CURRENT RESEARCH PROJECTS

– SOUTHERN FARMING SYSTEMS –

(Last updated 3 October 2007)

CONTENTS

Research Project Description

Project Title:

Eritrean Capacity Building Project – Dryland Agriculture

(Activity #453)

Principal Investigator:

Dr Alison Bowman

Funding Sources:

Federal Department of Agriculture, Fisheries and Forestry (DAFF).

Summary:

Following the exchange (2004) and signing (2005) of a Memorandum of Understanding between the Australian and Eritrean Ministers of Agriculture, two projects (Dryland Agriculture, Agricultural Education) were initiated in 2005 by DAFF. The undertaking of the Dryland Agriculture project was contracted to Alison Bowman (NSW DPI) and Prof Ted Wolfe (CSU).

A Stage 1 visit to Eritrea for the project was made in April – May 2005, to investigate: "… the current status of Eritrean agriculture with the aim of identifying specific areas of Australian research, expertise and experience that could be the focus of further technical capacity building to assist Eritrea in developing its natural resources and increasing its agricultural capacity, productivity and the efficient use of agricultural land and water resources."

A series of recommendations was produced for DAFF on possible activities that could be undertaken as part of a package of assistance to the National Agricultural Research Institute (NARI) of Eritrea. These recommendations were targeted toward livestock production and resource conservation. The 7 recommendations included proposals on forage evaluation, technical support, developing a strategic plan for the Livestock Division of NARI, landscape management, human resource development, stubble management and intensive livestock production for export.

In July 2005 a second visit was undertaken to Eritrea. The Stage 2 visit comprised reviewing the possible future project with the relevant research directors and staff at NARI and other potential stakeholders. We were particularly interested in assessing the capacity of staff of the Livestock Division of NARI to undertake and/or support research with potential pasture/forage species, and in understanding the local systems of land management and agricultural extension.

We concluded that the highest priority for the Australian Government was to assist Eritrea with a program to introduce a range of pasture and forage species and varieties sourced from the tropical, sub-tropical and temperate genotypes that are held in Australian collections. Australia has considerable strengths in evaluating pasture species and forages in terms of their productivity, persistence and commercialisation. Furthermore, Eritrean scientists would benefit from Australian expertise in animal nutrition, particularly in relation to the nutritive value of feedstuffs for grazing livestock and the use of decision support systems and information packages to guide the management of vegetation, land and livestock resources.

A 3-year project comprising these ideas was proposed to DAFF in August 2005. We are waiting for a response.

Research Project Description

Project Title:

Best Management Practices (BMPs) for Dryland Cropping Systems – Murrumbidgee Catchment

(Activity #454)

Principal Investigator:

Dr Alison Bowman

Funding Sources:

Murrumbidgee Catchment Management Authority (NAP funds).

Objectives:

Although this is only a 1 year project it is intended to help meet the longer term objectives of the CMA of optimising water use in dryland cropping systems in the mid and lower Murrumbidgee catchment through:

1. Better weed and disease management in cropping systems.
2. Improved ground cover through the increased implementation of conservation farming practices.
3. Improved landholder knowledge and management of soil water.

Summary

To achieve the above outcomes, the project consists of 3 component parts each managed by an independent project officer:

(a) A survey to benchmark landholder practices throughout the mid and lower Murrumbidgee catchment in 2005. This survey will provide a snapshot of landholder activity in the region, concentrating on conservation farming practices. The data will also provide the CMA with a basis on which to monitor and evaluate the impact of their other programs and activities.

(b) The development and packaging of information in relation to best management practices for identified problem weeds and disease in cropping systems. A needs analysis was undertaken with 5 landholder and 1 agribusiness group within the target region to prioritise problem weeds and diseases. These groups also identified what was required to assist with the implementation of BMPs. That is: either (i) management packages were available but needed extending to growers; or (ii) information was available but needed to be packaged; or (iii) information was not available and R&D effort needed to be made to rectify this. From this activity 4 issues have been identified (Management of Brome Grass, Management of Fumitory, Management of Cereal Root Disease and Economic Management of Summer Weeds) as requiring information packaging. This will now be the primary objective for the project officer.

(c) Monitoring of wateruse by a range of crop and pasture systems across the catchment. Five “Focus Farms” have been established in conjunction with the Murrumbidgee Grain and Graze project on which crop and pasture production and water use are being monitored. This will provide some “real life” data of what is happening under annual vs perennial pasture and grazed vs ungrazed crop systems. Monthly “Fact Sheets” are produced for growers and agribusiness to raise landholder awareness of water use by dryland crop and pasture systems.

Research Project Description

Project Title:

Legumes and reduced tillage for cereal-based cropping in southeastern Australia and the Democratic People's Republic of Korea (DPRK)

(Activity #325)

Principal Investigator:

Dr Jeffrey Evans

Funding Sources:

NSW Department of Primary Industries and the Australian Centre for International Agricultural Research (ACIAR Project No.: SMCN/2001/048)

Objectives:

1. In the DPRK, restore soil fertility and yields of staple cereal crops (rice and maize).
2. In Australia, evaluate the role of clover forage conservation crops in sustaining wheat production.

Summary:

In the Democratic People's Republic of Korea, rice and maize are staple foods. Fifteen years ago, yields of rice and maize achieved with inputs of nitrogen, phosphorus and potassium fertilisers (NPK) were frequently 6 – 8 t/ha. However, supply of these inputs declined with the collapse of the Russian economy, and with subsequent continuous cropping, soils have now become severely impoverished and eroded. Staple cereal yields have declined to 2 – 3 t/ha. Recovery of yields to historic potential is essential for self-dependence of the DPRK population for food.

The strategy for sustainable achievement of higher cereal yields involves restoring organic carbon and nitrogen in the soils by cultivating single-season winter tolerant legumes, such as hairy vetch and certain medics, and returning all the legume biomass to the soil (green manuring). In the sloping maize country, the second strategy is to preserve the fertility benefits of green manuring by using minimal soil cultivation and retaining plant material on the soil surface to protect soil from erosion. Over time, the project will measure the cumulative effect of these strategies on soil fertility, crop requirement for nitrogen fertiliser, and soil erosion.

In Australia, sustainable cropping also depends on diversifying crops in rotation. Single-season legume crops other than grain legumes are required to meet farmer needs for greater diversification. The Australian component of the ACIAR project aims to evaluate the agronomic and economic impact in cereal systems of clover grown for forage conservation. Both field experimentation and simulation modelling are being used to evaluate the clover-cereal system at the plant and soil level.

Research Project Description

Project Title:

Increasing sustainable production and soil fertility on broad-acre organic farms

(Activity #323)

Principal Investigator:

Dr Jeffrey Evans

Funding Sources:

NSW Department of Primary Industries and the Rural Industries Research & Development Corporation (DAN-195A).

Objectives:

1. Assess the fertility status of soils managed for organic, rain-fed cereal production.
2. Develop strategies to increase wheat yields on farms managed organically.

Summary:

Seasonal wheat yields on farms managed without synthetic pesticides and fertilisers (organic farming) are frequently lower than on neighbouring farms managed with these synthetic inputs (conventional farming). Pasture quality on organic farms may also be of lower quality than on conventional farms. These factors reduce the profitability of organic cereal-livestock farms and reduced productivity may lead to environmental damage through inefficient plant use of soil water and nitrate.

A survey of organic cereal-livestock farms in NSW revealed soils critically low in plant available phosphate, and pasture plants with symptoms of phosphorus deficiency. Contributing factors to phosphorous deficiency on these farms included: a lack of knowledge of nutrient balance, failure to fertilise soil with enough phosphorous fertiliser, and insolubility of rock phosphate fertiliser – the only allowable, practical fertiliser to restore exploited soil phosphorus in broad-acre, organic farming systems (superphosphate is not permitted by The International Federation of Organic Agriculture Movements).

Rock phosphate is usually applied to soil in a granular form. Alternatively, grinding rock phosphate should improve its solubility in soil and, hence, increase the release of plant available phosphate. However, in the cereal zone of southern Australia ground rock phosphate did not increase available phosphate. In contrast, the combined application of ground rock phosphate and elemental sulphur (1:1) significantly increased plant available phosphate, because the sulphur helps dissolve the rock phosphate. Work will continue to refine this approach towards a commercial product, and to understand its likely impact for the organic cereal-livestock industry.

Research Project Description

Project Title:

High water-use farming systems that integrate crops with perennial pastures

(Activity #348)

Principal Investigator:

Dr Neil Fettell

Funding Sources:

NSW Department of Primary Industries, the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC Project No. RE407) and the Grains Research & Development Corporation (GRDC Project No. UWA 396).

Objectives / Expected Outcome:

The integration of productive perennial pastures into annual cropping systems to provide for the ongoing improvement of the Australian dryland farming industry.

Summary:

Dryland salinity, caused by large-scale clearing of native vegetation and its replacement with annual crops and pastures threatens the productivity and viability of many farms across southern Australia. The situation is expected to continue to deteriorate with >12 Mha of land predicted to be lost from agricultural production within the next 50 years.

Phase farming is a system in which pastures and crops are rotated, the duration of each component determined by environmental, plant physiology and economic factors. Including perennial species such as lucerne in the pasture phase shows considerable promise as a productive way to increase water use in grain growing areas and reduce the risk of rising groundwater and salinity. Phase farming with perennial plants is new technology for the majority of southern Australian grain growers and there remains a significant challenge to achieve broad scale uptake. An economic production package to cover a wide diversity of soils and climate, developed in collaboration with the farming industry, would allow the technology to prosper.

The success of lucerne in reducing total water use is dependent upon its ability to create a zone of dry soil below the normal rooting depth of annual crops that acts as a buffer against water leakage from the soil to groundwater. However, recent research suggests that lucerne is not adapted to all soil types, nor is it equally effective at generating dry soil buffers in all environments. Even where lucerne does appear capable of drying the soil profile to depth, there is considerable uncertainty about how long the 'dewatering benefit' may last after the recommencement of cropping.

A second way in which the benefits of a perennial can be retained during the cropping phase is companion croppng, whereby crops are direct drilled into an existing perennial pasture. This allows a crop to be sown and harvested without the costs and risks associated with the removal and susbsequent re-establishment of the perennial species. This technology could provide growers with maximum flexibility to move between crop and pasture phases and allows the perennial to continue to control leakage during the cropping phase. This system is most likely to suceed in high rainfall regions.

Both companion cropping and phase farming involve difficult decisions on managing water and nutrients in seasonally variable environments. In companion cropping, there is also competition for water, nutrients and light between crop and pasture species. A mix of field work and modelling (using Agricultural Production System Simulator – APSIM) will be used to determine suitable regions and management practices for these two farming systems.

Research Project Description

Project Title:

Eastern barley agronomy research

(Activity #336)

Principal Investigator:

Dr Neil Fettell & Giles Butler

[Note: this is a collaborative project with the Queensland Department of Primary Industries & Fisheries (John Sturgess – Qld Experimental Leader; and Kym McIntyre - Industry Development Leader)]

Funding Sources:

NSW Department of Primary Industries and the Grains Research & Development Corporation (GRDC Project No. DAN 00028).

Objectives / Expected Outcomes:

1. Achievement of high barley yields at target proteins and faster, more effective adoption of new varieties which satisfy industry quality requirements resulting in a more stable and profitable industry. Better decision making tools for growers and advisers.
2. Agronomic guidelines for new varieties, based on previous year's trials, released to growers and advisors at GRDC Updates, Farming System Group meetings, and in State Cereal Guides and Fact Sheets.
3. Management packages based on several year's trial results and crop monitoring produced for growers and advisors in each region.

Summary:

This project aims to improve the profitability of barley producers in eastern Australia by increasing the production and reliability of supply of barley which meets the quality requirements of the malting, brewing and feed industries. This will be achieved by meeting growers' needs for agronomic information for producing barley of consistent quality, especially in relation to new varieties.

Without changes in management, the improved performance expected from new varieties will not be achieved and protein levels and grain size requirements for malting and animal feed may not be met. This approach proved successful for the introduction of the new variety Gairdner into the central west of NSW. Trials showed that Gairdner differed from the standard variety, Schooner, in sowing time, seeding rate and soil nitrogen requirements. Best agronomic practices, determined using a mixture of field experiments and crop monitoring, have greatly assisted farmers in the adoption of this new variety. By working with farmer groups, sufficient area was sown to produce the tonnage required for local segregation. Other key areas targeted were information on managing grain colour and barley diseases.

The project will continue this work at four "nodes", each linked to variety improvement so that the two are closely integrated. The sites are Hermitage/Toowoomba for southern Queensland, Tamworth for northern NSW, Condobolin for central and south-western NSW and Wagga Wagga for south-eastern NSW. In each region, the agronomic requirements of new varieties and lines close to release will be established. Promising varieties from the Eastern, Southern and Western breeding programs will be included so that information on the local performance of these varieties can be made available to farmers. Field trials will be used to establish their sowing time, seeding rate and nitrogen requirements. Use will also be made where possible of crop monitoring with grower groups to widen the findings from field trials. Agronomic work will be done in conjunction with farming systems groups such as the Eastern and Western groups in the north, and Central West Farming Systems further south.

Research Project Description

Project Title:

Best management practices for profitable oilseed production in low rainfall environments

(Activity #356)

Principal Investigator:

Dr Neil Fettell

Funding Sources:

NSW Department of Primary Industries and the Grains Research & Development Corporation (GRDC Project No. DAN 00011).

Objectives / Expected Outcome:

Better profitability and reliability of winter oilseed production leading to an increase in the area sown to oilseeds in lower rainfall areas.

Summary:

Canola is a minor crop in many low rainfall areas when compared to its production in higher rainfall zones. For example, in 2000 cereal production in the Condobolin district occupied approximately 390,000 ha while the canola area was only 7,000 ha. A profitable oilseed crop would be welcomed by producers but, based on current technology, farmers consider that the crop has a higher risk of failure than cereals.

Preliminary research conducted by NSW DPI in collaboration with Central West Farming Systems has indicated that good economic returns are possible from canola in low rainfall environments. These findings may change the way farmers perceive canola particularly if clear Best Management Practice guides can be produced.

Two areas require further field work to obtain results over a range of seasons and give farmers confidence in the results. The first of these is variety choice, particularly choosing the the most suitable maturity type for a particular area. Current NSW DPI recommendations are that farmers consider short-duration cultivars in lower rainfall areas. However, mid-April sowing is often possible and under these conditions it may be that medium duration varieties will be more successful. In 2000, medium maturity varieties performed very well even when sown in late May. This result may have resulted from the cool, wet conditions in late spring in 2000 and therefore the work needs repeating. Other considerations are the increased frost risk associated with early sowing and the danger of canola seedlings dying due to drought stress under the warmer conditions of early autumn. Further work combined with computer modelling will provide the information to answer these questions.

The second area requiring further work is the place of canola in rotations. Farmers have two options, sowing canola as the first crop after pasture or later in the crop sequence, usually following wheat. The choice depends on several factors: the relative profitability of prime hard wheat vs canola; the extent of broadleaf weed problems; the nutrient status of the paddock; and the value of stored water. Rules of thumb need to be developed (between the amount of water stored in the profile at sowing and performance of canola after wheat) to give farmers confidence that the extra investment in canola is worthwhile. A controlled field experiment combined with modelling is likely to be the most cost efficent way of providing this information.

This project aims to combine existing knowledge with carefully targeted field research and modelling to produce a best management package for low rainfall environments of eastern Australia.

Research Project Description

Project Title:

High water-use farming systems that integrate crops with perennial pastures

(Activity #348)

Principal Investigators:

Brett Honeysett & Dr Neil Fettell

Funding Sources:

The Grains & Research Development Corporation and the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (Program 4, subprogram 7). Funded until June 2006.

Objectives:

This project is exploring ways in which perennials, capable of utilising surplus soil moisture can be successfully integrated into annual farming systems to minimise deep drainage and prevent dryland salinity. This involves evaluating lucerne and other perennial pastures as productive components of crop and livestock systems. We are monitoring soil water use (down to 3m) and production on the Central West Farming Systems (CWFS) trial site, a lucerne companion cropping trial (cereal sown into an established lucerne stand), a phase farming trial at several district sites.

Summary:

Central West Farming Systems Trial (CWFS) 2003

Full scale monitoring began in September 2003, a very dry season. However, the long term effects of the rotations (Conventional tillage, Reduced tillage, Zero tillage and Perennial pastures) could be seen as 2003 marked the first year of the second 5 year rotation for the CWFS core site.

- After 6 years the two rotation systems which include lucerne (CT, RT) contained over 200 mm less soil water (after the pasture phase) than the continuous annual cropping system, in the top 3m of soil.
- Soil moisture contents below 100cm were considerably higher in annual plots

CWFS Site 2004

A very dry start to the year but hopefully the finish will be better. Total rainfall to date is 232 mm (about 50mm below average), much of this in late summer. The plots were sown in June/July with good establishment. The soil profile under the continuous cropping system in June 2004 contained 50 mm more soil water within the crop root zone than the crops sown after 2 or 3 years of lucerne. It will be interesting to see if this variation influences yield.

Companion Cropping Trial

Barley was sown into an established four year old lucerne stand with some plots receiving added N, and chemical suppression of lucerne at critical times to reduce competition. The aim is to see if opportunistic cropping can be carried out into a lucerne stand.

Phase farming trial

Annual crops (wheat, barley and peas) and pastures (medic sub-clover mix) and lucerne were sown in June and water added to some plots. The aim is to measure the rate and depth of water extraction under a wider range of soil moisture conditions than have occurred naturally so far in the years of the project.

Condobolin district sites

We have four properties located around Condobolin monitoring soil moisture and production in a perennial pasture and an annual crop. CSIRO are also monitoring drainage on these sites. Crops were sown June/July with good emergence on most sites. Pasture growth has been very poor to date due to seasonal conditions. Soil moistures in August 2004 indicated a rapidly drying top soil down to 50cm but some moisture at 70cm, possibly stored from the January – February rain.

Research Project Description

Project Title

The response of annual and perennial pastures to lime application in arable duplex soils of SE Australia

(Activity #326)

Principal Investigator:

Dr Guangdi Li & Dr Mark Conyers

Funding Sources:

Project funded by the NSW Department of Primary Industries with financial support from Australian Wool Innovation (1992 – 1997 and 2004), the Grains Research & Development Corporation (1997 – 2002), Acid Soil Action (1997 – 2003), Meat & Livestock Australia (1994 – 1997) and Land & Water Australia (1994 – 1997).

Objectives:

1. Test whether applying lime is profitible for pasture and sheep production (wool and wool/meat enterprises).
2. Test whether perennial pastures are less acidifying than annual pastures.
3. Evaluate effects of lime and pasture types on wool quality.

Summary:

"Managing Acid Soils Through Efficient Rotations" is a long-term experiment commenced in 1992. It was designed to develop and demonstrate a sustainable agricultural system that is economically viable and environmentally effective to manage the highly acid soils in the high rainfall (550 – 800 mm pa) region of south-eastern Australia. With the completion of its second cycle in 2004, a new 6-year cycle started with a slight modification of the original design in autumn. The proposed new cycle are focused on pasture and sheep responses to lime.

The key features for the new cycle are:

- Perennial pasture system versus annual pasture system. There are two types of perennial pastures, one with phalaris, cocksfoot, lucerne and sub-clover mix, the other with phalaris, chicory, lucerne and sub-clover mix. There are two types of annual pastures, one with annual ryegrass and sub-clover mix, the other with annual ryegrass biserrula and serradella mix.
- Limed treatment versus unlimed treatment. Lime will be applied every 6 years as originally designed. Soil chemical data will be collected.
- Pasture and sheep will be managed to maximise pasture and sheep production without degrading wool quality.

At the completion of the project, we will be able to demonstrate a) whether applying lime is profitable on pasture and sheep production (for wool and meat); b) whether perennial pastures are less acidifying and more productive than annual pastures. The outcome from the proposed project will be a comprehensive information package which can be used as a guideline for the wool producers to manage highly acidic soils economically and sustainably in south-eastern Australia. Furthermore, the site will be an excellent demonstration site for extension purposes.

Research Project Description

Project Title:

Managing perenniality in permanent pastures to improve catchment hydrology

(Activity #331)

Principal Investigator:

Dr Brian Dear & **Dr Guangdi L**i

Funding Sources:

Project funded by NSW Department of Primary Industries with financial support from the CRC for Plant Based Management of Dryland Salinity.

Summary:

Deep-rooted perennial pasture plants can play an important role in alleviating environmental problems of rising watertable, dryland salinity and soil acidification in the wheatbelt of southern Australia. Lucerne is the most widely sown perennial legume in cropping areas because it can fix nitrogen and use more water. However, more extensive use of lucerne is restricted by a number of factors including soil acidity, waterlogging, animal health problems and its susceptibility to continuous stocking. A national field evaluation program within the CRC for Plant-Based Management of Dryland Salinity is focussed on identifying new deep-rooted perennial plants to use more water in the soil and reduce deep drainage to the ground water, and salt tolerant species to address environmental problems associated with dryland salinity within the cropping zone of southern and eastern Australia.

There were 135 lines from 53 perennial species in 24 genera being evaluated across 4 States (NSW, VIC, SA and WA). These species were sown into general nursery, waterlogged soil nursery and acid soil nursery.

The general nursery sites were selected in the first phase of the evaluation programme to minimise the effects of soil factors on plant growth, such as soil acidity, waterlogging and low fertility. This was done to promote the establishment and survival of novel plant species, with which most participants had little or no previous experience. Lucerne tended to perform well at most sites. Species showing potential in the general nurseries will subsequently be evaluated on a range of soils where lucerne is less well adapted, in accordance with the initial objective of the programme. Waterlogged and acid soil nurseries are targeted for those more difficult soils.

Research Project Description

Project Title:

Developing new perennial legumes and herbs to reduce recharge in southern NSW

(Activity #330)

Principal Investigator:

Dr Jim Virgona & **Dr Guangdi L**i

Funding Sources:

NSW Department of Primary Industries and the CRC for Plant-Based Management of Dryland Salinity.

Objectives:

1. Assess and classify the potential for increased perenniality by examining the capacity for regeneration of native grasses (especially C4 – summer growing).
2. Investigate practical, low cost, management strategies (grazing, burning, fertiliser, herbicide) that will improve the perenniality in these landscapes.
3. Examine the impact of increased perenniality on critical hydrological characteristics that will allow application beyond the study catchments.

Summary:

This project is applicable to permanent pastures in high rainfall zone (550 – 700 mm) of southern Australia. It is targeted at land classes that are unable to be sown into exotic perennial species, such as lucerne or phalaris, because those areas are too acid and/or too infertile and non-arable. At the first phase of this project, a native grass survey of the relevant parts of the landscape was done to determine the potential for regeneration of native perennial species. This survey covered approximately 60 farm properties in three catchments, Murray, Murrumbidgee and Lachlan catchments.

In the second phase of the project, the focus was on devising management strategies for improving perenniality. The sites were selected to represent a representative range of botanical diversity. The target species were identified and investigated to determine characteristics important for regeneration, i.e., germination, phenology and seed production. Field experiments were conducted to manipulate botanical composition by grazing management, fertiliser management and/or weeds control by spray etc. Climatic factors and changes in soil water content were measured to calculate the water balance at each site.

The outputs that would result from the successful completion of this project are: a) Decision guidelines that would enable landholders to determine what areas have the potential to be improved and provide these landholders with management strategies to increase their native perennial grass component; b) Determination of the prevalence of native grasses in each catchment; c) Increased knowledge of native perennial grasses, their ecology and impact on soil water relations, and d) Suitable landscape management strategies to reduce impacts on salinity in terms of recharge and stream dilution.

Research Project Description

Project Title:

Improving the productivity and sustainability of rainfed farming systems for the western loess plateau of Gansu province, China

(Activity #324)

Principal Investigators:

Dr Guangdi Li, Dr Yin Chan, Dr Damian Heenan, Dr Gordon Murray & Gerard O'Connor

[Note: This is a collaborative project which is being led by Dr Bill Bellotti at Adelaide University]

Funding Sources:

NSW Department of Primary Industries, the Australian Centre for International Agricultural Research (ACIAR Project SMCN/1999//094), Adelaide University and the CSIRO Agricultural Production Systems Research Unit.
[Note: The project commenced in 2001 and was due for completion in December 2004. However, an extension has been granted till July 2005 and requests have been made for a further extension of 18 months.]

Objectives:

1. Develop conservation tillage cropping systems in Gansu, China. (NSW Department of Primary Industries has been mainly responsible for this objective).
2. Develop legume-cereal crop rotations.
3. Analysis of current and proposed new farming systems with the aid of system simulation models.
4. Building the capacity of Chinese staff in all research areas listed above.

Summary:

In the Loess Plateau of northwest China, poor endowment of natural resources and high population pressure combined with unsustainable agricultural practices, have resulted in widespread poverty and degradation of land and water resources. Severe erosion of topsoil is widespread resulting in siltation of the river system particularly the Yellow River and loss of agricultural land.

Two Chinese Institutions, Gansu Agricultural University and Gansu Grasslands Ecological Research Institute, combined with Adelaide University, NSW Dept of Primary Industries and the Agricultural Production Systems Research Unit to conduct this bilateral project with ACIAR funding. NSW Dept of Primary Industries has been mainly concerned with the first Objective.

The field research focuses on two contrasting sites, Dinxi with 400 mm average rainfall with spring wheat the dominant crop and Xifeng with average rainfall of 550 mm and winter wheat the dominant crop. Developing farming systems with reduced erosion potential is of paramount importance. As a result, conservation farming systems with no-till and stubble retention in the paddock are compared with traditional practices where stubble is used in the farm house for fuel and feed for livestock and soil cultivated and harrowed several times. At the lower rainfall site the effect(s) of plastic mulches are also being investigated.

Recently, a final review of the work in China has been very successful. Conservation tillage experiments were successfully established at field stations and more recently on farms. Local farmers around the trials have displayed much interest in the performance of the various treatments. No-till with stubble retention has yielded as much, if not better than, as traditional systems. The work in Australia on reduced early growth under no-till has not been conclusive.

Research Project Description

Project Title:

Acid soil tool – calculation of the payback period for lime application

(Activity #601)

Principal Investigator:

Dr Guangdi Li

Funding Sources:

NSW Department of Primary Industries and Australian Wool Innovation Ltd (AWI Project No. WP217)

Objectives:

To develop an acid soil tool for determining the pay back periods for lime application for annual and perennial pastures under different animal enterprises.

Summary:

The acid soil tool will be developed based on data from a long-term agronomic experiment, known as MASTER experiment, conducted in southern NSW in 1992-2006. MASTER experiment had 8 treatments with 3 main comparisons: a) Annual systems versus perennial systems; b) Continuous pasture systems versus pasture-crop rotation systems; and 3) Limed treatments versus unlimed treatments.

The acid soil tool will determine the pay back periods for lime application for annual and perennial pastures under different animal enterprises, including a self-replacing Merino flock, Merino wethers and prime lamb enterprises in comparison with cropping enterprise. This tool can be used as a guideline for wool growers for making decisions about lime use in the mixed farming systems in the 500-850 mm rainfall zone in southern NSW and northern Victoria.

Research Project Description

Project Title:

Murrumbidgee Grain & Graze

(Activity #390)

Principal Investigator:

Guy McMullen

Funding Sources:

Meat and Livestock Australia, Australian Wool Innovation, the Grains Research & Development Corporation and Land & Water Australia.

Objectives:

1. Increase long term profitability and sustainability of mixed farms in the Murrumbidgee catchment through adoption of whole farm feed budgeting with particular consideration to enterprise mix and protection of the natural resource base, particularly water use, ground cover and biodiversity.
2. Engage, through communication, extension and participation activities, at least 1500 producers in Murrumbidgee Grain & Graze activities between 2004 – 2008.

The project consists of 4 interlinked modules, as outlined below. The primary one in which NSW DPI is involved is the Research and Development Module (b).

Module (a) Landscape zone management: demonstrating natural resource management on farm

Increases in productivity and profitability can be made by more efficient utilisation of the whole farm feed production base. However these increases do not occur equally over the whole farm. Identification and management of more productive areas can generate greater profitability to allow sustainable management of less productive areas. This may include fencing off areas for biodiversity, salinity recharge, water quality or soil health outcomes. Farm-scale demonstrations of this type of 'zone management' in conjunction with local landholder groups can be used to highlight the synergies between improved productivity and protection of the natural resource base, instead of the competition for resource allocation between these factors. They can also be used to demonstrate return on investment in NRM activities which is a key criteria for farmers to adopt sustainable land management practices.

This project links to the Sustainable Agriculture programs of the Murrumbidgee Catchment Management Authority (MCMA). These programs include:

- National Landcare Program (NLP) project titled "Profitable farmers, sustainable systems, healthy landscapes" which involves the establishment of 12 focus farms to apply sustainability programs for different farming landscapes.
- The MCMA project (funded by the National Action Plan – NAP) titled "Developing and implementing BMPs for dryland cropping systems to achieve improved soil and water use", which will use the same 12 focus farms for measuring water use and ground cover throughout the crop and pasture phases.
- A specific NAP project devised by the MCMA to develop natural resource management outcomes parallel to the Grain & Graze objectives.

Use of the same focus farms (and co-operating landholder groups) by the MCMA projects and the Murrumbidgee Grain & Graze project will demonstrate whole-farm sustainability issues and ensure integration of relevant outcomes.

Whilst management changes for increased productivity are usually reasonably easy to measure (e.g., increased yield or liveweight gain) and therefore easier to justify the investment involved, improvements to the natural resource base are less tangible. For growers to adopt natural resource management principles, they need to be able to measure the changes through a series of practical sustainability indices that can be used on-farm. These sustainability indices for the Murrumbidgee region will be developed in the NLP project for use in Grain and Graze outcomes.

Module (b) Research and Development: increasing productivity with grazing wheats & long season annuals

Perennial pastures are a key element of mixed farming systems in the Murrumbidgee catchment, having achieved a high level of adoption as a result of successful, comprehensive research over the last 10 years. However whole farm feed profiles show that there are still gaps in this system in terms of feed availability and utilisation for both autumn and spring lambing/calving enterprises. Grazing wheats and long season annual legumes (from the NAPLIP program) have been identified as 2 management options that could be used in conjunction with perennial pastures to fill these gaps. Whilst

there has already been some adoption of these (particularly wheats), further research is required to ensure they are used efficiently.

With respect to grazing wheats and pasture mixes containing long season annual legumes, there is little information on seasonal dry matter production and forage quality. These are important parameters to have for the range of potential varieties to create feed production curves. Producers can use these curves to pinpoint periods when fodder will be adequate/inadequate/excessive to meet specific stock requirements. Whole farm fodder budgets (e.g., ProPlus) can then be used to determine if or when alternative feed strategies will need to be used. Constant monitoring of wheat dry matter and quality throughout the growing season will also enable the use of Grazfeed to model liveweight gains of different classes of stock at different periods, and compare them with the actual weight gains achieved on large scale plots. This model can be used to determine if feed on offer is adequate, or if alternative or supplementary feed sources are required to ensure livestock requirements are met at all critical stages. This information can then be used in the whole farm fodder budgeting process.

An understanding of water use and ground cover will provide valuable information on the sustainability of the grazing wheat and pasture system. Minimising accessions to the water table through adoption of high water using species will have positive implications for salinity prevention or management on-farm and in the Murrumbidgee catchment, as highlighted in the Murrumbidgee Blueprint referred to below. The water use efficiency of these species can be compared to those of perennial pastures identified in previous research (Dear et al.), to ensure the whole farm feed production system is contributing to improved water use. The identification of systems with high ground cover will also have positive implications on-farm and in the catchment, minimising the loss of nutrients and moisture in run-off, and organic matter through wind erosion. This has been a common problem with traditional dryland lucerne pastures.

In mixed farming systems, a profitable rotation is one that will contribute not only to fodder production, but also grain yield and quality. Determining grain recovery of grazing wheats will help growers select the most profitable option for their system, taking into account financial contribution to both the livestock and cropping enterprises.

Implementing known high water use and high ground cover systems will address one of Grain and Graze's key objectives of 'better water quality', as well as addressing the Murrumbidgee Catchment Authority's targets of 'benchmarking and improving water use efficiency values for crops', 'reducing accessions to saline susceptible areas' and 'develop targeted extension programs to increase groundcover'.

Module (c) Value adding Prograze for sustainable mixed farming enterprises in the Murrumbidgee catchments

At present, inefficient utilisation of the pasture resource results in levels of animal liveweight gain per hectare well below the theoretical potential. The profitability from the livestock enterprises of mixed farms in the Murrumbidgee catchment could be increased by improving the utilisation of this forage base with consideration to protection of the natural resource base. The principle challenge facing farmers in this region is coping with the seasonality of pasture production, in particular filling the winter feed gap and utilising the spring peak, whilst maintaining ground cover and optimising water use. Improving the management of the forage and natural resource base would in part be achieved through improving the skills of mixed farmers in grazing management, fodder budgeting and identification of key sustainability indices (developed in module a). Learning to create a feed profile would enable growers to identify feed deficits or surpluses relevant to their specific animal enterprises, then determine the most appropriate management strategy or combination of strategies to ensure more efficient utilisation. This may mean adopting new technology (e.g., long season annuals) to fill a specific feed gap and provide greater ground cover, or making changes to animal enterprises to better utilise current feed production (e.g., spring lambing). The successful PROGRAZE course would provide the vehicle for this, requiring some addition to the present documentation to further emphasise impact on natural resource issues such as biodiversity, ground cover and water use (using sustainability indices), as well as increasing its relevance to mixed farming enterprises. A physical farm survey would be undertaken at the beginning of the course and after 12 months to highlight changes in both whole farm feed management and natural resource management.

This module addresses the Grain and Graze outcome of 'confident and knowledgeable mixed farmers, making decisions and using management tools which sustain production and promote biodiversity'. It also addresses the Murrumbidgee Catchment targets of 'develop best practice grazing management systems with land managers' and 'develop targeted extension programs to increase groundcover'.

Module (d) Communication module: fact sheets (case studies) and field days

Many growers have already incorporated perennial pastures into their mixed farming systems, helping to alleviate feed budget shortfalls. Many have adopted various management strategies to suit individual enterprises mixes, ensuring feed supply meets livestock demand. Presenting these strategies as case studies, in one-page fact sheets disseminated to other growers, will help increase further adoption of these management strategies, as will dissemination of the original research findings to highlight other advantages such as water use, nitrogen input and disease carry over. Case studies where growers have been able to lock-up land for species preservation as a result of better feed utilisation elsewhere will also be highlighted, as will instances of reduced recharge from the use of perennial pastures.

Fact sheets will be used to disseminate results from the R&D module as they emerge to ensure a continuous information flow. They can be used as learning aids in Module c.

The communications module will also consist of regular updates, via field days and seminars to inform growers of results from the R&D trials. Sessions will also be held to demonstrate the use of Grazfeed to determine livestock performance of particular feed sources, as well as demonstrating and highlighting the use of whole farm fodder budgeting (ProPlus).

The communications module will help achieve the Grain and Graze outcome of ‘confident and knowledgeable mixed farmers’. They will address the Murrumbidgee Catchment’s targets of ‘increase the adoption and extent of perennial pastures’ and ‘rotate cropping with perennial pastures’.

NB. Modelling the impact of mixed farming production systems on the natural resource base in the Murrumbidgee catchment will be undertaken during the project. It is understood this will be co-ordinated by the national Grain and Graze project using models identified by the management committee and initiated at a later stage.

Research Project Description

Project Title:

Whole farm salinity management strategies for cotton production in the Macquarie Valley

(Activity #374)

Principal Investigator:

David Mitchell

Funding Sources:

NSW Department of Primary Industries and the Cooperative Research Centre for Sustainable Cotton Production.

Objectives:

1. Identify crop, fallow and water management strategies, which will reduce the rate of deep drainage and shallow water recharge.
2. Assess whole farm salt balance strategies that limit the impact of using poor quality for irrigation water.
3. Use the information acquired in aims 1 and 2 to leverage funds from other funding areas by development of a detailed research proposal.

Summary:

All irrigation water contains salt, and when this water is added to the root zone to grow crops, the water is extracted by the plants and the salt is left behind. How irrigators manage the salt remaining in the rootzone will have a direct effect on the life of the irrigation enterprise. The only feasible way of managing this salt is by flushing the salt down the soil profile by application of more irrigation water than the plant needs. This extra water is called the leaching requirement and is related to the salt content of the irrigation water and the salt content of the rootzone soil.

If there is too much leaching (deep drainage), then a watertable may develop, but if there is insufficient leaching then salinity will occur. A balance is needed between excess water draining below the root zone and a build up of salts in the root zone. This balancing act requires development of management options at a whole farm level to manage salinity.

The evidence of deep drainage under irrigated conditions in the Macquarie Valley is contained in Brereton (1996) “Groundwater conditions for the irrigated lands between Narromine and the Macquarie marshes” which reported two groundwater mounds present in the Lower Macquarie valley, one north of Narromine and another south east of Warren. This evidence of salinity is combined with the very high salinity risk assessment of the Backwater–Boggy Cowal system in the “Salinity strategic plan for the central west catchment” (Humphries 1999, DLWC). This sub catchment encompasses the majority of the irrigated area south of the Macquarie Valley between Narromine and Warren.

Historically in the Australian cotton production areas, salinity has always been seen as a localised issue that did not pose any major threat to production. However research over the last ten years, has begun to challenge this perception. Over the next ten years, salinity has the potential to have a significant effect on cotton production in the northwest. High-risk areas are the Macquarie, Lower Namoi and Bourke districts.

Gaps identified in current salinity research and extension activities include; monitoring of whole farm water and salt balance, linking of water quality to crop and salinity management, economic impact assessment and the development and promotion of BMP guidelines for cropping systems that minimise salinity. Specific water balance research is being planned within the Australian Cotton CRC, and this project aims to complement this work by focusing on salinity management and whole farm salt balance.

Methods

Five long term monitoring sites were established on major irrigated cotton growing soils in the Lower Macquarie Valley. Deep drainage and changes to salt store were determined for the five sites by solute mass balance (Slavich 1992, Willis 1995, Friend 2000, Weaver et al. 2004) (table1). Over the 2003 – 04 irrigation season deep drainage was higher under meander plain soils (red soils) than compared to the back plain soils (grey soils). There was an increase in the soil salt store over all sites. The highest increase in the salt store came from a site that used moderately brackish water. This site had an 3.5 t/ha increase in the soil salt store over one irrigation season. Soil cations were measured at the five sites which enabled the effect of irrigation on the exchangeable sodium percentage of the soil. From the initial analysis it appears that irrigation may increase the risk of sodicification on the meander plain soils. There does not appear to be such a risk on the back plain soils.

Future research directions

An additional post winter soil sampling has been completed. The soil will be analysed for EC and chloride. Additional data analysis will be undertaken particularly documentation of cropping history on the five sites.

Additional funding will be sought from CW CMA to continue the understanding of the salt and water dynamics under irrigated farming systems in the Macquarie Valley. Particular emphasis will be placed on establishing the effect of irrigation water on the sodium levels on the meander plain soils irrigated with lower quality water.

Detailed results of the study have been distributed to the five co-operators, and result summaries will be distributed amongst the cotton industry in the Macquarie Valley.

Research Project Description

Project Title:

Western Farming Systems Project – NSW Agriculture Component

(Activity #375)

Principal Investigator:

David Mitchell

Funding Sources:

The Grains Research & Development Corporation.

Objectives:

1. Enhance the economic and environmental performance of grain-based farming systems in the NSW northwest agro-ecological zone identifying opportunities for, and resolving constraints to, the implementation of more profitable and sustainable farming systems.
2. Evaluate the performance of new farming systems with respect to whole farm profitability; on farm ecological sustainability; and off farm environmental and community impacts.
3. Monitor changes in the knowledge, awareness, skills and attitude of key stakeholders, leading to an improvement in the performance of commercial grain enterprises.

Summary:

The project consists of two core sites; one at Cryon 50 km west of Walgett and one 10 km east of Coonamble. Three farming systems were established in 1996 at each site; continuous cropping, legume pasture to cropping, grass pasture to cropping.

In each of the three farming systems there were a number of cropping systems; for example continuous cereal, pulse/cereal, opportunity cropping. Most treatments were zero till, with all treatments were split plus or zero nitrogen.

The project uses participatory research methodology, this involves farmers, agri-business and research staff at all stages of the project. The project was started in 1996 and farmers, agri-business and research staff decided on the crop rotations as well as what depth of soil moisture was required to allow planting of the rotations. Parameters such as starting moisture and nitrate are measured as well as yield and grain quality.

Project participants meet regularly through the growing season to discuss the effect of crop choice, fertilizer and tillage on the yield, quality and gross margin of the faring systems.

The initial project aim was to provide an improvement in the performance of grain-based farming systems in the NSW northwest agro-ecological zone by 2003. A phone survey will be conducted that will interview approximately 200 grain growers in the area to assess the effect of the project on grain based farming systems. This will include a general (but quantifiable) advancement in the knowledge, awareness, skills and attitude of key stakeholders, leading to an improvement in the performance of commercial grain enterprises; and the development of new farming systems that are likely to deliver further advances in the performance of grain-based farms in the zone, during the period 2003 – 2010.

The gross value of production (GVP) of the grains industry in the Western Farming Systems district of northern NSW is around $200 million per annum. Results from the established research sites in phase I of the project showed increases in cumulative gross margins of up to 30 per cent by moving from continuous cereal to rotations including pulses or canola. This improvement is largely the result of reduced disease, increased nitrogen and water use efficiency leading to increased wheat yield and protein. Assuming an increase of 50 percent in adoption it is anticipated (based on results so far) that improved rotations and tillage practices will increase the GVP for grains in the WFS zone by up to 15 percent or $30 million per annum.

Research Project Description

Project Title:

Tools to reduce the impact of climate variability in South Eastern Australia

(Activity #408)

Principal Investigator:

Dr De Li Liu

Funding Sources:

NSW Department of Primary Industries and collaboration with the Victoria Department of Primary Industries through the Grains Research & Development Corporation.

Objectives:

1. Identify and quantify the risks associated with management options available to growers, in relation to climate variability by using crop simulation models.
2. identify and quantify the impact and suitability of management options to reduce the incidence of climate risks.
3. Evaluate existing forecasting systems for seasonal rainfall and temperatures.

Summary:

Rainfall variability and frost damage are the major sources of yield fluctuation in dryland crops in south-eastern Australia (SEA). Winter crop production in the region varied up to 7 fold as a consequence of climate variability, particularly drought and frost. Yield losses due to frost vary from 5 to 35% in New South Wales and from 5 to 50% in Victoria, depending on severity and timing. Although there are no accurate figures available on the value of production lost to frost, an extensive frost causing a direct yield reduction of only 5% on 1 farm in 5 in New South Wales, South Australia and Victoria would represent a financial loss of more than 34 million dollars p.a. at current prices.

Although climate variability is inherent in dryland farming, the management of climate risk in SEA grain farming systems can be improved significantly. In SEA, where the lack of reliable summer cropping alternatives reduces the options to spread risk, annual farm cashflow is more likely to be diminished in poor seasons. Furthermore, the many subsoil limitations and generally lighter soils mean that growers are less able to buffer their crops with stored soil water. In this poorly buffered system, growers face a delicate balance whereby early sowing would help to avoid moisture stress in spring but would increase the risk of frost damage at other critical stages.

This project is developing a Climate Variability Analyser (CVA) to facilitate the analysis of climate variables including number of frost days, heat stress, seasonal rainfall and the break of season for sowing, in conjunction with seasonal forecasting. CVA can be used to evaluate forecasting systems using cross validation and reliability plots. In NSW, a regular leafsheet named “Weather or not” is produced for farmers through the project.

Research Project Description

Project Title:

Decision support systems for avoiding frost damage through reliable prediction of time to flowering for wheat and barley in NSW

(Activity #410)

Principal Investigator:

Dr De Li Liu

Funding Sources:

NSW Department of Primary Industries and residual funds from a consultancy income from National Land & Water (Audit Theme 5, Project 4C).

Objectives:

To model plant production systems and associated processes and to conduct experiments to provide data to define particular parameters for functions used in the phenology models.

Summary:

Each year in Central and Southern NSW wheat farmers are faced with having to wait for planting rains and so the sowing opportunity varies from early April to late July. Subsequently, decisions on variety by planting time by frost risk are key decisions in the farming system. Data collected in this project over a number of years will greatly enhance our understanding of plant /environment interactions to assist in minimising such risks.

This project will conduct phenology trials (time of flowering) throughout central and southern NSW using the existing District Agronomist network. District Agronomists in conjunction with Technical Assistants (where available) will be responsible for securing land approximately (12m x 12m) and labour to conduct the phenology trial consisting of 5 planting times, 30 entries. 50 seeds will be supplied for each entry for each sowing time, which should be sown by hand in 1- metre rows with about 30 cm row spacings between entries. Once sown, emergence date will be recorded along with any other relevant observations. Later, full head emergence will be recorded for each entry together with planting time and minimum temperatures (on day of visiting site), using the max-min thermometer supplied.

At the end of flowering of all entries and sowings, all recordings of flowering date along with other observations will be made available to the project supervisor. This will be accompanied by the meteorological weather data (year of trial) from the nearest meteorological station for the period from planting to maturity ego (March – November).

Computer software will be developed to help farmers to select crop, variety and sowing dates, and to assess the risk of frost and estimate yield. The software will be based on the SOWMAN, a prototype developed based on an experiment conducted at Wagga Wagga. The software will be windows basis.

Research Project Description

Project Title:

Optimising the quality and yield of spelt and other specialty grains under organic production

(Activity #458)

Principal Investigator:

Robyn Neeson, Helen Allen, Dr Jeffrey Evans and Dr David Luckett.

[Note: This is a collaborative project with the Department of Natural Resources & Environment, Victoria and Grower Cooperators]

Funding Sources:

NSW Department of Primary Industries and the Rural Industries Research & Development Corporation (RIRDC UCS-38A)

Objectives:

Improve the supply and quality of organic spelt (*Triticum aestivum* var. *spelta*), Kamut® (*Triticum turgidum*) and cereal rye (*Secale cereale*) by selecting superior lines of spelt for organic production and developing a preliminary agronomic package for spelt production.

Summary:

With the increasing awareness of the link between diet and health, there is growing demand for specialty grains and their products within the health food sector. It is claimed that specialty grains such as spelt, cereal rye, and Kamut® exhibit superior nutritional attributes to other more common cereals such as wheat. It is these nutritional claims that have sparked the greatest interest, particularly in the health food sector. The greatest demand is for organically produced specialty grains; however, supply constraints are frustrating industry expansion. This is largely being attributed to low producer confidence due to lack of locally adapted varieties, relevant agronomic information and market irregularities.

This project aims to identify potentially new and more reliable cultivars of spelt that are better adapted to organic production. Greater confidence in organic production requirements and techniques for these grains will lead to a more sustainable organic grain industry that is better able to expand to its market potential. The project consists of 8 experiments which will be conducted in three areas: i. Genetics, ii. Crop Nutrition, and iii. Agronomy. The project will determine improved agronomic information on optimal sowing dates, sowing rates and P requirement to optimise the yield and quality of spelt, Kamut® (khorasan wheat) and cereal rye. This information will provide producers (organic and conventional) with alternative cropping and market opportunities for marginal cropping zones (soils of low nutrient capacity).

Outputs of the project will aim to improve the supply and quality of organic spelt by:
- Selecting superior lines of spelt for organic production
- Producing production guidelines for spelt production.

Research Project Description

Project Title:

Improving lucerne performance for acid soils

(Activity #332)

Principal Investigator:

Dr Brendan Scott

Funding Sources:

NSW Department of Primary Industries and the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (Part of CRC Project No. RE310 (P3 SP5 Auricht)).

Objectives:

Significantly increase the area of lucerne in the dryland farming regions of Australia by improving performance on acid soils. This to be achieved by:

- Developing a screening method for selecting lucerne plants tolerant to acidic soils containing aluminium.
- Selecting plants which outperform existing options in acid soils.

Summary:

Lucerne is currently the only perennial legume proven to restore a hydrological balance in the dryland agricultural regions of Australia (average annual rainfall, 300 – 550 mm). Lucerne is adapted to the climate and farming systems of much of this area, however performance of existing cultivars is seriously impaired in strongly acidic soils. Acidity impacts on a number of aspects of lucerne performance covering both the plant, the nodulating strain of Rhizobium, and the symbiotic relationship between the two. There may be scope for improvement.

The opportunity exists to select lucerne plants which exhibit better root growth in acidic soils with toxic concentrations of aluminium, and to use these plants to produce improved cultivars. Commercial release of improved cultivars will see wider use of lucerne and important benefits from this deep rooted species in the use of deep soil moisture. Another part of this project, based in WA and SA, is seeking improved rhizobia for lucerne when grown on acidic soils.

The project is linked to the SARDI lucerne breeding effort and the NSW Agriculture breeding effort at Tamworth.

A method of screening was developed using annual Medicago species. The method of screening was to grow plants for 3 days on floating rafts in a tank on a laboratory bench. A nutrient solution was used and pH was maintained at 4.3 by daily correction. After3 days the plants were exposed to a "pulse" of Al at 75 mM of Al. This exposure had the potential to kill the growing point of the root. Roots were then stained, rinsed in deionised water and placed in new "recovery" nutrient solutions at 10 mM Al. After 3 more days in the "recovery" solution the roots were inspected and new unstained root growth was measured. The results of the seven day solution culture screening test have been compared to the growth of annual Medicago in an acidic soil. About 60% of the variation in the glasshouse soil experiment was accounted for by the 7 day laboratory screening test. The screening method was then applied to lucerne populations.

The screening test has been used on 11 cultivars and breeders lines of lucerne, and plants selected for their root growth under aluminium stress. Between 2 and 4 % of plants have been selected within each line, then transplanted into pots and later transferred to the breeding programs in Adelaide and Tamworth. Seed from the selected plants was compared to the original unselected population in the 7 day test. Selection improved the root growth under the conditions of the test in all four populations compared. This demonstrated that the character was heritable, and could be used in a breeding program. While the test has not been evaluated in soil with lucerne, our experience with the annual medics suggests that we have improved the aluminium tolerance, and hence acidic soil tolerance, of lucerne.

Research Project Description

Project Title:

Permanent beds for irrigated rice-wheat and alternative cropping systems in north-west India and south-east Australia

(Activity #388)

Principal Investigator:

Geoff Beecher, **Rajinder Singh** & **John Thompson** .

[Note: This a collaborative project with CSIRO Land & Water (Dr Elizabeth Humphreys) and the Punjab Agricultural University, India (Dr Y. Singh)]

Funding Sources:

NSW Department of Primary Industries, Australian Centre for International Agricultural Research, the Grains Research & Development Corporation and the Cooperative Research Centre for Sustainable Rice Production (Project No. CRC 2001-06).

Objectives:

1. To identify potential benefits of permanent beds over contour layout.
2. To evaluate alternative irrigation methods for rice based cropping systems on beds.
3. To identify cropping flexibility options with permanent beds and different irrigation systems.

Summary:

Permanent beds are an alternative layout for growing rice, compared to the traditional flat bed system. This project is investigating the use of permanent beds to improve the productivity, profitability and sustainability of irrigated rice-wheat (RW) cropping systems in north-west India, and the cropping systems in the rice-growing areas of southern Australia. Permanent beds (a paddock layout where the cropped zone and the irrigation furrows are distinctly and permanently separated) are a radical change from conventional flooded and puddled rice systems traditionally used on a flat layout. These traditional systems can be detrimental to the growth of post-rice crops, and consume enormous amounts of energy in terms of tilling the land when switching between crops.

There may be significant advantages from growing rice on raised (permanent) beds. Raised beds greatly improve surface drainage for both rice and other crops in a rotation, leading to improved plant establishment and yield of crops grown after rice. There is also increased crop flexibility due to the ability to grow more plant species that are sensitive to waterlogging. Water use efficiency from a permanent bed cropping system and potential for double cropping with this system should be increased while the groundwater recharge should be decreased.

As part of this project team, I do economic analysis to estimate the potential financial, economic, environmental benefits arising from converting to this new rice farming system and look at the costs of conversion to permanent beds from different existing irrigation layouts. I also estimate the returns on the R&D investment in this research by incorporating the total costs involved in research and extension and the flow of benefits from the new technology.

Research Project Description

Project Title:

Maximising returns from water for Australian vegetable crops

(Activity #391)

Principal Investigator:

Mark Hickey & **Rajinder Singh**

Funding Sources:

Horticulture Australia Limited.

Objectives:

1. To describe crop types, major irrigation systems used and systems performance.
2. To identify irrigation problems that effect yield and quality.
3. To identify major constraints to production e.g., salinity, water access and quality.
4. To analyse the impact of different irrigation technologies and management strategies that help to improve productivity and environment.

Summary:

In Australia all of the 132,000 hectares of vegetable crop worth in excess of $1.8 billion is irrigated. Currently there is a transition from flood/furrow irrigation (where the crop is surface irrigated across the total soil surface or by furrows between permanent beds) to drip irrigation (where the crop is irrigated by use of plastic tubing which has drip emitters located frequently along the tube which may be located on the surface or buried in the cropping bed). This is occurring across perennial and annual horticulture in most irrigated regions. The aims of this research project are to analyse the existing irrigation delivery and management options together with scoping of the new technologies to assess their applicability to the vegetable industry.

The economic analysis will conduct in-depth case study gross margin analysis into 5 key crops (lettuce, sweet corn, broccoli, carrots and greenhouse cucumber) selected from the major production regions of Australia and conduct a benefit/cost analysis of conversion from existing systems like furrow and overhead sprinklers to more efficient irrigation systems, like drip irrigation.