with the impending changes to water allocation policy this research provides a critical insight into alternative irrigation delivery practices that improve efficiency. Where lucerne is irrigated with saline water the drop tube system exhibited itself as a suitable application tool due to comparable seed and hay yields compared to the border check system. The new water allocation policy will prescribe 30-48% allocation reductions. The demonstrated increased efficiency of the drop tube system in comparison to the border check system evaluated in this research will provide opportunity for increasing maximisation of returns per ML pumped and is of particular interest where less water is available for irrigation for each licenced irrigator.

Since the commencement of this research at least six new drop tube systems have been installed on existing spray centre pivot systems – such was the compelling evidence of this research in its first year as well as field day observations during the first season. Anecdotal reports from the irrigated seed producers concerned suggest strongly their advocacy for the advantages of drop tube delivery over spray delivery. Advantages of the drop tube system include being able to irrigate in windy and hot weather with no efficiency reduction, less impact of saline water on infrastructure and significantly increased seed yield of up to 30% has been recorded for a broad spectrum of lucerne varieties grown under this technology in comparison to conventional spray applicators left within the systems for yield comparative purposes. No declines in production or profitability have been reported by the producers concerned and such is their satisfaction that additional drop tube modifications have been installed on existing spray pivots. In addition, several border check irrigators have developed plans to install drop tube pivots as a replacement and alternative for border check irrigation systems.

To date the lucerne seed irrigator in the research region has had unlimited volume of water permitted to be pumped for seed production but has only been limited by the area which could be irrigated. The new water allocation policy will regulate the volume an irrigator can pump per year and is likely not to restrict the area permissible to irrigate. The new policy will permit the establishment of a water trading market. For the first time water will have a value which will be established by supply and demand factors.

Irrigators will need to become savvier in how they manage their water. Irrigation efficiency will drive capital investment into new irrigation infrastructure such as drop tube pivot systems. An irrigator will need to make financial decisions regarding how they will use their allocation either by maintaining their border check systems, investing into increased water efficient systems as an addition to their existing border system or replacing their border system with a more efficient system. An irrigator will also need to be aware as to how they can utilise the water trading market to manage their allocation and area of production.

On the basis of this research and other commercial examples of the drop tube system, a lucerne seed irrigator may choose to invest into a more efficient system and with declining allocations may be able to maintain production. Depending upon their individual circumstances (e.g. available suitable land) they may leave their existing border check system intact and use it as a rotation tool when the lucerne is out of production under the drop tube system. Alternatively the irrigator may redevelop existing border check irrigation into a more efficient system such as the drop tube. Irrigators will need to assess their own properties, financial status and production capacities to capitalise on their irrigation availability and a more efficient system will be a valuable tool to increase return per ML pumped as well as assist in maximising their production capacity.

The new water allocation policy will highlight the need for irrigated lucerne seed producers to evaluate more water efficient irrigation systems. It is predicted that the new policy will drive improvement in the return per ML pumped and the diversification into improvements of the border check system or investment into more efficient irrigation systems such as the drop tube system evaluated by this research.

7. Recommendations

The following are recommendations from the research findings:

1) Irrigation of lucerne for seed and hay with drop tube centre pivots with saline irrigation water is comparably productive as border check irrigation. On the basis of the research findings, irrigators can confidently investigate the drop tube system as an alternative irrigation system that can permit maintaining current production levels as well as increasing profit per ML pumped.

2) Irrigators need to understand what is meant by irrigation efficiency and that maximising return per ML pumped is the critical aspect of irrigating any crop. Irrigation efficiency is not about minimising water applications for a mediocre return but maximising effective outputs of for example, lucerne seed and hay, and the corresponding net profit per ML pumped.

3) With the use of any irrigation system, irrigated seed producers should consider monitoring soil moisture to know when to irrigate so as to aid in irrigating efficiently.

4) Soil moisture monitoring tools and other soil moisture aids should be used in systems such as drop tube pivots when it is possible to apply specific quantities of water. Understanding concepts such as readily available water and root zone storage are important in determining what volumes of irrigation to apply to achieve wetting of the crops root zone. This knowledge is important in optimising irrigation efficiency.

8. References

1: **DWLBC** (2006) 'Minimising salt accession in the South East of South Australia – the Border Designated Area and the Hundred of Stirling'. Reports 2006/19 and 2007/pending.

9. Photo Gallery

Photo 1: Ripening lucerne seed crop under border check irrigation

Photo 2: Ripening lucerne crop

Photo 3: Mature growth under border check irrigation

Photo 4: Growth of lucerne seed crop under border check irrigation


Photo 5: Ripening lucerne seed crop under drop tube irrigation


Photo 6: Mature growth under drop tube irrigation


Photo 7: Drop tube pivot system


Photo 8: Lucerne growth under drop tube irrigation


Photo 9: Drop tube emitter


Photo10: Drop tubes


Photo 11: Drop tubes spaced 50 cm apart

An Alternative to Border Check Irrigation

RIRDC Publication No. 08/014

Australia produces pasture seeds ranging from temperate to subtropical species for domestic use and for export markets. The export value of certified pasture seeds exceeds $36 million. Lucerne and clover are the major leviable seed crops. Total production of leviable temperate legume seed currently exceeds 10,000 tonnes. Lucerne and clover seed exports to the world in 2004 were valued at over $25 million. In the three calendar years from 2002-04, the export value of lucerne seed exports rose by 55% and the export value of clover seed rose by 32%.

Perennial grasses are grown for seed in all States with Victoria having the greatest production. Perennial grass seed production is not yet levied for R&D. The main subtropical grasses grown for seed in north-eastern New South Wales, Queensland and the Northern Territory are Rhodes Grass, Setaria, Panicum, Carpet Grass and Paspalum.

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