CURRENT RESEARCH PROJECTS

– NORTHERN FARMING SYSTEMS –

(Last updated 3 October 2007)
## CONTENTS

Eastern Farming Systems (Phase II) – a partnership for participatory research, development and extension in the north eastern grain belt ........................................................................................................ 3  
(Activity #335) ........................................................................................................................................................................ 3  
Giles Butler (NSW Leader) .................................................................................................................................................. 3  
Barley improvement for the Grains Research & Development Corporation Northern Region ................................................................................................................................. 4  
(Activity #337) ........................................................................................................................................................................ 4  
Giles Butler (NSW Experimental Leader) ........................................................................................................................................ 4  
Weed competition in chickpea, faba bean, canola and wheat .................................................................................................. 5  
(Activity #378) ........................................................................................................................................................................ 5  
Warwick Felton ........................................................................................................................................................................ 5  
Eastern Barley Agronomy Research ........................................................................................................................................... 6  
(Activity #336) ........................................................................................................................................................................ 6  
Dr Neil Fettell & Giles Butler ......................................................................................................................................................... 6  
Impact and role of novel insecticides in integrated pest management (IPM) ................................................................................ 7  
(Activity #380) ........................................................................................................................................................................ 7  
Viliami Heimoana ....................................................................................................................................................................... 7  
Farming systems research for crop diversification in Cambodia and Australia ............................................................................ 8  
(Activity #310) ........................................................................................................................................................................ 8  
Dr Bob Martin ............................................................................................................................................................................. 8  
Diseases of cotton VIII ................................................................................................................................................................. 9  
(Activity #311/342) ................................................................................................................................................................... 9  
Dr David Nehl ........................................................................................................................................................................... 9  
An assessment of the economic impacts of NSW agriculture research and extension: Conservation farming and reduced tillage in northern NSW ........................................................................................................ 10  
(Activity #344) ........................................................................................................................................................................ 10  
Fiona Scott & Dr Bob Farquharson .............................................................................................................................................. 10  
Management of Fusarium diseases and common root rot of cereals in the northern cropping zone ......................................... 11  
(Activity #345) ........................................................................................................................................................................ 11  
Andrew Verrell, Dr Steven Simpfendorfer & Dr Kevin Moore .................................................................................................. 11  
More profitable chickpeas through disease management – northern region ............................................................................ 13  
(Activity #346) ........................................................................................................................................................................ 13  
Andrew Verrell & Dr Kevin Moore ........................................................................................................................................... 13  
Direct and indirect measurement of deep drainage in north western NSW cracking clays ......................................................... 14  
(Activity #385) ........................................................................................................................................................................ 14  
Richard Young ........................................................................................................................................................................... 14  
Direct measurement of deep drainage below the root zone ....................................................................................................... 15  
(Activity #386) ........................................................................................................................................................................ 15  
Richard Young ........................................................................................................................................................................... 15  
Collaborative recharge validation project – northern NSW site .................................................................................................. 16  
(Activity #387) ........................................................................................................................................................................ 16  
Richard Young ........................................................................................................................................................................... 16  
Carbon sequestration under summer/winter response cropping in north western NSW ............................................................. 17  
(Activity #495) ........................................................................................................................................................................ 17  
Richard Young and Dr Brian Wilson ........................................................................................................................................ 17  
Mobilisation of 100 tonnes of salt/ha under cropping in north western NSW – a threat to agricultural and natural ecosystems? I & II ................................................................................................................... 18  
(Activity #534 / 535) ................................................................................................................................................................. 18  
Richard Young ........................................................................................................................................................................... 18
Research Project Description

Project Title:

Eastern Farming Systems (Phase II) – a partnership for participatory research, development and extension in the north eastern grain belt
(Activity #335)

Principal Investigator:

Giles Butler (NSW Leader)

[Note: This is a collaborative project with the Queensland Department of Primary Industries & Fisheries (Mr David Lawrence – QDPI&F leader and overall EFS leader), the Queensland Department of Natural Resources, Mines & Energy (Dr Geoff Titmarsh – QDNRMME leader), and the CSIRO (Dr Peter Carberry – CSIRO leader)].

Funding Sources:

NSW Department of Primary Industries, the Queensland Department of Primary Industries and Fisheries, the Queensland Department of Natural Resources, Mines & Energy, the Commonwealth Scientific & Industrial Research Organisation and the Grains Research & Development Corporation (GRDC Project No. DAQ00050).

Objectives:

1. Priority Farming Systems themes for the project identified through a partnership of the project team, farmers and agribusiness in the region.
2. Greater participant understanding and insights developed from participatory on-farm research on priority farming systems themes identified in the project.
3. Greater participant understanding and improved management decisions resulting from the development and use of action learning activities on priority farming systems themes identified in the project.

Summary:

The Eastern Farming Systems project (EFS) relies heavily on the involvement of farmers, agribusiness and relevant Research Advisory Committees (RACs) in the planning and conduct of on-farm research. EFS began in July 1997 and has demonstrated the value of participatory Farming Systems Research in the higher rainfall zone of the northern grains belt – roughly delineated as east of the Newell and Leichhardt highways in northern NSW and southern Queensland.

Phase I of the project generated new scientific knowledge, instigated changed farming practices, and improved research, development and extension processes. The field research program ranges from paddock monitoring and data collection to on-farm replicated experiments using farm scale equipment. Data collected from farmers’ fields are used to validate the Agricultural Production Simulator (APSIM) a model that can extrapolate and generalize the findings. The second phase is continuing with these initiatives, but will also place greater emphasis on the diffusion of research findings beyond the research locations.

The vision for Phase I was that farming systems practiced in the north-eastern grain belt would benefit from farmers, advisers and researchers together exploring options for improved economic and environmental sustainability. This vision, the mandate area, types of research issues addressed and participative processes of the initial EFS project remain highly relevant and are again proposed for the second phase.

Phase II will concentrate on addressing 3 – 4 priority Farming Systems themes each year as negotiated and reviewed with industry and the project team. RAC representatives on the management committee will ensure the relevance of these themes to the region. Phase II will produce Action Learning Modules (ALMs) to address priority systems issues. ALMs are designed to enhance participants' understanding of priority issues and consequently improve their management with more informed decision making. ALMs will help farmers to "navigate" through the available information, to understand it, and apply it to their own "real-time" farm decisions. This will help EFS Phase II bring technical issues to life for growers and ensure activities go beyond simply creating awareness.
**Research Project Description**

**Project Title:**
Barley improvement for the Grains Research & Development Corporation Northern Region  
(Activity #337)

**Principal Investigator:**
Giles Butler (NSW Experimental Leader)

[Note: This is a collaborative project with the Queensland Department of Primary Industries & Fisheries (QDPI&F) (David Poulsen – Breeder and overall project leader; Glen Fox – Grain Quality Leader; Greg Platz – Pathology Leader; Kym McIntyre – Industry Development Leader; and Emma Mace – Biotechnology Leader)]

**Funding Sources:**
NSW Department of Primary Industries, the Queensland Department of Primary Industries & Fisheries and the Grains Research & Development Corporation (GRDC Project No. DAQ00038).

**Objectives:**
1. Greater productivity, stability and market demand for barley in the Qld/NSW grain growing, intensive livestock and malting/brewing industries through delivery of i) improved feed and malting barley varieties and ii) information for use in managing the value chain.
2. A highly effective research and extension team with the intellectual capacity and resources to deliver an integrated regional barley improvement program for Eastern Australia with national linkages.
3. Extension of agronomy, pathology and quality information to support decision making and market development in the grain growing, intensive livestock and malting/brewing industries.

**Summary:**
This project is an integrated barley improvement program for the GRDC Northern Region. It combines coordination, breeding, pathology, quality and industry development. The strong linkage between the QDPI&F and NSW DPI developed for the existing Northern Barley Improvement Program will continue in this project.
Research Project Description

Project Title:
Weed competition in chickpea, faba bean, canola and wheat
(Activity #378)

Principal Investigator:
Warwick Felton

Funding Sources:
NSW Department of Primary Industries and the Grains Research & Development Corporation (Project No. DAN 465).

Objectives:
1. Determine yield loss caused by weeds in chickpea, faba bean and canola compared to wheat.
2. Investigate the effect of row spacing on yield in weed competition trials.
3. Investigate fertiliser placement in weed competition trials in order to improve the crop competitiveness against weeds.
4. Determine the critical stage in the growing season that weeds must be sprayed in order to maintain optimum crop yields.

Summary:
Experiments at Tamworth in 2001, 2002 and 2003 with chick pea, faba bean, canola and wheat sown at row spacings of 32 and 64 cm examined competition by "weeds" at densities of nil, 3, 9, 27 and 81 /m². Triticale was used as a mimic weed to simulate competition by wild oat. Using mimic weeds in competition or weed control experiments provides more uniform weed treatments than can usually be obtained by sowing actual weeds, or using naturally occurring weed populations. The technique means paddocks do not become contaminated with real weeds, and weeds not wanted can be removed by spraying without compromising the experiment. The heads of the mimic weeds can be removed before the grain of the weed is set allowing easy harvest of the treatments, and contamination of the crop grain sample is avoided. Weeds were more competitive in chickpea than faba bean and canola, and least competitive in wheat. However, differences varied between years.

More and more farmers are planting crops in wider rows because there is less chance of the no-tillage planter machine being blocked by residues of the previous crop. Also, wider rows make it possible to apply agricultural chemicals in bands between the crop rows. This enables a wider range of options as well as reducing the overall amount of chemical applied to the field. In weed-free treatments, wide row spacing did not reduce the yield of chickpea, faba bean or canola. Wide rows reduced wheat yield in 2002 and 2003. However, weeds are more competitive in wider rows and farmers must be more diligent to effectively control weeds in this system.

The time of removal of weeds can be an important decision for the grower. If a selective herbicide is applied early, weeds that germinate after the application will continue to grow and compete with the crop. An experiment was carried out where a herbicide was applied to control the weeds in a chickpea crop at 5, 7, 10, 13, 16 and 19 weeks after sowing. There was no significant loss in chickpea yield until spraying was delayed to 13 weeks after sowing with 27 weeds /m² and 16 weeks with 9 weeds /m². Therefore it is feasible to delay post-emergence herbicide application until 8 – 10 weeks after sowing.
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. DAN000028).

Objectives:
1. The 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:
Impact and role of novel insecticides in integrated pest management (IPM)
(Activity #380)

Principal Investigator:
Viliami Heimoana

Funding Sources:
NSW Department of Primary Industries and the Cotton Research & Development Corporation (Project No. DAN 160C).

Objectives:
1. Research the efficacy of new insecticides for controlling Helicoverpa species in cotton.
2. Evaluate the impact of these insecticides on other pests and beneficial insects.
3. Evaluate the efficacy of new insecticides for controlling aphids in cotton.
4. To evaluate the impact of these new insecticides on other pest and beneficial insects.
5. Assess the most appropriate positioning of these new insecticides in the cotton crop protection IPM strategy.

Summary:
Transgenic cotton varieties such as Ingard® and Bollgard® II were developed by inserting genes from the soil bacterium Bacillus thuringiensis (Bt) into cotton. These genes produce proteins that are toxic to the main insect pest of cotton – the cotton bollworm (Helicoverpa). When the caterpillars eat the Ingard® or Bollgard® II cotton they die. The introduction of transgenic cotton has reduced the overall volume of insecticide application in cotton. However, it is anticipated that insecticides will continue to play a significant role in pest management in the cotton industry. Transgenic cotton still needs Helicoverpa protection late in the season and protection from secondary pests throughout the season. The secondary pests become more important as the moderating effect of Helicoverpa sprays on these pests is delayed.

Recently the industry has been at risk of losing some of the insecticides registered for cotton due to resistance build-up or environmental problems. There are also chemicals which are not recommended for use due to their negative effect on beneficial insects and the consequently adverse effects on the IPM strategy. IPM by definition is "The utilisation of all available resources to achieve the most sustainable, economical, practical, and effective solution to control a pest population". One of the IPM options is to find new pesticide chemicals that can be used for pest management in cotton that satisfy the requirements described above. This project allows timely independent assessment of the claims of chemical companies as to the impact of new chemicals on target pest and beneficial insects under Australian conditions.

The chemicals tested are either newly registered or yet to be registered insecticides and, for Helicoverpa, include amorphous silica, azadirachtin, novaluron, indoxacarb, methoxyfenocide, phenyl ether derivative and semicarbozone. For aphid control they include acetamiprid, carbofuran, chlothianidine, imidacloprid, pymetrozine, pyriproxifen, thiamethoxam and a PSO/Carlton oil mixture.

The ‘old’ and ‘new’ insecticides are tested under experimental conditions on non-transgenic and transgenic cotton in the field. The results of this research provide essential data that will assist in placement of these insecticides in the Integrated Pest Management (IPM) and Integrated Resistance Management (IRM) programs. This will provide regular field monitoring of the efficacy or resistance stage of these insecticides on the target pest and their effect on other pest and beneficial insects.
Research Project Description

Project Title:
Farming systems research for crop diversification in Cambodia and Australia
(Activity #310)

Principal Investigator:
Dr Bob Martin

Funding Sources:
NSW Department of Primary Industries and the Australian Centre for International Agricultural Research (ACIAR Project No. ASEM/2000/109).

Objectives:
1. Identify and overcome constraints to the adoption of non-rice upland crops in Cambodia and non-cereal crops in north-western New South Wales by analysis of on-farm data and experimentation.
2. Develop simple diagnostic and analysis tools that farmers and advisers can use to monitor the performance of their crops and how they fit into the farming system.
3. Produce appropriately packaged technical and financial information.

Summary:
The overall goal of this project in Cambodia is to contribute to food security at household and national levels through the development of technologies and opportunities for the production of non-rice upland crops. In Australia the overall goal is to overcome the constraints to crop diversification and adoption of sustainable practices in north-western NSW.

In Cambodia, the focus crops are upland maize, soybean, mungbean, peanut, cowpea and sesame and in Australia the focus crops are dryland chickpea, faba bean and canola. We identify constraints to crop diversification by asking the farmer, taking samples and measurements from his fields, from literature and from scientific investigation. We survey farm households to understand the farming systems practised, utilisation of farm resources, and the potential for improving both yield and productivity.

Our field experiments draw on scientific knowledge and on consultation with extension workers. The focus of field research is: evaluation of varieties; resistance to insect pests and diseases; time of sowing and seeding rates; crop rotations; reduced tillage to conserve soil moisture and soil structure; and Rhizobium inoculation of the legume crops (Rhizobium bacteria form nodules on the roots of legumes and supply the plants with nitrogen fixed from the atmosphere).

Cambodia experiences a monsoonal climate with distinct wet and dry seasons. During the wet season, rainfall is extremely erratic and ‘mini’ droughts can occur at any time – exposing cash crop farmers to risk. The highly variable climate of Australia’s northern cropping zone also exposes farmers to risk. We are developing a spread-sheet based decision support system “Crop-choice”. Crop-choice will combine climate data, paddock data, scientific knowledge and economic and marketing information to help the farmer make more profitable and sustainable decisions.

The project is developing a diagnostic ‘tool kit’ that Cambodian advisers and farmers can use to reduce the risk of growing upland crops. These can be as simple as rain gauges, pH kits, push probes to estimate the depth of wet soil, and testing of seed viability. These kits will include photographs to assist with the identification of insect pests and diseases. We will also provide training to advisers on gross margin analysis (income – variable costs). The final products of the project will be a series of “Agfact” extension publications to enable the knowledge to be disseminated to farmers in areas beyond the study range.
Research Project Description

Project Title:

Diseases of cotton VIII
(Activity #311/342)

Principal Investigator:

Dr David Nehl

Funding Sources:

NSW Department of Primary Industries and the Cotton Research & Development Corporation (CRDC Project No. DAN177C).

Objectives:

1. Monitor the distribution and importance of all diseases in cotton and identify environmental and cultural factors influencing the emergence or re-emergence of disease threats.
2. Continue to develop and/or evaluate control strategies for Fusarium wilt, Verticillium wilt, and seedling diseases of cotton, (e.g., seed treatment fungicides, induced resistance, rotation crops, biofumigation crops, cover crops, late sowing with BollgardTM).
3. Conduct investigations of host-pathogen-soil interactions contributing to the severity of soilborne diseases of cotton and identify features that might be exploited for disease control
4. Continue long-term field experiments on the role of pathogens, mycorrhizal fungi (VAM) and other soil organisms in the soil ecosystem (soil ‘health’).
5. Facilitate delivery and deployment of cotton disease management strategies that utilise available methods in a cost effective, integrated manner with the least impact on the environment.

Summary:

Cotton production in Australia is worth up to $1.3 billion in export income (in non-drought years). A number of diseases are currently of concern. Fusarium wilt of cotton now occurs on at least 74 farms in NSW and is spreading exponentially. If the current rate of spread continues, Fusarium wilt will be present on 90% of cotton farms in NSW by 2010. Black root rot of cotton increased rapidly during the 1990s and now occurs in all production areas of Queensland and NSW (except Menindee) and its distribution within and between farms continues to advance. Verticillium wilt of cotton declined during the 1990s with the widespread use of resistant varieties but is increasing again in some areas. Seeding disease is particularly severe in the cooler cotton regions of NSW.

Unless cotton diseases can be managed effectively, they have the potential to cause yield losses that threaten the profitability and sustainability of cotton production. The research proposed here will enable: further development and confirmation of disease management strategies; transfer of this information to growers for the more effective control of cotton diseases; collateral development of control measures in other projects; identify new disease threats if they arise; and the distribution and potential importance of diseases of cotton to be monitored. Controlling cotton diseases will have clear benefits to the long-term profitability and sustainability of the Australian cotton industry and associated rural communities.
Research Project Description

**Project Title:**
An assessment of the economic impacts of NSW agriculture research and extension: Conservation farming and reduced tillage in northern NSW
(Activity #344)

**Principal Investigator:**
Fiona Scott & Dr Bob Farquharson

**Funding Sources:**
NSW Department of Primary Industries.

**Objectives:**
This assessment of research, development and extension (R, D &E) in conservation farming and reduced tillage (CFRT) in northern NSW was conducted as part of a systematic process of evaluating the economic, social and environmental impacts of five major research, extension and education programs. The CFRT program was a key area of investment by the former NSW Agriculture. A systematic evaluation process enables the NSW Department of Primary Industries to set research priorities, allocate resources and to demonstrate that it uses research (and/or extension) resources in ways that enhance the welfare of the people of NSW. This evaluation has been conducted by economists who were not part of the CFRT program, who have made an objective and independent evaluation.

**Summary:**
Our approach has been first to describe qualitatively the economic, social and environmental impacts of the investment in the research, development and extension of conservation farming and reduced tillage. We examine the share of public and private funding in the investment. We then attempt to quantify as many impacts as practicable to arrive at a common measure of economic performance, such as the benefit-cost ratio (BCR).

This analysis evaluates the investments by the former NSW Agriculture in these programs from the late 1970s to 2002. In assessing the ‘with’ and ‘without’ technology scenarios, key outputs from research, development and extension activities and communication strategies used are described to give credence to claims about the contribution of NSW Agriculture, and to assumptions about the rate and extent of adoption of the technology.

“No till” includes maintenance of stubble cover during fallows, sowing into an undisturbed seedbed, and weed control via herbicides. “Conventional tillage” involved up to six cultivations during the fallow period to control weeds. “Reduced tillage” is usually defined as fewer cultivations than conventional tillage and also incorporates weed control via herbicides during the fallow. Reduced tillage forms the majority of fallow weed control, via herbicide and cultivation just before sowing the next crop.

In general the estimated financial results showed a healthy return to NSW taxpayers of funds invested in the conservation farming and reduced tillage program. When benefits of no till only to 2002 were considered, the results showed an estimated net present value (NPV) of $78.4 million and a benefit cost ratio of 4.1:1. When reduced tillage is included, the net present value rises to $205.4 million with a benefit cost ratio of 9.0:1.

Additional analysis with projected adoption figures to 2020 for no till only showed a mean benefit cost ratio of 11.4:1 and a net present value of $302 million with 90% of benefit cost ratio values falling between 7.9:1 and 14.9:1. Adding in the estimated benefits from reduced tillage to 2020 increased the estimated mean benefit cost ratio to 20.5:1, with a mean net present value of $568 million.

**Publication:**
Research Project Description

Project Title:
Management of Fusarium diseases and common root rot of cereals in the northern cropping zone
(Activity #345)

Principal Investigators:
Andrew Verrell, Dr Steven Simpfordorfer & Dr Kevin Moore

Funding Sources:
NSW Department of Primary Industries and the Grains Research & Development Corporation.

Objectives:
1. Development of management packages for reducing losses to Fusarium diseases in cereals.
2. Extension of management options to support growers to understand and manage crown rot, common root rot and Fusarium head blight.
3. Strategic support to durum, bread wheat and barley breeding programs.

Summary:
Crown rot caused by the fungus *Fusarium pseudograminearum* is the most serious constraint to winter cereal production in northern NSW. Although it is more common in the northern cropping belt, it can occur throughout all mainland cereal-growing areas and is estimated to cost the Australian grains industry $56 million per annum. Common root rot, caused by the fungus *Bipolaris sorokiniana* is estimated to cost growers $22 million per annum. These pathogens are endemic in the northern cropping system and the diseases therefore must be managed in such a way so as to reduce losses. Crown rot is the primary target of this project but is frequently found in association with common root rot. The experiments therefore aim to assess the effects of management on both diseases.

Much of the information on the management of crown rot has traditionally arisen from field observations and monitoring activities, as opposed to replicated field experimentation. This appears to have limited the understanding by growers and scientists of the interaction of crown rot with components of the cropping system. A previous project examined crown rot in a cropping system context. Around 2.5 hectares of replicated experiments at the Tamworth Agricultural Institute are being used to examine the effects of crop rotation, fallow and stubble management, grass weeds and the interaction of nitrogen and soil moisture on crown rot and common root rot. In all trials the effects of management on crown rot are examined in terms of its key components of survival, infection and yield loss. Crown rot and common root rot are present in all trials and have been measured since 2000. This information will form the basis of a prototype decision support package to assist growers in the Northern Region to understand and manage crown rot.

This project will extend and further develop previous research to refine the management of crown rot in northern NSW. The rotation experiment is phased to allow assessment of the long term effects of the major winter and summer break crops on crown rot and common root rot. The fallow/stubble management experiment is designed to examine long term interactions of treatments with these two diseases. Both trials will be reviewed at the end of the 2005 season to consider splitting to capture varietal or nitrogen rate interactions. The project will focus further on the role of grass weeds in the carry over of the crown rot pathogen and explore the effect of the timing of herbicide application on disease levels.

The project team will continue its extension effort in supporting growers and agronomists in understanding and managing crown rot, Fusarium head blight and common root rot. Targeted on-farm management work plus annual evaluation and monitoring of disease risk in paddocks will also provide a valuable tool for extension. Collaborations with Dr R Hare (NSW Agriculture) and Dr M Turner (University of Sydney) will evaluate durum and bread wheat lines incorporating sources of resistance to Fusarium diseases.

The project also aims to provide a better understanding of the mechanisms of resistance to crown rot by examining the role of toxins in whitehead formation, clearly defining the role of zinc, and extending the water by nitrogen research to capture interactions with different varieties. Findings from the project will be regularly used to refine and update a decision support package for the management of crown rot in the Northern Region.

Serious outbreaks of Fusarium head blight (FHB) caused by *Fusarium graminearum* occurred in wheat crops on the Liverpool Plains of northern NSW in 1999 and 2000 with yield losses ranging from 20 – 100% and major downgrading in quality. However, the economic significance of FHB is magnified by the possibility that infected grain can also contain toxins such as deoxynivalenol (DON). Moist and warm weather during flowering favour infection. The risk of FHB has
reduced the confidence of farmers in growing durum wheats in this region but also poses a threat to bread wheat and barley production.

This project aims to evaluate selected commercial and advanced durum, bread wheat and barley cultivars grown in the Northern Region for their susceptibility to FHB on an ongoing basis. Ratings will be incorporated into a management document and sowing guides to allow growers to select varieties under varying risk situations. The project will also provide strategic support to Dr Hare's durum breeding program based at TCCI to evaluate material targeted for the incorporation of resistance to FHB. The project further aims to identify promising findings on the management of FHB in the USA and other countries (e.g., chemicals and application techniques, biocontrol agents) and evaluate their efficacy under Australian conditions. Findings from the project will be regularly extended to growers and used to update management information for FHB in the Northern Region.

It is envisaged that this project will benefit the northern grains industry by increasing cereal yields through improved understanding and management of crown rot, FHB and common root rot by growers. An improved understanding of the mechanisms of resistance to crown rot and a broadening of resistance to Fusarium diseases in durum and bread wheat will further reduce losses to these diseases. This information is particularly relevant to current durum varieties which are highly susceptible to both Fusarium diseases. Improved management and resistance to Fusarium diseases should restore confidence in growing durum varieties and lead to increased plantings in the Northern Region.
Research Project Description

Project Title:
More profitable chickpeas through disease management – northern region
(Activity #346)

Principal Investigators:
Andrew Verrell & Dr Kevin Moore

Funding Sources:
NSW Department of Primary Industries and the Grains Research & Development Corporation.

Objectives:
1. Refinement and delivery of variety specific Aschochyta management packages for chickpea growers in the Northern region.
2. Quantify the potential importance of chickpea Botrytis Grey Mould in the Northern Region as a pre-requisite to developing management packages and setting breeding priorities.
3. Education and training of growers and agronomists in managing chickpea diseases. On-farm surveys to identify emerging problems and set breeding and pathology priorities.

Summary:
Growing chickpeas in the northern region needs to be more cost effective. Whilst up-coming chickpea varieties are less susceptible to Aschochyta they still require management, and they are all still susceptible to Botrytis Grey Mould. Phytothora root rot continues to be a major threat in the north.

The project will: refine existing Aschochyta packages to match economic constraints for current varieties and develop strategies for new ones; develop a Botrytis package; improve fungicide efficiency; explore novel control measures for Aschochyta, Botrytis and Phytothora; continue surveys to detect emerging problems; and progress grower agronomist training.

The work will be based at Tamworth using facilities and methods developed by GRDC projects.

Expected outcomes are; increased adoption and profitability of chickpeas; variety specific disease management packages and identification of new priorities for breeding and disease management.
Research Project Description

Project Title:
Direct and indirect measurement of deep drainage in north western NSW cracking clays
(Activity #385)

Principal Investigator:
Richard Young

Funding Sources:
NSW Department of Primary Industries and the Grains Research & Development Corporation (Project No. DAN 00059).

Objectives:
1. To develop the capability to predict the ‘on-farm’ financial and hydraulic consequences of land use change on a range of cracking clay soils and climate regions in north-western NSW.
2. To assess the impact of salts leached by deep drainage on groundwater.
3. To devise management practices to reduce the leaching of salt stored below the root zone of crops and pastures.

Summary:
This research will deliver profitable and well planned farming systems for a range of soil and climatic environments in north-western NSW. It will facilitate rational and informed decision-making by CMAs leading to reduced saline discharge and reduced stream salinity levels. Informed and rational decision making will also lead to stabilisation of unproductive and fragile landscapes. Higher water use efficiency is the key to farm management designed to minimise mobilisation of salt and excessive deep drainage.

We are investigating the amounts of deep drainage and salt movement under cropping systems, perennial pastures and remnant native vegetation in north-western NSW. It is attempting to answer the question: how much deep drainage occurs under cropping compared to native vegetation in cracking clay soils and does it do more good than harm? Deep drainage may have positive as well as negative impacts on ecosystems downstream.

This project is relevant to farmers and extension agronomists, policy makers within government, Catchment Management Authorities (CMAs) and users of groundwater. We are collecting data on the water and salt balances, hydraulic characteristics and behaviour of black and grey cracking clay soils (Vertosols) under pastures and crops. These data will be used to validate simulation models such as the Agricultural Production SIMulation model (APSIM) that predict the consequences of changes in land management and practices.

Deep soil cores are being taken from farmers’ paddocks with a history of cropping or sown pasture and from areas of remnant native vegetation. Changes in the chloride concentration down the soil profile are used to estimate historic or long-term deep drainage. Chloride concentration is used as an indicator of water and solute flow rates through the soil.

APSIM, once verified against experimental and survey hydrology results and farmer yield information, will be used to test land use scenarios that might reduce salinity risk, increase water use efficiency and maintain or increase profitability. The results of this project will enable policy makers and CMAs to use decision support systems such as LUOS (NSW Department of Natural Resources’ Land Use Options Simulator). Farmers and advisers will have access to software (or hard copy summaries) similar to APSRU’s ‘Whopper Cropper’. Whopper Cropper is an easy-to-use computer program designed to provide crop management advisers with the latest technology in cropping systems modelling and seasonal climate forecasting.
Research Project Description

Project Title:
Direct measurement of deep drainage below the root zone
(Activity #386)

Principal Investigator:
Richard Young

Funding Sources:
NSW Department of Primary Industries and Grains Research & Development Corporation (Project No. DAN 00059).

Objectives:
1. Refine the capability to predict the 'on-farm' financial and hydraulic consequences of land use change on cracking clay soils in north-western NSW.
2. Devise meaningful and credible management strategies for profitable farming systems with acceptable impacts on the farm resource base and the wider environment.
3. Assist in the development of scheduling practices for subsurface drip irrigation by characterising the patterns and rates of wetting of the soil profile.
4. Explore the use of electrical imaging as a hydrological research and irrigation scheduling tool.

Summary:
The efficient use of water, with minimal loss from deep drainage and soil evaporation and a reduced impact on the environment, is becoming more critical for both irrigated and rainfed agriculture on the cracking clay soils of the Liverpool Plains and north western NSW. Inefficient water use not only cuts into profit, it can also lead to environmental damage – for example, rising water-tables and dryland salinity.

With this project we are quantifying the pattern of soil wetting, both laterally and to a depth of 5 m, and the soil water balance under crops, fallows and perennial pastures. A site of 4 ha has been established on a deep alluvial cracking clay (grey Vertosol) on the NSW Department of Primary Industries Liverpool Plains field station, Breeza.

Tension lysimeters (stainless steel trays inserted into the soil to which a suction equal to that in the surrounding soil is applied) are being installed at depths of up to 5 m to measure deep drainage and solute movement below the root zone. The pattern of soil wetting will be measured in three dimensions using electrical imaging, neutron scattering and an array of moisture probes and tensiometers. Detailed and extensive characterisation of soil hydraulic properties is in progress.

The data will be used to validate models of crop production and water balance using the Agricultural Production SIMulator (APSIM) and to determine the proportion of soil solutes (salt, agricultural chemicals) mobilised by major wetting events and to refine the design and management of subsurface drip irrigation in cracking clays.
Research Project Description

Project Title:
Collaborative recharge validation project – northern NSW site
(Activity #387)

Principal Investigator:
Richard Young

[Note: This is a collaborative project with the University of Technology, Sydney and the Department of Natural Resources (Dr Mark Littleboy – statewide Principal Investigator)]

Funding Sources:
Formerly funded by the State Salinity Strategy and now possibly the Natural Heritage Trust and National Action Plan via the NSW Department of Natural Resources.

Objectives:
1. Provide data on the hydrology and production of agricultural activities, forests and native vegetation to validate simulation models used to predict end of catchment outcomes of land management options for CMAs.
2. Assist in devising meaningful and credible land management strategies to reduce salt mobilisation and stream salinity levels.

Summary:
Data are being collected at sites near Quirindi in the Liverpool Plains catchment and other sites at Baldry, Wagga and the Hunter Valley to validate various inputs to the Catchment Scale Salt Balance Model-CATSALT and the Land Use Options Simulator – LUOS. This software is used to provide predictions of salt balance from simulated land use scenarios to help find the best choices to combat salinity in the Murray Darling Basin. Insights from these studies identify the likely trade-offs in the balance between achieving targets to reduce salinity and providing water for domestic, agricultural and industrial use.

This project is a collaborative effort between hydrologists, hydro geologists, modellers, foresters and agronomists from the Department of Natural Resources, NSW DPI and the University of Technology, Sydney. The water balance and productivity of an eight year old ironbark plantation is being compared with native pastures and remnant native vegetation.

We are using a range of methods to measure or estimate the components of the water balance. These include direct measurement of grassland evapotranspiration using the Bowen ratio method which uses the gradient of temperature and vapour pressure deficit to calculate evapotranspiration. Transpiration by trees is being determined by measurements of sap flow, soil water both intermittently by neutron scattering and logged continuously with ‘theta’ moisture probes. Fluctuations in groundwater under each land use are recorded continuously.

We will also use environmental isotopes to determine from whence and when trees obtain water. This could be recent rainfall stored in the soil, not-so-recent rain stored in groundwater or the regolith (loose uncemented mixture of soil and rock particles that covers the Earth's surface).
Research Project Description

**Project Title:**

Carbon sequestration under summer/winter response cropping in north western NSW
(Activity #495)

**Principal Investigator:**

Richard Young and Dr Brian Wilson

[Note: This is a collaborative project with the Department of Natural Resources]

**Funding Sources:**

NSW Department of Primary Industries and the NSW Climate Action Grants Program.

**Objectives:**

Determine if the biomass productivity and water use conferred by zero-tillage summer/winter response cropping on the cracking clay soils of north-western NSW translate into net carbon sequestration and, if so, determine the net fixation of carbon, the form in which it is fixed and how stable it is.

**Summary:**

Research in Australia so far has shown that cropping results in a reduction of soil organic carbon although where crop residues are retained and zero tillage is used, soil organic carbon levels are usually larger than where there has been frequent cultivation. To restore organic carbon in cropping soils, it has been shown that several years of perennial pastures are needed.

However, it appears that all published work has involved studies on winter cropping with summer fallows, where rates of carbon emission due to the respiration of soil biota are greatest.

On the cracking clay soils of the Liverpool Plains, it has been clearly shown that planting a crop in response to the amount of water stored in the soil, increases cropping frequency, plant water use, biomass production, grain yield and farm profitability compared to winter cropping or long fallow rotations.

In this project, we are asking, can this exceptional biomass productivity and water use conferred by zero-tillage summer/winter response cropping on the cracking clay soils of north-western NSW translate into net carbon sequestration? Furthermore, if there is net fixation of carbon, in what form is it fixed and how stable is it?

To test this hypothesis, we are looking at:

- The changes in soil carbon under perennial pastures and six cropping systems – including response cropping which differ up to two-fold in biomass productivity from a field experiment (1994-2000) conducted on the Liverpool Plains.
- A comparison of soil carbon stocks from paired sites (conventional/zero-tillage cropping vs native vegetation) in north western NSW.
- The changes in soil carbon under response and conventional cropping on two Liverpool Plains farming properties which were initially sampled in 1998.
Research Project Description

Project Title:
Mobilisation of 100 tonnes of salt/ha under cropping in north western NSW – a threat to agricultural and natural ecosystems? I & II
(Activity #534 / 535)

Principal Investigator:
Richard Young

Funding Sources:
NSW Department of Primary Industries and the National Action Plan for Salinity & Water Quality.

Objectives:
Determine the best way to manage water and salt stores under rainfed cropping on cracking clay soils (Vertosols) in north western NSW so that the large existing soil salt stores pose a minimal threat to agricultural and natural ecosystems and to stream and groundwater resources.

Summary:
The aim of these two projects is to determine the best way to manage water and salt stores under rainfed cropping on cracking clay soils (Vertosols) in north western NSW so that the large existing soil salt stores pose a minimal threat to agricultural and natural ecosystems and to stream and groundwater resources.

The project outputs will be field knowledge and suggested practices for the management of sustainable cropping systems on Vertosols that will reduce mobilisation of salt stores and their discharge into fresh groundwater, streams and associated flood plains and wetlands. The Namoi, Gwydir-Border Rivers and Central West CMAs are supporting this project, and all three CMAs have stated the need for information on salt stores and the threat they may pose to groundwater and river systems.

Our argument is that most of the possible damage has been done already to these semi-arid landscapes by continuous conventional farming over the last 20 – 50 years. However, with new conservation farming systems, the potential for deep drainage and salt mobilisation is far greater because of the increased capture and conservation of rainfall. This raises the question: is this potential for deep drainage and mobilisation of substantial salt stores a threat to the viability of agriculture, surface and groundwater quality, remnant native vegetation and associated biodiversity, wetlands and other fragile landscapes?

Under investigation are the alluvial clay landscapes in the Warren, Coonamble, Walgett, Mungindi and Burren Junction areas of NSW. To achieve the aims of the project we will:
- Estimate size of salt stores and extent of historic deep drainage under farmers’ cropping paddocks and native vegetation;
- Investigate the hydrology of the underlying alluvium, determine the depth to the water table under cropped and adjacent landscapes from existing bore records and by sampling existing non-artesian bores; and, where necessary, determine depth and nature of alluvial aquifers by drilling and installation of observation bores;
- Predict the water use, deep drainage rates, consequent mobilisation of salt, and the economic yield of alternate cropping and crop-pasture systems;
- Determine, as far as possible, the most likely time and place of discharge into river systems or deeper fresh water aquifers if deep drainage from leaky land uses is not controlled;
- Conduct scenario simulations to test the outcomes of alternative management practices;
- Develop a sequence of land management practices that might, for example, leach salt below the root zone of most crops and pastures and then keep it there by a combination of response cropping and judicious pasture phases;
- Collaborate with farmers and agronomists in the investigation areas to determine current problems relating to near surface salt stores and to test model outputs and proposed management practices.