

# **CURRENT RESEARCH PROJECTS**

## **– PASTURES & RANGELANDS –**

**(Last updated 15 July 2008)**

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# Research Project Description

## Project Title:

Evaluating opportunistic cropping for control of Invasive Native Scrub (INS) and restoration of native perennial grasslands in western NSW

(Activity #573)

## Principal Investigator:

Dr Yohannes Alemseged

## Funding Sources:

NSW Department of Primary Industries and the Western Catchment Management Authority

## Objectives:

Invasive native shrub (INS) is regarded as one of the major problems threatening the pastoral lands of western New South Wales. The objective of this study is to evaluate the benefits of opportunistic cropping in the restoration of native perennial grasslands in the region. The data will be used to develop BMP's for the management of INS using short-term cropping.

## Summary:

Invasive Native Scrub (INS) is regarded as one of the major environmental problems threatening the pastoral lands of western New South Wales. An estimated 20 million hectares (almost 20% of the state) is said to be affected by, or is liable to, invasion by shrubs. Areas affected by this invasion not only have their productivity greatly reduced but also have become severely degraded.

Many landholders believe the only economically viable way of treating INS and promoting regeneration of native grasslands is through opportunistic cropping. They argue that cropping could provide an economic means of controlling INS within the cropping paddocks and could generate additional income for control of INS in other areas of the property unsuitable for cropping. The *Native Vegetation Act 2003* also recognise that INS causes environmental degradation and lists temporary land use change (cropping) as a viable form of management to re-establish native vegetation.

However, the claimed improvement in environmental outcomes following opportunistic cropping has received virtually no critical evaluation. The post cropping scenario regarding regrowth and vegetation succession in the Australian rangelands is not well defined. Understanding how opportunistic cropping influences subsequent vegetation type is the first essential step in determining the value of cropping as a tool to restore INS affected areas.

The proposed study will provide an evaluation of the benefits of opportunistic cropping in the rehabilitation of perennial native grasslands and will therefore contribute significantly to the management of INS in western NSW. The proposed survey will demonstrate whether the current post-cropping management is sufficient to restore native grasslands. A positive outcome would allow landholders to use short term cropping with confidence as a means of managing INS. Should the project show that current post-cropping management is not generating the desired outcome it will provide a basis for the development of further research aimed at determining the major limitations and developing management practices to overcome them.

# Research Project Description

## Project Title:

EverGraze in the Central West and Lachlan Catchments of NSW: Best practice grazing management of native pastures  
(Activity #542)

## Principal Investigator:

Dr Warwick Badgery

## Funding Sources:

NSW Department of Primary Industries and the Future Farm Industries Cooperative Research Centre

## Objectives:

1. Determine if higher intensity management systems for native pastures result in:
  - Improved pasture perenniality;
  - Improved animal production and profitability;
  - Improved environmental outcomes (e.g., reduced groundwater recharge or improved biodiversity).
2. Determine if higher intensity management systems for native pastures can be integrated with other farm forage resources to improve whole-farm profitability and reduce the risks associated with climate variability.

## Summary:

This project is aimed at quantifying the benefits of more intensive grazing management systems from both production and environmental perspectives. Intensive grazing management systems have gained substantial popularity in the high rainfall zone but their benefits are not well quantified. Two experiments will be established near Orange on the Central Tablelands.

Experiment 1 will investigate the effects of grazing management system on livestock production and pasture response. There will be 3 grazing management treatments - continuous grazing; medium intensity rotational grazing (4 paddocks) and high intensity rotational grazing (20 paddocks). Each treatment will cover an area of 6 ha and will be replicated twice. The experiment will be stocked with Merino ewes which will be mated to terminal prime lamb sires. Pasture composition/production, soil fertility, water and biodiversity will be measured in relation to both management system and landscape position, and animal production will be measured in relation to grazing management system.

Experiment 2 will investigate the effects of fertiliser and grazing intensity on pasture response. The experiment will comprise three levels of grazing intensity with or without superphosphate. The levels of grazing intensity will be: (a) low intensity (continuous grazing at 5 DSE / ha); (b) medium intensity (grazed 25% of the time at 20 DSE / ha); and (c) high intensity (grazed 5% of the time at 100 DSE stocking intensity). Only some cells, to represent grazing at contrasting times, will be established for the high intensity grazing treatment. The entire experiment will cover an area of 5 ha and each treatment will be replicated 4 times. Superphosphate will be applied to half the area of each grazing intensity treatment.

# Research Project Description

## Project Title:

Improved phalaris (*Phalaris aquatica*) varieties (EC35)  
(Activity #358)

## Principal Investigator:

Dr Suzanne Boschma

[Note: This is a collaborative project which is being led by the CSIRO]

## Funding Sources:

Australian Wool Innovation.

## Objectives:

1. Improved understanding of the types of phalaris that will survive under grazing in northern NSW.
2. Identification of material to become the basis of a possible new cultivar.
3. Increased awareness of the benefits of phalaris in the region.

## Summary:

Grazing enterprises on the North West (NW) Slopes of NSW are characterised by low stocking rates (typically 1 – 5 dry sheep equivalent/ha), with opportunities for pasture improvement existing for well-adapted pasture species. Native pastures based largely on frost-susceptible warm season grasses dominate pastures on the NW Slopes and are considered to be one of the main reasons for low stocking rates in the region. Introduced tropical grasses have become increasingly important as the area has summer-dominant rainfall (60% AAR falls December – March). However, tropical pastures have low quality and productivity during the cooler parts of the year. Because of this and the fact that the cooler months have the most reliable soil moisture, pastures based on temperate species are considered to offer the opportunity for increased productivity. Introduced temperate grasses have not been widely sown on the slopes as there is a perception that they are suited only to the cooler Tablelands climate and because producer dissatisfaction with performance of the available cultivars.

In the 1980s, the introduced pasture species Phalaris was found to be highly persistent under light intermittent grazing on the NW Slopes compared to other temperate grass species. It was concluded that Phalaris was possibly the only introduced temperate perennial grass suitable for the region and that the highly vigorous winter-active cultivars, Sirosa and Sirolan, gave the best performance. However, these cultivars have been less persistent under more practical grazing conditions with many stands failing within 5 years.

In 1998, Phase I of this project commenced, involving field evaluation of 102 wild and bred Phalaris lines sown at 3 sites on the northern slopes of NSW. This evaluation highlighted 8 lines (most being 'wild' types) with persistence superior to commercial cultivars. As the wild lines are seed-shedding 2 approaches were undertaken to improve seed production. Firstly, there was selection within the wild populations for favourable characteristics such as large seed heads and secondly, the wild lines were crossed and back-crossed with the most persistent seed-retaining line to produce seed retaining populations.

Phase II of the project commenced winter 2004 with 7 lines and 5 controls (cultivars) sown in 2 experiments on the northern slopes. These experiments will be evaluated over the next 3 years for seedling vigour, flowering time, summer dormancy, persistence and production. In 2007, a line will be recommended for release as a cultivar.

# Research Project Description

## Project Title

Development of a more suitable forage base for the dairy industry

(Activity #373)

## Principal Investigator

Prof. William Fulkerson & James Neal

## Funding Sources

NSW Department of Primary Industries, the University of Sydney, Dairy Australia, the Dairy Industry Development Company (NSW) Ltd, Wrightsons and PGG Seeds.

## Objectives

1. To determine the water use efficiency (WUE), measured as production of digestible energy per mm of water used, and forage quality when forage species are provided with optimal and less than optimal water availability.
  - There are significant differences in water use efficiency between forage species.
  - There are significant differences in water use efficiency between seasons for any particular forage species.
  - There are significant differences in forage response to moisture stress in terms of yield and quality.
  - There are significant differences in how forages extract water from the soil.
2. To incorporate data on WUE and forage quality into a model to develop the most profitable whole-farm feed plan considering the seasonal growth pattern of forages, cost of alternate feeds, climate and availability of irrigation water.
  - There are significant differences in benefits and costs of forages for use in dairy systems.
  - Changing the area of forage sown to different species can improve the outcomes of the whole farm system.

## Summary

Nationally, the dairy industry is the largest agricultural user of irrigation water. The current drought in eastern Australia, and government policy to increase environmental flows in rivers, have highlighted the importance of utilising water as efficiently as possible. Pasture production accounts for up to 35% of variability in farm profit. Species selection and management may have significant impact on water use efficiency and farm profitability.

In this context, thirty-five of the most commonly used dairy forages, and some more exotic ones, are being evaluated for their water use efficiency, in a large replicated experiment on an alluvial clay soil near Sydney.

Data from the first summer showed that maize out-yielded all other species by up to 60%. Maize was also twice as efficient as common pasture grasses such as perennial ryegrass, cocksfoot and prairie grass in using water to produce digestible energy. Generally, summer growth and water use efficiency of tropical plants such as maize, sorghum and kikuyu was significantly higher than for temperate species such as perennial ryegrass, which use a different photosynthetic pathway.

The deepest water extraction was achieved by lucerne and chicory, as water was extracted down to 175 cm in the first summer, while white clover extracted water from only the top 100 cm.

It appears both the rooting pattern and photosynthetic pathway of these plants are important factors influencing water use efficiency.

# Research Project Description

## Project Title

Monaro research, development and demonstration of sustainable grassland management  
(Activity #359)

## Principal Investigator

Mark Norton, Luke Pope, Doug Alcock, Belinda Hackney, Mike Keys & Robert Smith

## Funding Sources

NSW Department of Primary Industries and the Natural Heritage Trust (Project No. SECMB C1/8) (through the Southern Rivers Catchment Authority).

## Objectives

The project is investigating a variety of land management techniques to determine appropriate management regimes to maximise land productivity but retain or enhance the natural resources of the Monaro by:

1. Developing low input management strategies to maximise productivity of native pastures while retaining the biodiversity and long term sustainability of this natural resource;
2. Developing integrated control strategies for high priority weeds including serrated tussock, African lovegrass and Chilean needlegrass; and
3. Demonstrating these management applications within the pilot area of The Monaro Grasslands Project.

## Summary

This project is part of a larger study on sustainable land use in the Monaro region. Our role is to develop sustainable pasture management practices for the portion of the Monaro which is suitable for agricultural production. The project is a combination of grazing demonstrations, and smaller experimental plot work on evaluation of legumes and control methods for troublesome perennial grass weeds.

Three pasture management treatments have been imposed on 2 major sites to explore ways in which landholders can increase productivity to remain viable, while preserving the natural values of Monaro grasslands. Pastures are closely monitored to determine possible detrimental effects on pasture composition and biodiversity, while animal production is recorded to determine the benefits to landholders. In separate small plot experiments, a range of legumes is being evaluated for use in pastures, and methods of re-vegetating degraded areas for control of serrated tussock are being tested.

# Research Project Description

## Project Title

Grain & Graze regional initiative: Central West/Lachlan  
(Activity #360)

## Principal Investigator

Dr Ron Hacker

*[Other NSW DPI staff involved: Dr David Michalk (Orange), Mr Richard Maccallum (Condobolin), Dr Warwick Badgery (Orange)]*

## Funding Sources

NSW Department of Primary Industries, Land & Water Australia, the Grains Research & Development Corporation, Australian Wool Innovations Limited, Meat & Livestock Australia, Central West Catchment Management Authority, Stipa Native Grasses Association, Central West Farming Systems and Central West Conservation Farming Association.

## Objectives

1. Develop more profitable/sustainable farming systems through research and collation of existing farmer knowledge;
2. Improve environmental outcomes from mixed farming systems, by reducing the leakage of water and nutrients, and by identifying opportunities for better biodiversity outcomes;
3. Increase the capacity for better and more confident decision making in the mixed farming community by providing networking, training and extension opportunities relating to production and natural resource management.

## Summary

This project is one of nine regional initiatives incorporated into the national Grain and Graze program. Its focus is the mixed farming areas of the Lachlan and Central West Catchments. As a generalisation, farms in the east of the region are dominated by meat producing livestock activities, complemented by short cropping phases that produce winter cereals and oil crops. In contrast, farms in the western area aim to produce high protein bread wheat, and crop a larger proportion of the farm using longer rotations. Livestock production in this western sector has traditionally been based on wool producing flocks.

The project is being implemented as six integrated sub-projects:

- Communication, education & extension – this sub-project will be the key to dissemination of project results and will be closely integrated with the activities for the three producer organisations that are associated with the project.
- Producer cases studies – six case studies of successful mixed farming systems, including both innovative and traditional operations.
- Forage profiles and production options – use of simulations models to match the production profiles of the forage types available across the region to the requirements of alternative livestock enterprise, thus identifying 'best bet' whole-farm systems.
- Biodiversity in mixed farming landscapes – this sub-project will contribute to the analysis of case study properties, and assess the potential to achieve better conservation outcomes across the region, and good economic results, by redesigning mixed farming landscapes.
- Eastern zone pasture cropping systems – an investigation of the benefits and management requirements of the pasture cropping system that some landholders in the east of the region have developed and adopted in recent years, involving the direct sowing of winter-growing cereals into dormant, summer-growing perennial pastures.
- Western zone alley farming systems – a large scale evaluation of the potential of the perennial forage shrub old man saltbush, incorporated as alleys into traditional cropping paddocks, to improve summer forage availability and allow production of prime lamb rather than the traditional wool.

Synthesis of results across these sub-projects will lead to a better understanding of the combinations of native & sown pastures, crops and livestock that will lead to both economic and environmental benefits.

# Research Project Description

## Project Title:

Climate science for better Natural Resource Management in western NSW  
(Activity #415)

## Principal Investigator:

Dr Ron Hacker

*[NOTE: This is a collaborative project with the Department of Natural Resources (Dr John Leys, Mr Stephan Heidenreich) and the Queensland Department of Natural Resources, Mines & Energy (Mr Peter Timmers)]*

## Funding Sources:

NSW Department of Primary Industries and Land & Water Australia (Managing Climate Variability R&D Program, DAN19).

## Objectives:

1. Develop a capacity to predict regional trends in total ground cover, and provide early warning of potential degradation events, by linking AussieGRASS products and seasonal climate forecasts.
2. Demonstrate the potential of the PaddockGRASP model to support sustainable natural resource management at the property level.
3. Develop protocols to allow the PaddockGRASP model to be readily parameterised for individual properties.

## Summary:

Ground cover has been identified as a basic sustainability indicator in all Catchment Blueprints in western NSW because of the fundamental linkage with soil erosion. Ground cover targets have been specified in several Blueprints. The ability to estimate ground cover over large areas is fundamental to the capacity of Catchment Management Authorities (CMAs) to monitor the success of their investments. An additional capacity to predict future trends in ground cover would greatly enhance the capacity of CMAs to proactively foster sustainable management by, for example, issuing land degradation alerts under specified conditions.

Recent research by the Department of Natural Resources has shown that potential exists to derive estimates of the variable component of total ground cover from estimates of total standing dry matter produced by the 'AussieGRASS' spatial simulation system. Estimates of total ground cover could then be produced by adding this variable component to the static component that results from surface features such as rock, soil biological crusts and perennial vegetation. Combining a capacity to model total ground cover with seasonal climate forecasts and to estimate the probability of future ground cover trends, will provide a powerful tool to assist land management.

While development of this capability will be of value to regional and State organisations, the most important land management decisions are made by individual property owners. Enhancing graziers' capacity to estimate forage production on their properties, and the likely trends in both forage production and (if possible) ground cover, will provide a powerful tool to manage both production and environmental risk. Application of pasture growth models, combined with seasonal climate forecasts at the paddock level has commenced experimentally in both Queensland and NSW. Extension of this capacity to include ground cover, and the development of protocols to allow the models to be rapidly calibrated for individual properties, will provide graziers with a previously unknown capacity to manage risk in pastoral businesses and contribute to regional NRM targets established by CMAs.

# Research Project Description

## Project Title:

Sustainable Grazing on Saline Lands: Water, soil and salt movement from sustainable salt-tolerant pastures in NSW  
(Activity #365)

## Principal Investigator:

Dr Warren King & Dr Dassa Dassanayake

## Funding Sources:

Australian Wool Innovation and Land & Water Australia (primarily) – funded through the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (Project No. UWA 32).

## Objectives:

To develop perennial grass-based pastures on salt-affected land that support profitable livestock production systems and which reduce the environmental impacts of saline discharge sites. Specifically, to:

1. Determine the economic value of the forage produced from these systems for wool and sheepmeat production.
2. Determine salt and water movement from salinised land under both volunteer/naturalised pasture and salt tolerant perennial pasture.
3. Develop pasture management systems that maximise pasture and animal production, minimise negative on- and off-site environmental impacts and allow sustainable use of salt-affected land.

## Summary:

The NSW Salinity Strategy identifies declining water quality as a major consequence of increasing salinity in inland NSW. High salt loads have deleterious effects on drinking and irrigation water quality, the biodiversity of river systems and can lead to damage of infrastructure such as roads and buildings. Saline discharge areas are major contributors to salt loads in streams.

If current agricultural practices are maintained, it is estimated that the next 20 years will see a 300% increase in the area at risk of salinity in the major catchments of the Murray Darling Basin, to more than half a million hectares (National Land and Water Resources Audit Australian Dryland Salinity Assessment 2000). In the next 50 years, that increase is projected to be 700%, to more than 1.3 million hectares. Much of this increase will be in the tablelands and slopes of New South Wales.

'Sustainable Grazing on Saline Land' addresses the major issues for research into the productive and sustainable use of already salinised land in New South Wales. The project will assess the impacts of the 'best practice' establishment of a perennial grass-based pasture on pasture and animal production, water, soil and salt movement and biodiversity at two saline discharge sites in the Lachlan catchment. This project will allow replicated comparisons to be made between existing degraded pasture on saline land and current best practice grazing systems for saline land. New pasture species (including native species) will also be assessed.

The knowledge provided will help land managers, Catchment Management Authorities (CMAs) and other agencies maximise the effectiveness of their investment in dryland salinity management.

Producer networks will be part of the process of experimental design development and will play a key role in the communication of the information from this project.

## Research Project Description

### Project Title:

National field evaluation and selection of new pasture plants from the salinity CRC to improve hydrologic stability of farming systems – Northern NSW component

*(Activity #366)*

### Principal Investigator:

Dr Gregory Lodge

### Funding Sources:

CRC for Plant-based management of Dryland Salinity and NSW Department of Primary Industries.

### Objectives:

To develop new perennial legumes, grasses and salt tolerant species which can be used to:

1. reduce drainage to groundwater and streams in crop-pasture rotations;
2. increase ground cover in discharge areas where saline water is coming to the surface causing salt scalds or resulting in large surface flushes of salt into river systems.

### Summary:

The project addresses the major problem of dryland salinity caused by inefficient use of rainfall by current farming practises which lead to rising watertables. It aims to increase the number of perennial pasture species options available to farmers to increase the perenniality of their farming systems. Perennial plants have deeper root systems and higher water use than annuals, and so have a higher potential to lower the watertable. They also maintain higher ground cover, reducing runoff and surface movement of salt into streams.

Initially, nurseries were established in key sites representative of areas where water enters, or discharges from, the sub-surface system on the North-West Slopes of New South Wales. A total of 16 sites has been established covering a range of species including browse shrubs, perennial legumes, perennial grasses (native, temperate and tropical), herbs and annual legumes. As well as being regionally relevant, these sites are part of a national evaluation program and experimental design, data collection and data analysis conform to agreed protocols. These species-rich nurseries are evaluating a broad range of plant types to identify those that are well adapted to target environments and should become the focus of more detailed selection and breeding. This will allow a rapid start to the field program while the breeding/selection programs are building momentum. During this period, genetic resource centres in South Australia and Western Australia will be increasing availability of seed of a wider range of material for sowing in the second and third years. The nursery sites will assess a range of material over a minimum of 3 years for both herbage mass production and persistence under grazing. These nurseries will allow advanced material and existing cultivars to be evaluated relatively quickly. In the third and fourth years of the project, plants identified by the selection/breeding program will progressively feed into the field evaluation program and trials will focus in more detail on particular species.

# Research Project Description

## Project Title:

Characterisation of Pasture Soil Biology Constraints – Northern NSW  
(Activity #367)

## Principal Investigator:

Dr Gregory Lodge

## Funding Sources:

NSW Department of Primary Industries and Meat & Livestock Australia.

## Objectives:

1. Identify pasture sites representing a range of pasture performance in the North-West Slopes and Northern Tablelands of NSW and collect soil and plant samples for use in bioassay and analysis to quantify and characterise soil biological constraints and prioritise key organisms for development of molecular assays.
2. Provide field sites for validation and calibration of molecular assays of significant detrimental and beneficial organisms in pasture soils.

## Summary:

This project builds on previous studies across southern Australia in which biocide (fungicide and nematicide) treatments have demonstrated significant gains in pasture production through reduction of soil biological constraints associated with fungal pathogens and plant parasitic nematodes. It also provides field sites to link with a separately funded, broader pasture soil biology initiative that aims to develop knowledge, tools and strategies for enhancing soil biological health in Australian pasture systems to underpin productivity gains and sustainability for grazing industries. No such studies have previously been undertaken in northern NSW and the results will be of benefit to producers, advisers and other research programs.

Pastures at 20 sites (three locations at each site) on commercial properties were surveyed in spring 2003 to collect soil and agronomic information for the North-West Slopes and Northern Tablelands of NSW. Species dominant at these sites included lucerne, phalaris and subterranean clover (in both sown and native pastures). Soil samples (0 – 15 cm) were analysed for nematode status (both plant parasitic and free living), soil chemical analyses, microbial activity, labile and total carbon. As part of the broader soil biology initiative, soils were sent to the South Australian Research and Development Institute (SARDI) for bioassay to identify pathogens and to develop molecular DNA assays for key soil organisms as essential tools for research into enhancing pasture soil biological health.

Based on the outcomes of the survey and bioassays further field sites were selected to quantify the effects of soil biological constraints in 2004. In autumn 2004, a further 8 field sites were established to evaluate the effectiveness of nematicide and fungicide applications on both plant parasitic nematodes and fungal pathogens.

# Research Project Description

## Project Title:

EverGraze in the Namoi and Border Rivers–Gwydir Catchments of northern NSW  
(Activity #543)

## Principal Investigator:

Dr Gregory Lodge

## Funding Sources:

NSW Department of Primary Industries and the Future Farm Industries Cooperative Research Centre

## Objectives:

1. Document the limitations to different pasture and sheep/wool production systems;
2. Develop simple, evidenced-based benchmarks for different pasture and animal production systems;
3. Develop a whole farm economic model for assessing the profitability and risk of alternative production systems;
4. Demonstrate the production and environmental benefits of lucerne mixtures compared with lucerne monocultures or annual forage crops;
5. Study the relationship between production and biodiversity;
6. Develop simple tools to enable producers to assess soil and pasture health, and to assess and monitor biodiversity;
7. Assess the impact of lucerne mixtures and other perennials on ground water recharge and salinity at catchment scale.

## Summary:

About 42% of the 92,500 sq km of land in the Namoi and Border Rivers-Gwydir Catchment Management Authorities regions in northern NSW is occupied by native grasslands. This project is aimed at identifying how producers can best integrate native pastures, sown pastures and supplements on individual properties for profitable production and environmental benefits.

Field surveys, producer focus groups and property records will be used to develop a data base of soil, pasture and animal production data for several individual paddocks on 20 properties representing various sheep enterprises, grazing methods, proportions of native and sown pastures, and use of forage crops and supplements. Climatic and other environmental data will also be collated. Statistical modelling of this data will then be used to define best management practices for soil, plants and animals.

Field experiments will be used to compare the environmental outcomes (e.g., water use, perenniality and ground cover) of lucerne mixtures, lucerne monocultures and forage oats.

The profitability and risk of alternative production systems will be evaluated by means of a whole farm economic model.

The 'Sustainable Grazing Systems' pasture growth model will be refined and used to analyse a range of 'what if' scenarios and the 'Catchment Analysis Tool' developed within the CRC for Plant Based Management of Dry Land Salinity will be used to assess the catchment scale implications of alternative production systems.

# Research Project Description

## Project Title:

Integration of woody forages into mixed farming systems

(Activity #370)

## Principal Investigator:

Richard Maccallum

*[Note: This project is a sub-project of the Central West / Lachlan Grain & Graze project led by Dr Ron Hacker]*

## Funding Sources:

NSW Department of Primary Industries and Grain & Graze (includes the Grains Research & Development Corporation, Meat & Livestock Australia, the Western Research Institute and Land & Water Australia).

## Objectives:

1. Establishing a farm-scale research and demonstration site of a new production system incorporating woody forages (OMSB – old man saltbush) integrated as alleys with a pasture and cropping rotation.
2. Quantifying the competitive and complimentary effects of OMSB into the traditional mixed farming system.
3. Substantiating the hydrologic, productive, economic and biodiversity benefits of the new production system.

## Summary:

Most of the mixed-farming enterprises in the drier region of the cropping belt rely on wheat and wool production for income. The variable climate of the area results in fluctuating production and income. However, the incorporation of permanent plantings of woody perennials, such as OMSB, into these mixed-farms provide an opportunity to mimic the former, stable natural vegetation and water-use patterns. The introduction of a perennial, drought resistant fodder plant into the farming systems in the western zone has the potential to confer a number of advantages over the current system (largely based on annuals), especially in relation to the resilience/reliability of the system to maintain production. In addition, its incorporation into the farming system does not require the development of new markets or marketing infrastructure, but rather its presence can be used to reduce risk and increase farm profit by a shift in product focus – e.g., wool-growers can move into prime lamb production with greater confidence. An improvement in the hydrological balance is expected, and benefits to biodiversity should occur from the restoration of mid-storey shrub species.

This project will be undertaken at the Condobolin Agricultural Research and Advisory Station. The basic design is a comparison between two farming systems, one using alleys of OMSB as part of the feed supply for stock for at least half the year, and the other, a conventional crop-pasture rotation. Paired paddocks will be selected to ensure uniformity of site position in the landscape, slope, soil and pasture cover. The paddocks will be randomly allocated a treatment. Fifteen of the 17 paddocks in the OMSB treatment will have OMSB planted on 20% of their area (in 15m strips) with the intervening cropping/pastures alleys 60m wide. The OMSB stands will be established using speedlings supplied from a commercial planter who will plant into fallowed strips of land during autumn-early spring.

Two flocks of sheep will be rotationally grazed through the 15 paired paddocks and their production monitored. Merino ewes will be mated to crossbred rams in early summer so lambs reach market weight by the end of the spring flush. OMSB will then be used to maintain feed supply to one flock of ewes and lambs over the summer-autumn period or until the lambs are sold. Some supplemental feeding of grain is planned for both flocks, especially in drier years when pasture availability usually becomes limited in autumn.

Fifteen sets of the seventeen paired paddocks will have a 5-year cyclic rotation of cropping (wheat for 2 years) and pasture phase of medics and lucerne (3 years). Each year, three new paddocks will start the rotation so that all phases of the rotation can be assessed in any year. Cropping and pasture (including OMSB) production will follow district best-bet practice. The remaining 2 sets of paddocks will be held as feeding paddocks if poor seasonal conditions require these measures.

Data on crop establishment, dry matter and grain (yield and quality) will be recorded. Pasture and shrub growth will be monitored regularly, especially prior to, and post-grazing. Individual (ewes and lambs) body weights will be monitored monthly, regular dye banding and seasonal ultra-sounding of ewes will be recorded. Monthly soil moisture readings (to 2.5m) from strategic locations in each paddock will allow water use to be monitored.

This project will supply quantitative data on the benefits incorporating persistent and resilient perennial species into an otherwise annual-based production system that is subject to a highly variable climate. These benefits will come from the ability to change enterprise as well as gain better market prices and timeliness of sale of products.

# Research Project Description

## Project Title

Effects of phosphorus and surface-applied lime on wool production on the tablelands of NSW  
(Activity #347)

## Principal Investigators

Mark Norton

## Funding Sources

NSW Department of Primary Industries, Acid Soil Action (1998 – 2003) and Australian Wool Innovation (Project No EC664).

## Objectives

This project aims to deliver a clear framework for wool producers to determine appropriate rates of lime and superphosphate for increased wool cut and profit/ha. This will be done by:

1. Providing information on liming of deep acid soils;
2. Determining the optimum target rate for superphosphate on a range of soils;
3. Determining whether there are interactions between lime and superphosphate;
4. Evaluating costs and benefits of these practices to wool producers.

## Summary

Surface application of lime is the only option available to reduce soil acidity and increase wool production on large areas of the tablelands which are both non-arable and acidic. The aim of this project is to study the effects of lime applied on the soil surface. This includes the rate at which lime moves into the soil profile, and the subsequent pasture and animal responses. This project is a large grazing experiment studying the effects of lime and superphosphate on soils, pastures and fine wool production.

Detailed measurements are being made including soil chemistry, pasture production and composition changes, and wool production and quality. Results to date indicate that considerable time is required for lime to move into the soil and influence production. For this reason, and because drought has been present at the site since 2002, it has been difficult to show positive effects of lime so far. The project will continue until 2007.

# Research Project Description

## Project Title:

Improving the persistence and drought tolerance of temperate perennial pasture grasses – the role of summer-dormancy  
(Activity #372)

## Principal Investigator:

Mark Norton

## Funding Sources:

NSW Department of Primary Industries, Institut National de Recherche Agronomique (INRA), University of Queensland, and Meat & Livestock Australia Pty Ltd (Project No. stu135).

## Objectives:

1. To improve understanding of the environmental and genetic factors which influence the expression of the “summer-dormancy” response and determine whether it has different levels of expression in a range of important grasses, eg tall fescue, cocksfoot and phalaris. The implications of different levels of summer dormancy expression in terms of drought tolerance, soil water use, and plant survival will be studied.
2. To study the interaction between summer drought and defoliation intensity and frequency on survival and regrowth as influenced by the summer dormancy trait.

## Summary:

The persistence of perennial pasture grasses in NSW environments is generally poor especially where subjected to severe summer drought. However, to improve the sustainability of farming systems in these environments, it is clear that we must increasingly utilise perennial species because when there is an undue reliance upon annuals, degradation in various forms, e.g., dryland waterlogging, salinity and acidification, becomes serious and widespread. Summer dormancy, a trait present in several important perennial pasture grasses which originate in the Mediterranean, has the ability to greatly improve plant survival over summer. However, its potential has not been adequately exploited as the mixed farming regions of NSW remain dependent primarily on annual pasture species. If summer dormant grasses could perform near their potential the pasture landscape would be quite different and this would have important positive benefits for natural resource sustainability. Our failure to understand many of the physiological and agronomic characters associated with summer dormancy is related to our inability to adequately use these plants. Therefore, this project is addressing 4 of the major questions in the field of summer dormancy using the grasses, phalaris, cocksfoot and tall fescue. The questions are:

1. How is summer dormancy best defined agronomically and physiologically?
2. Are summer dormancy and drought tolerance independent phenomena?
3. Does the plant have to enter reproductive growth to induce summer dormancy?
4. Does cutting or grazing in spring affect the induction of dormancy and the plant response to drought during the following summer?

This project, involving international cooperation with France, carried out several experiments to answer these questions in the field and controlled environments and is presently in the `analysis and writing-up` stage. It is disseminating its findings through publication in International Journals, presentations at Conferences and by giving talks to farmers at Field Days. Ag-Facts will also be prepared at the project's conclusion to ensure that `farmer-friendly` documentation is available over the long term.

# Research Project Description

## Project Title:

Determining the critical success factors in oversowing short-term ryegrass into tropical grass pastures  
(Activity #401)

## Principal Investigator:

Katrina Sinclair

## Funding Sources:

NSW Department of Primary Industries and the Far North Coast sub regional team of Subtropical Dairy Program (SDP).

## Objectives:

Determine the critical success factors in oversowing short-term ryegrass into a tropical pasture in autumn. The results obtained from this study will then be incorporated in further studies in order to validate these establishment principles.

## Summary:

To sustain year-round milk production on the far north coast of NSW dairy cows graze tropical grass pastures such as kikuyu, Rhodes grass and setaria in the summer to early autumn period and, as growth of these grasses declines in the cooler months (late autumn to mid-spring), these pastures are commonly oversown with short-term ryegrasses. These short-term ryegrasses are re-established annually in autumn using high sowing rates (35 to 40 kg ryegrass/ha) and maintained with monthly applications of nitrogen fertiliser (50 to 60 kg N/ha).

The successful establishment of a short-term ryegrass into a kikuyu pasture depends on restricting the growth of kikuyu in the autumn so as to provide sufficient light to the germinating ryegrass seedlings as well as reducing the competition for available soil moisture. Consequently, the management of kikuyu before and after the sowing of short-term ryegrass has a significant impact as to the success or otherwise of ryegrass establishment.

Far north coast dairy farmers use different establishment techniques in oversowing ryegrass into their tropical grass pastures, which they believe is successful for their farm system. However, failures are not uncommon resulting in either re-sowing, which not only results in a winter feed deficit but also substantial increases in feed costs. Underpinning the numerous successful ryegrass establishment techniques used in the region must be a number of factors that are critical to ryegrass establishment. Elucidating these critical success factors may decrease the risk associated with the practice of oversowing into tropical grass pastures thereby assuring the supply of high quality forage over the winter/spring period.

Personal interviews will be conducted on a number of dairy farmers from different areas within the region as to the time and the method they have adopted in oversowing short-term ryegrass. These interviews will be transcribed and analysed to determine the principles that must be considered when establishing short-term ryegrass.

# Research Project Description

## Project Title:

Evaluation of the phenotypic variation in kikuyu populations

(Activity #402)

## Principal Investigator:

Katrina Sinclair

[Note: This is a collaborative project with the Queensland Department of Primary Industries & Fisheries (QDPIF) and the Victoria Department of Primary Industries which is being led by Kevin Lowe (QDPIF)]

## Funding Sources:

NSW Department of Primary Industries, Dairy Australia and Meat & Livestock Australia.

## Objectives:

1. Provide background knowledge of kikuyu necessary to conduct a breeding program to improve its animal productivity.
2. Investigate the phenotypic variation in kikuyu by demonstrating that there is substantial variability in both natural populations (by collecting planting material from a wide range of environments) and mutagenically-treated plants. This material can provide the basis for selection of elite, high quality lines.
3. Determine if yield and quality are not significantly correlated within populations.
4. Establish which of the agronomic traits are important in sward formation.

## Summary:

The quality of tropical grasses is a major limitation to animal production in tropical and subtropical areas and this is mainly associated with the lower digestibility, relative to temperate species. The problem is the higher fibre levels of tropical grasses compared to temperate grasses and a major improvement would need to see increases in the digestion of the Neutral Detergent Fibre content of these plants. The main advantage of tropical grasses is in their ability to use the higher light levels in tropical areas to achieve high growth potential. Any improvement in quality will need to be achieved without seriously affecting this ability as a previous attempt to increase the quality of a tropical grass resulted in a grass with leaf of higher digestibility at least in cutting studies, but which did not persist under good management. Kikuyu (*Pennisetum clandestinum*), which is an important grass for the dairy and beef industries in subtropical areas of Australia, South Africa and New Zealand, has been selected as a target species.

The commercial kikuyu cultivars available in Australia appear to have come from a limited genetic base and there are no accessions in the Australian Tropical Resource Centre at Biloela. There appears to have been some selection of material by NSW Agriculture in the 1920s and it is possible that not all Australian material may have come from the same source. Therefore an evaluation of kikuyu plants from widely varying locations in Australia may provide valuable genetic variability. Alternatively, genetic manipulation may be an appropriate way to progress quality improvement in the species. An early attempt using the cultivar Whittet (by David Luckett 1996) has had some success.

Individual, spaced plants of kikuyu will be sown in the field under non-limiting nutrient and moisture conditions. Agronomic and quality attributes will be measured to determine the range of genetic variation in the species.

# Research Project Description

## Project Title:

Evaluation of *Brassica* species and perennial herbs in a mixed sward with temperate grasses on the north coast of NSW  
(Activity #403)

## Principal Investigator:

Katrina Sinclair

## Funding Sources:

NSW Department of Primary Industries and the Far North Coast sub-regional team of Subtropical Dairy Program (SDP).

## Objectives:

1. Evaluate the suitability of a perennial herb in a mixed sward with a temperate grass in terms of seasonal dry matter production, persistence composition, and forage quality.
2. Evaluate a range of forage *Brassic* spp. for their productivity, forage quality and grazing acceptability following an early autumn sowing.

## Summary:

In order to sustain year-round milk production on the north coast of NSW temperate grasses are grown in the cooler months to offset the decline in the production of tropical grasses. High yielding short-term ryegrass swards are the most common temperate pastures sown with a mixed pasture of perennial ryegrass and white clover less commonly sown due to its lack of persistence. From an evaluation of perennial temperate grass species, prairie grass and tall fescue were considered to be the most promising alternatives to perennial ryegrass.

The dairy industry currently uses more water than any other agricultural industry and with the current water reforms being undertaken in NSW the availability of water will almost certainly be restricted. There has been considerable attention to improving the water use efficiency of irrigation systems as well as determining the differences between species in their dry matter response and water use.

Perennial herbs such as chicory and plantain are raising considerable interest because of their ability to persist under high temperatures and to be productive under limiting soil moisture while still providing high quality forage. The perennial temperate grasses – perennial ryegrass, prairie grass and tall fescue – with either chicory or plantain will be evaluated for their productivity, quality, persistence and suitability as companions.

On the north coast of NSW, forage rapes (*Brassica napus* spp. *biennis*) have become an important autumn-grown fodder crop providing high quality feed when short-term ryegrass swards are establishing. Previous studies by Fulkerson and Slack have determined optimal management for growth and forage quality of *Brassica napus* L. (cv Bonar). There is now increasing interest in evaluating alternative species and cultivars to Bonar forage rape to fill the early autumn feed gap. A range of commercially available forage *Brassic*as, forage rapes, turnips, kales, Swedes and an experimental radish line will be sown and evaluated.

# Research Project Description

## Project Title:

Seasonal climate forecast to improve dairy farmers' feedbase management

*(Activity #404)*

## Principal Investigator:

Katrina Sinclair

## Funding Sources:

NSW Department of Primary Industries, CSIRO (Agricultural Production Systems Research Unit – Managing Climate Variability R&D Program).

## Objectives:

1. Investigate the opportunity for dairy farmers to use climate variability and seasonal forecasting data in their seasonal feed management strategies.
2. Evaluate in collaboration with dairy discussion groups, dairy service providers and advisers the skill and usefulness of integrating climate variability and seasonal climate forecasting (SCF) with a feed modelling capability, for investigation of seasonal pasture and fodder production options for the sub-tropical dairy region.
3. Provide to dairy farmers an education and training package on accessing and using climate and weather information.
4. Develop and deliver a learning package of feed management options in association with SCF to sub-tropical dairy farmers, their advisers and the dairy industry service sector.

## Summary:

The sub-tropical dairy industry in NSW and Queensland is being challenged by a deregulated domestic market and increased competition for land and water for urban development and other intensive agricultural enterprises. To remain viable dairy farmers are intensifying their pasture-based production systems by increasing herd size, stocking rate and inputs of fertiliser and supplements. Dairy farmers are facing unfamiliar territory and increased risk in managing the feedbase to supply milk year-round to processors.

This project will investigate the usefulness of seasonal climate forecasting (SCF) to improve the decision-making capacity of farmers in the sub-tropical dairy region in feedbase management. Regional historical weather data will be analysed for seasonal patterns and variability. The predictive skill of SCF indicators such as the Southern Oscillation Index (SOI) and Sea Surface Temperature (SST) will be examined.

Currently available crop and pasture models (APSIM and DairyMod) that use climate and soil data to estimate feed on-offer will be evaluated for their potential to add value to climate variability and SCF information and be used to conduct virtual experiments to evaluate alternative seasonal pasture and fodder production options.

Dairy farmers in the subtropical dairy region will have increased knowledge and understanding of weather and climate information and will be able to use seasonal forecasting data in their feed management strategies to improve risk.

# Research Project Description

## Project Title:

Warm season legumes for tropical and subtropical dairy production

(Activity #405)

## Principal Investigator:

Katrina Sinclair & Kerry Moore

[Note: This is a collaborative project with the Queensland Department of Primary Industries & Fisheries (QDPIF) and dairy farmers, led by Mr R.G. Walker (QDPIF) and Mr K.F. Lowe (QDPIF)]

## Funding Sources:

Dairy Australia, the NSW Department of Primary Industries and the Queensland Department of Primary Industries & Fisheries.

## Objectives:

1. Document management and measure the contribution to farm productivity of already established legume pastures on dairy farms in NQ, SE Qld and northern NSW.
2. In a farmlet research project examine the relationship between the proportion of *Arachis* and other tropical legumes in the summer and winter forage component of a dairy production system in terms of animal productivity and cost of production.
3. Use this farm and research information to develop an extension program to highlight successful production systems.

## Summary:

Deregulation of the dairy industry has increased the pressure to improve the efficiency of feeding systems, either by increasing milk production per hectare and/or producing milk at lower cost. Within the higher rainfall subtropics, a coastal zone from central NSW to north Qld, pasture can be grown year-round and remains the cheapest form of forage. Cool season forage production is based on irrigated temperate species, often ryegrass and clover mixtures, is well established.

Warm season forage production is based on tropical grasses fertilised with high rates of nitrogen, and there is concern about the sustainability and cost of this practice. Pasture systems based on the twinning tropical legumes have failed as stocking pressure increased under intensification. However, a number of productive tropical legumes have been identified as being capable of withstanding high stocking rates persistent. The legumes identified included *Arachis pinto* cv. *Amarillo*, *A. glabrata* and *A. paraguariensis*, *Vigna parkeri* cv. Shaw, *Aeschynomene villosa* cvs. Reid and Kretschmer, *Centrosema pubescens* cv. *Cardillo* and *Aes. fallcarta* cv. Bargoo.

It has been demonstrated that the tropical legume, pinto peanut, *Amarillo* (*Arachis pinto*), could replace half the area of nitrogen fertilised tropical grass and achieve similar milk production levels per cow. On a farm with 100 ha of grass and using 200 kg N/ha/year, the use of *Amarillo* pinto peanut in half the area would save 20 t urea at \$400/t, or \$8,000/year. Successful adoption of a tropical legume into a tropical grass pasture base could contribute to the sustainable improvement of milk production in northern Australia.

Farmer's awareness of these legumes needs to be improved by involving them in discussions of their agronomy and production. This would require practical assessment on farms with a focus on management strategies and a research component to fill knowledge gaps which may arise.

*Amarillo* pinto peanut will be established into a tropical grass base at Wollongbar Agricultural Institute (WAI) and on two co-operator farms in the Lismore/Kyogle district. The agronomy, management and productivity of these pastures will be monitored to develop best management practices (BMPs). An extension program will be developed for dairy farmers and dairy service provide to communicate these BMP's.

At WAI glasshouse studies will be conducted to determine the response of *Arachis pinto* to temperature and defoliation. Also, at WAI a small plot study will be conducted on the established kikuyu/*Arachis pinto* sward to determine the optimum seasonal grazing management.

# Research Project Description

## Project Title:

A genealogical study of the Australian native grass *Austrodanthonia caespitosa* (Gaudich.) H.P. Linder  
(Activity #393)

## Principal Investigator:

Cathy Waters

## Funding Sources:

NSW Department of Primary Industries, Charles Sturt University and the Cooperative Research Centre for Plant-Based Solutions for Dryland Salinity.

## Objectives:

1. To determine the genetic structure (pattern of variation among and within populations) and its relationship to landscape and environmental factors for *Austrodanthonia caespitosa*.
2. To determine the effects on performance (adaptation) of a number of populations of *Austrodanthonia caespitosa* in a series of reciprocal transplant experiments.
3. To develop a model for delimiting seed provenance boundaries (adaptation zones) for *Austrodanthonia caespitosa* by combining molecular genetic information with biogeographical and morphological data.

## Summary:

The potential for native grasses to control the deep drainage that leads to rising water tables and dry land salinity has been well documented in the uplands of the Murray-Darling Basin (Johnston et al. 2001). Here, low water-use of exotic pastures in summer has been identified as a major contributor to water table recharge and increases in dryland salinity. Many species, including *Austrodanthonia caespitosa* have been identified as useful in these situations (Johnston et al. 2001; Jones and Johnston 1998; Norton et al. 2001). However, no seed of commercially registered cultivars is available for broad-scale use in agricultural areas, limiting our ability to address this major environmental problem.

The native seed market currently relies on opportunistic harvesting of seed from wildland stands (Mortlock 1999, Loch and Whalley 1997), and thus seed supply is determined by local seasonal conditions. Sourcing non-local seed is sometimes the only option. In eastern Australia there appears to be a policy of using locally-sourced seed wherever possible (Mortlock 1999). In particular, Landcare and community revegetation projects have created a demand for this 'local provenance' material. A popular belief is that seed of local provenance will be best adapted to the target site and that non-local seed will be somehow less fit or mal-adapted (Knapp and Rice 1994; Linhart 1995; Loch and Whalley 1997; Jones and Johnston 1998). If true, the use of the wrong plant material could result in establishment failure, long-term mortality or disruption to the surrounding ecosystem. However, the major argument against using local provenance material is that we are unable to easily define provenance boundaries. The lack of such guidelines provides a major obstacle for the broad-scale use of Australian native grasses (Waters et al. 2003).

This project will address this deficiency by developing guidelines for provenance determination in one important native species and potentially identifying principles that might guide provenance establishment in others.