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**Research and Extension Capabilities:  
Program Economists in New South Wales Agriculture**

**Edited by:  
David T Vere  
John D Mullen**

**Economic Research Report no 14**



**NSW Agriculture**

**Research and Extension Capabilities:  
Program Economists in New South Wales Agriculture**

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**Economic Research Report No. 14**

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# **Research and Extension Capabilities: Program Economists in New South Wales Agriculture**

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## **Executive Summary**

In 1997 the economists in NSW Agriculture conducting applied economics research at its larger research stations were assigned to the Department's major programs of the Department. This report reviews some of their achievements since that time.

The report begins with a section describing the role of Program Economists and their management. Then follows a brief review of the main areas of interest of each of the twelve economists. A large section of the report is devoted to outlining major areas of research and extension where program economists, often working cooperatively, have made a significant contribution. These areas include:

- Analyses of market conditions for agricultural products;
- Field crop economics;
- Grazing and pasture economics;
- Integrated weed and pest management economics;
- Farming systems economics;
- Provision of farm management information;
- Research and extension evaluation and policy.

Aspects reviewed in these areas included the key findings from research, research objectives, future directions of research and for each area, a selection of the most significant publications produced by program economists.

The final section of the report is a listing of publications by program economists since 1997. Since then they have written 9 book chapters, 57 refereed journal papers, 23 refereed research bulletins, 40 papers in conference proceedings, 94 invited and contributed conference papers, 56 miscellaneous reports and work papers; and 43 farm management papers.

## 1 Role Of Program Economists

NSW Agriculture Program Economists work in the Department's product programs located within the Divisions of Animal Industries and Plant Industries.

The work plan of economists is oriented towards the objectives of their 'home' Program. In addition there are CRC and industry funded positions within the same structure, usually working on specific projects.

NSW Agriculture Economists in Programs conduct research and extension in broad areas;

- analyses of the economic, environmental and social impacts of alternative agricultural technologies and resource management strategies for major farming systems in NSW;
- provision of economic information relevant to decision-making by the clients of NSW Agriculture;
- assistance in identifying priorities for research and extension resources within the Programs in NSW Agriculture.

[Dr. J.D. Mullen](#), Economics Coordinator, assists in the coordination of economics research across the main Programs in NSW Agriculture and in the professional development and assessment of the Program Economists. Work planning and staff assessment processes are jointly undertaken by Program Managers and John Mullen. Most program economists seek promotion on the basis of applied economics research with five of them progressing within the research scientist classification.

Economic policy work is undertaken within the Economic Services Unit of NSW Agriculture.

## 2 Directory Of Program Economists

[John Brennan](#), Field Crops Program

[Lloyd Davies](#), Meat, Dairy & Intensive Livestock Program

[Bob Farquharson](#), Farming Systems Program

[Garry Griffith](#), Meat, Dairy & Intensive Livestock Program

[Robyn Hean](#), Farm Forestry Unit (Agricultural Resource Management Program)

[Randall Jones](#), Pastures and Rangelands Program and CRC for Australian Weed Management

[John Mullen](#), Agricultural Resource Management Program and Economics Coordinator

[Salahadin Khairo](#), Pastures and Rangelands Program

[Fiona Scott](#), Farming Systems Program

[Rajinder Pal Singh](#), Agricultural Resource Management Program

[David Vere](#), Pastures and Rangelands Program

[Ziaul Hoque](#), Cooperative Research Centre for Sustainable Cotton Production

---

## 2.1 John Brennan

**Qualifications:** B.A. (Hons) (1970, U. Melb.), M.Ag.Sc. (1981, U. Melb), PhD (1989, UNE)

**Joined NSW Agriculture:** 1980

**Present Position:** Principal Research Scientist, Field Crops Program

**Location:** [Wagga Wagga Agricultural Institute](#)

**Contact Details:** Phone: 02 -6938 1851 Fax: 02-6938 1809

Email: [john.brennan@agric.nsw.gov.au](mailto:john.brennan@agric.nsw.gov.au)

### **Current research program:**

- Evaluate economic issues relating to profitable and sustainable farming systems in Southern NSW, with particular emphasis on:
    - (a) developing whole-farm analyses of farming systems;
    - (b) undertaking economic analysis of new technologies to draw out the economic implications for sustainable southern farming systems; and
    - (c) assisting in developing appropriate policies for managing an incursion of Karnal bunt of wheat;
  - Improve research resource allocation and priority setting through the provision of economic information of relevance to Departmental and industry research and development activities through:
    - (a) economic information and support for the Field Crops Program;
    - (b) economic evaluations of R&D activities.
  - Improve the efficiency of crop improvement programs through the provision of appropriate economic information and analysis, with particular emphasis on:
    - (a) evaluating the value of plant breeding for improved characteristics;
    - (b) assessing the impact of crop improvement research on Australia; and
    - (c) undertaking economic analyses of other plant improvement issues, particularly wheat breeding, international spillovers, genetic diversity, disease losses, and crop variety trials;
  - Provide economic support for activities to enhance the protection and management of the State's soil and water resources.
-



## 2.2 Lloyd Davies

**Qualifications:** WDA (Hons 1971), B.Ag.Ec.(Hons) (1975, UNE), Grad. Dip. Mngt (1997), MBA (1998, Newcastle).

**Joined NSW Agriculture:** 1971 as trainee.

**Present position:** Special Economist, Meat, Dairy & Intensive Livestock Program

**Location:** Tocal Agricultural Centre, Paterson

**Contact Details:** Phone: 02 4939 8947 Fax: 02 4939 8950

Email: [lloyd.davies@agric.nsw.gov.au](mailto:lloyd.davies@agric.nsw.gov.au)

### Current research program:

- Co-ordinate farm management information delivery within NSW Agriculture;
  - Farm business management training of farmers and farm advisors;
  - Economics of the NSW beef and dairy industries. Analysis of regional performance, assisting industries in developing benchmarking programs, analysis of farm level impacts of new technology, drought recovery issues;
  - Evaluation of farm level impacts of new technologies in the beef, dairy and intensive livestock industries.
- 

## 2.3 Robert (Bob) Farquharson

**Qualifications:** B Ag Econ (UNE 1976), M Econ (UNE 1991), M Sc (Ag and Resource Econ) (UC Davis 1998)

**Joined NSW Agriculture:** 1987

**Present position:** Special Economist, Farming Systems Program

**Location:** [Tamworth Centre for Crop Improvement](#)

**Contact Details:** Phone 02-6763 1194 Fax: 02-6763 1222

Email: [bob.farquharson@agric.nsw.gov.au](mailto:bob.farquharson@agric.nsw.gov.au)

### Current research program:

The main focus of the research program is to assess the economic impact of alternative agricultural technologies and resource management strategies for sustainable cropping and grazing systems in northern New South Wales. The main areas of work include:

- Analysing the impacts of alternative technologies and economic conditions in the broadacre industries of northern New South Wales;
  - Providing economic information on resource use, production and marketing relevant to the Farming Systems Program and to the clients of NSW Agriculture; and
  - Assisting in identifying priorities for research and extension resources within the Farming Systems Program, particularly in northern New South Wales.
-

## 2.4 Garry Griffith

**Qualifications:** B.Ag.Ec.(Hons)(1972, UNE); M.Ec.(1978, Macquarie); PhD (1980, Guelph)

**Joined NSW Agriculture:** 1968 as trainee

**Present Position:** Principal Research Scientist, Meat, Dairy & Intensive Livestock Program

**Location:** [Armidale Beef Industry Centre](#)

**Contact Details:** Phone: 02-6770 1826 Fax: 02-6770 1830

Email: [garry.griffith@agric.nsw.gov.au](mailto:garry.griffith@agric.nsw.gov.au)

**Professional Activities:** Associate Editor, AJARE; Editorial Board, AAR

Past President of AARES (1999)

Adjunct Professor, Graduate School of Agricultural and Resource Economics, UNE

### Current research program:

- Development of modelling frameworks for measuring the benefits from investments in R&D and from promotion and policy changes and for doing benefit/cost analyses. This includes both farm models and industry models and covers both cost-reduction and quality-enhancing technologies;
  - Assessment of how the benefits of new technologies, promotion or policy changes are shared between producers, processors and consumers. Specific projects are in the grazing and livestock industries with research linkages with the Sheep and Beef CRC's in the areas of technology impact evaluation;
  - Provision of technical advice to other Program Economists, contributions to the wider profession and supervision of postgraduate students;
  - Provision of economic advice to MDLIP Program.
-

## 2.5 Robyn Hean

**Qualifications:** B.Ec., Hons (1992, UTas); PhD (2001, UNE)

**Joined NSW Agriculture:** September 1999

**Present Position:** Economist, Agroforestry Unit (Agricultural Resource Management

**Location:** [Tamworth Centre for Crop Improvement](#)

**Contact Points:** Phone: 02-6763 1285 Fax: 02-6763 1222

Email: [robyn.hean@agric.nsw.gov.au](mailto:robyn.hean@agric.nsw.gov.au)

**Professional Activities:** Secretary, Australian Agricultural and Resource Economics Society  
New England Branch; Coeditor, SEA News

### **Current research program:**

- Providing general economic advice to the Agroforestry Unit, including paddock-level economic analysis of integrating trees into agricultural production systems in salinity-hazard areas of NSW;
  - Farm-level economic analysis of agroforestry options for dryland-salinity mitigation identified for consideration by the CRC for Plant-based Management of Dryland Salinity;
  - Developing catchment-level modelling frameworks for measuring the benefits and costs of alternative plant-based management approaches to dryland salinity;
  - Assessing the economics of agroforestry systems in the presence of carbon-sequestration credit payments.
-

## 2.6 Randall Jones

**Qualifications:** B. Fin. Admin. (1983); Dip. Ag. Econ. (1983); M.Ec. (1991) (UNE)

**Joined NSW Agriculture:** 1983

**Present Position:** Senior Research Scientist, Pastures and Rangelands Program & CRC for Australian Weed Management

**Location:** [Orange Agricultural Institute](#)

**Contact Details:** Phone: 02-6391 3960 Fax: 02-6391 3975

Email: [randall.jones@agric.nsw.gov.au](mailto:randall.jones@agric.nsw.gov.au)

### **Current research program:**

- Economic research into the impact of specific target weeds in annual cropping systems and perennial pastures ecosystems in southern Australia;
  - Determination of the economic benefits from weed control technologies being developed by the Weeds CRC;
  - The research involves an integrated modelling framework which will measure the impact of technologies at the farm and market levels using a combination of farm, industry and economic surplus models. The farm-level benefits from weed management technologies are assessed through the development of dynamic bio-economic models of cropping and pasture systems;
  - Economic research of sustainable grazing systems in the perennial pastures ecosystems in southern Australia.
-

## 2.7 John Mullen

**Qualifications:** B.Ag.Ec. (1972); M.Ec. (1978) (UNE); PhD (1985, Texas A&M)

**Joined NSW Agriculture:** 1968 as trainee

**Present Position:** Principal Research Scientist, Agricultural Resource Management;  
Economics Coordinator; Adjunct Professor, Faculty of Rural Management, University  
of Sydney, Orange

**Location:** Orange

**Contact Points:** Phone: 02-6391 3608 Fax: 02-6391 3650

Email: john.mullen@agric.nsw.gov.au

**Professional Activities:** Co-Editor of the Australian Journal of Agricultural and Resource  
Economics

### Current research program:

- Economic issues associated with land degradation, such as soil acidity, in farming systems in New South Wales;
  - The economics of agricultural research and extension in Australia including:
    - The distribution of the benefits from R&D;
    - Productivity growth in agriculture;
    - Returns from agricultural R&D;
    - Expenditure on R&D and extension in Australia;
    - Project evaluation.
  - As Economics Coordinator provide leadership in economics research in NSW Agriculture with a particular focus on resource management in key farming systems through the coordination of work plans, staff assessment, professional development and mentoring activities.
-

## 2.8 Salahadin Khairo

**Qualifications:** B.Ag.Ec. (AUA)(1990, Ethiopia); Gra.Dip.Res.Ec. (1997, UNE); M.Ec. (UNE, 1999)

**Joined NSW Agriculture:** 2003

**Present Position:** Economist, Pastures and Rangelands

**Location:** [Trangie Agricultural Research Centre](#)

**Contact Details:** Phone: 02 6888 7404 Fax: 02 6888 7201

Email: [Salahadin.Khairo@agric.nsw.gov.au](mailto:Salahadin.Khairo@agric.nsw.gov.au)

### Current research program:

- Assist in modelling farming systems in the Little River locality for evaluating the consequences for farm profit and salinity externalities of alternative land use or crop rotation strategies;
- Define and describe in terms of resources and constraints, the production system in the Rangelands and identify in conjunction with farmers a representative farm(s) to be used in economic evaluations of farming systems for this region;
- Provide economic information to landholders and NSW Agriculture including farm enterprise budgets and whole farm budgets for the Central West region; contract rates; Agfacts and other extension publications.

## 2.9 Fiona Scott

**Qualifications:** B.Ag. Ec., Hons (1993, UNE)

**Joined NSW Agriculture:** 1993

**Present Position:** Economist, Farming Systems Program

**Location:** [Tamworth Centre for Crop Improvement](#)

**Contact Details:** Phone 02-6763 1156 Fax: 02-6763 1222

**Email:** [fiona.scott@agric.nsw.gov.au](mailto:fiona.scott@agric.nsw.gov.au)

### Current research program:

- Focus on projects involving the economic analyses of rotations of cereals, legumes, oilseeds and pastures;
- Describe the production systems in the northern wheat-sheep belt and identify representative farms to be used in economic evaluations of farming systems for this region. This may include assessing the economic impact of alternative agricultural technologies and resource management strategies for sustainable cropping and grazing systems in northern New South Wales;
- Providing economic information to landholders and NSW Agriculture staff including farm enterprise budgets and whole farm budgets for the northern region.

## 2.10 Rajinder Pal Singh

**Qualifications:** B.Sc. Agric. Honours (1977), M.Sc. Ag Econ (1981), PhD. (1993 Guru Nanak Dev. University, India)

**Joined NSW Agriculture:** 1998

**Present Position:** Economist, Agricultural Resource Management Program.

**Location:** [Yanco Agricultural Institute](#)

**Contact Details:** Phone: 02-6951 2618 Fax: 02-6955 7580

**Email:** [rajinder.pal.singh@agric.nsw.gov.au](mailto:rajinder.pal.singh@agric.nsw.gov.au)

### Current research program:

- Conduct economic analyses of the on-farm implications of options within Land and Water Management Plans;
  - Compare the water use efficiency of different irrigated farming systems;
  - Work with CRC (Rice) to evaluate the impact of new technologies, water reforms proposals, other natural resource issues and measurement of returns to CRC investment on R&D;
  - Conduct whole farm analyses within the intensive vegetable industry to identify crop rotations and management practices that are profitable and sustainable;
  - Analyse the economics of switching from furrow to high tech irrigation systems within extensive horticultural industries;
  - Provide economic information to landholders and NSW Agriculture including Farm Enterprise Budgets and Whole Farm Budgets for the southern irrigated region.
-

## 2.11 David Vere

**Qualifications:** B.Ag. Ec. (1970) UNE; M.Ec. (1980) (UNE)

**Joined NSW Agriculture:** 1967 as trainee

**Present Position:** Senior Research Scientist, Pastures and Rangelands Program

**Location:** [Orange Agricultural Institute](#)

**Contact Details:** Phone: 02-6391 3850; Fax: 02-6391 3899

**Email:** david.ver@agric.nsw.gov.au

### Current research program:

- Development and application of economic model in evaluating the impacts of problems in temperate grazing systems at farm and industry levels; economic analysis of the technology and problems of pasture improvement on the New South Wales tablelands including pasture weeds; general equilibrium impacts of weeds on Australian agriculture;
  - Economic analysis of the impacts of production technology adoption, policies and events in the state and Australian grazing industries; refinement and application of quarterly econometric models of the Australian grazing industries; forecasting in the Australian grazing industries; sub-program leadership and economic evaluations within the Australian Sheep Industry CRC;
  - Economic analyses of livestock production systems on the New South Wales tablelands;
  - Economic analyses of livestock diseases on the Australian grazing industries.
- 

## 2.12 Ziaul Hoque

**Qualifications:** B.Sc.Ag.Econ. (Hons)(BAU, 1987), M.Sc.Ag.Econ (Ag Finance)(BAU, 1989), M.Ec.(Ag Econ)(Uni. Sydney, 1997)

**Joined NSW Agriculture.:** April, 1999

**Present Position:** Economist, IPM in the Cotton Industry, Field Crops - Plant Fibres Program.

**Location:** [Australian Cotton Research Institute, Narrabri](#)

**Contact Details:** Phone 02-6799 1553 Fax 02-6799 1186

**Email:** ziaulh@mv.pi.csiro.au

### Current research program:

- Economic evaluation of different IPM strategies in terms of resistance management in the short and long term;
  - Cost/benefit analyses of research and development programs conducted by the Co-operative Research Centre for Sustainable Cotton Production.
-



### **3 Research And Extension Capabilities**

#### **3.1 Analyses of market conditions for agricultural products**

##### **Key Messages**

- The ability of producers, consumers and other market participants to share in the economic benefits of market interventions such as new technologies depends on the economic conditions in the markets for New South Wales agricultural products.
- Reliable estimates of relevant market characteristics such as elasticity values are crucial in accurately calculating the expected impacts of such interventions.
- For many of the major New South Wales agricultural products, the export market is the largest market. Changing demand and supply conditions in the world market are quickly transmitted to the domestic market.
- Program Economists have been active in the development of economic modelling systems that account for demand and supply relationships, domestic and export markets and the strong inter-relationships between product.
- Forecasts of market supply and demand conditions and National Competition Policy studies have been important applications of these modelling systems. In the latter studies, some have favoured deregulation, while others have demonstrated the benefits of the regulations.

##### **Economists Involved**

Garry Griffith, David Vere, John Mullen, Bob Farquharson, John Brennan.

##### **Departmental Programs Involved**

Farming Systems; Field Crops; Meat, Dairy and Intensive Livestock Products; Sheep and Wool; Pasture and Rangelands; Economic Services Unit.

##### **Background**

In analysing the market conditions for New South Wales and Australian agricultural products, economists are interested in two main issues; (i) the degree to which producers, processors, retailers and consumers of these products respond to economic incentives, and (ii), the degree to which these markets are influenced by external conditions. Knowledge of these issues allows for the reliable calculation of the costs and benefits of the adoption of new technologies, of advertising campaigns or of the imposition or reduction of domestic or trade policy instruments.

The first issue relates to the slope and position of the relevant demand and supply curves. These data can be classified as the 'elasticity conditions of the market'. A price elasticity is defined as the percentage change in quantity for a given percentage change in price. Thus, the price elasticity of demand for beef is the percentage change in the demand for beef in a given market, following a one per cent change in the price of beef in that market. Elasticity values greater than one, where changes in quantities are greater than changes in prices, are 'elastic', while elasticity values less than one, where changes in quantities are less than

changes in prices, are 'inelastic'. The ability of market participants to share in the economic benefits of market interventions such as new technologies depends on these elasticity values. Inelastic demand and supply curves suggest a greater ability to share in these benefits while elastic demand and supply curves suggest a lesser ability to share in these benefits. Thus, estimates for relevant elasticities are crucial in evaluating the expected impacts of new technologies, advertising campaigns, trade market interventions, etc.

The second issue relates to the external market context of the product of interest, and this may take many forms. First, the demand for New South Wales and Australian agricultural products comes from both domestic and overseas markets. For many of the major products, the export market dominates. Demand in export markets is typically elastic, and with fewer trade barriers, this suggests that changing demand and supply conditions in the world market are quickly transmitted to the domestic market. The influence of the US cattle cycle on the world and New South Wales cattle markets is a good example.

Second, much of the supply of New South Wales agricultural products comes from mixed farms. Cattle compete with sheep and lambs and crops for available land in many areas of the state. The relative profitability of the different options influences the share of land going to different enterprises. Analysis of the market conditions for any one of these products has to take account of the cross-commodity relationships determining supply. Relatedly, several of these products are also substitutes in final demand. This suggests the development of a modelling framework that has these inter-relationships between products specifically included in a consistent manner.

Program Economists in NSW Agriculture have undertaken numerous economic studies of the market conditions for New South Wales agricultural products. Much of the work done has been on reviewing previous research and on obtaining reliable estimates of demand and supply elasticities where gaps exist. Another part of the work has been on developing integrated modelling frameworks for the linked commodity markets in the broadacre agriculture sector. Several of the Economists have been involved in estimating the benefits and costs of proposals for deregulation of some New South Wales agricultural products (in particular, milk, rice, malting barley, feed barley and canola).

Economics research undertaken in NSW Agriculture in this area seeks to develop quantitative economic models of New South Wales and Australian agricultural industries so that the net benefits of new technology offerings can be reliably assessed. Appropriate advisory messages can then be developed to speed up the adoption of those technologies that are expected to be profitable.

### **Research Objectives**

- Review of previous research on demand and supply elasticities for New South Wales and Australian agricultural industries.
- Where gaps exist, estimation of demand and supply elasticities using appropriate theoretical concepts and statistical techniques.
- Development of quantitative economic models of New South Wales and Australian agricultural industries based on both time series econometric and synthetic modelling methodologies.

- Application of these models to assessing the expected impacts of domestic or trade policy proposals.
- Application of these models to evaluating the expected impacts of new technology offerings.

### **Industry Outcomes**

- Improved policy formulation in agriculture in New South Wales.
- Improved farm management decisions because of a better understanding of how markets work and the factors that influence them.

### **Future Directions**

- Further development of integrated models of cropping and grazing industries.
- Updating existing estimates of supply and demand elasticity values.
- Application to new technologies proposed by NSW Agriculture scientists including those attached to Cooperative Research Centres.

### **External Links**

The University of New England.

The University of Queensland.

Monash University.

### **External Funding**

The Cooperative Research Centre for Cattle and Beef Quality.

The Australian Sheep Industry Cooperative Research Centre.

The Cooperative Research Centre for Weed Management Systems.

Rural Industries Research and Development Corporation.

Australian Research Council.

### **Significant Publications**

Farquharson, R.J. and Griffith, G.R. (2001). 'Single desk selling by the NSW Grains Board: Public benefit or public cost?' *Australian Agribusiness Review*, [Online]. <http://www.agribusiness.asn.au/Review/2001v9/Farquharson/FarquharsonGriffith.htm>

Griffith, G.R., Vere, D.T. and Bootle, B.W. (1995). 'An integrated approach to assessing the farm and market level impacts of new technology adoption in Australian lamb production and marketing systems: the case of large, lean lamb.' *Agricultural Systems* 47 (2), 175-198.

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## 3.2 Field Crop Economics

### Key Messages

- Field crops represent a dominant component of agriculture in New South Wales, and field crops research and extension represent a very significant proportion of NSW Agriculture's activities.
- Public wheat breeding programs have been shown to be a profitable investment, with high returns on the money invested in the programs.
- The potentially important role of new plant breeding technologies and new breeding approaches has also been evaluated.
- The losses from various wheat diseases have been estimated, so that the areas where research is likely to have the highest pay-offs have been identified.
- The yield losses in rice due to cold temperatures can be overcome economically by the development of cold tolerant rice varieties.
- Some areas of research, such as the development of some feed grains with particular characteristics for livestock, have been shown to be unprofitable investments.
- The importance of international germplasm flows has been identified, and the role that international agricultural research centres play in improving Australia's agricultural productivity has been quantified.
- The value of crop variety trials and the need to ensure adequate testing of varieties across environments have been evaluated.

### Economists Involved

John Brennan, Bob Farquharson, Fiona Scott and Rajinder Pal Singh.

### Departmental Program Linkages

Field Crops Program.

Farming Systems Program.

### Background

In the five years to 2002, an average of 5.7 million hectares was planted to field crops in New South Wales each year. Cereal crops represented 81% of the total area in recent years, with 4% pulse crops, 7% oilseeds and 7% cotton. Wheat (3.4 million hectares) is the predominant crop, with barley (0.5 million hectares), oats (0.3 million hectares) and rice (0.13 million hectares) the main cereal crops. The proportion of non-cereals has been increasing in the past decade, mainly due to the increasing importance of canola (0.5 million hectares) and cotton (0.4 million hectares).

Field crops represent 22% of the gross value of agricultural production in New South Wales. Wheat (17% of the state total) is the main field crop, by value. Over 10,000 farm holdings in New South Wales undertake grain production as a major enterprise. The majority of the grain produced in New South Wales is exported.

Crop improvement programs are conducted by NSW Agriculture for each of the major crops. The provision of economic information and analysis to these programs leads to more appropriate resource allocation decisions. A key program component is the development of disease resistance and integrated disease management for the field crops. Wheat diseases have been estimated to cause losses averaging \$77 million per year in NSW.

### **Research Objectives**

- To provide basic economic information and analysis on cropping to support the Departmental programs
- To improve the efficiency of crop production programs and the adoption of new technologies through the provision of economic analyses of new cropping technologies
- To improve the efficiency of crop improvement programs through the provision of appropriate economic information and analysis
- To reduce the losses caused by plant diseases through the provision of economic information and analyses on plant diseases and methods of control
- To reduce losses caused by environmental constraints on crop production

### **Industry Outcomes**

- The economic information and analytical support, through the provision of enterprise budgets and other supporting information for farmers and advisers, has assisted Departmental officers to improve the efficiency of crop production in New South Wales.
- Reliable economic information and analysis on various aspects of crop improvement programs has ensured that those programs are producing varieties that provide significant efficiency gains for New South Wales farmers.
- Economic analysis on the costs of crop diseases and the value of disease resistance has ensured that appropriate disease management strategies are employed in the grains industries
- The economic information on pay-offs from research enables research funding organisations to improve research resource allocation that enhances the outcomes of research programs and improves farm productivity
- The economic analysis undertaken has led to improved research resource allocation for international agricultural research into crops.
- The analysis undertaken has led to improved allocation of resources priority setting for crop variety trials and within the feed grains sector in New South Wales.

### **Future Directions**

- Further provision of information and analyses on cropping activities to support the Field Crops and Farming Systems Programs, including the economic benefits of improved climate forecasting;
- Continuing economic support for the Department's crop improvement programs, particularly the role of competitive cultivars and new breeding technologies;
- Continuing assessment of the returns from research, particularly in relation to rust resistance in wheat;
- Continuing economic evaluation of issues relating to sustainable rice production;

- Continuing economic assessment of the role of research spillovers in the benefits of R&D activities, particularly from CIMMYT in Mexico;
- Continuing economic analysis of issues relating to crop diseases, particularly rust diseases and Karnal bunt of wheat.

### **External Links**

Because the majority of the grain produced in New South Wales is from mixed farms, there are close links between different states in their work on field crops economics.

There are international links with field crop improvement, because of the close relationship between many Australian breeding programs and their counterparts in international agricultural research centres, particularly CIMMYT in Mexico, ICARDA in Syria and ICRISAT in India. There are also collaborative linkages with the Rural Economy Research Centre, Teagasc, Ireland.

### **External Funding**

Funding for field crops economic research has been received from a number of sources, including:

Grains Research and Development Corporation.

Rural Industries Research and Development Corporation.

Australian Centre for International Agricultural Research.

Cotton Research and Development Corporation/Australian Cotton CRC.

CRC for Sustainable Rice Production.

European Community Fifth Framework.

### **Significant Publications**

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- Smale, M., Meng, E., Brennan, J.P. and Hu, R. (2003). 'Determinants of spatial diversity in modern wheat: examples from Australia and China.' *Agricultural Economics* 28, 13-26.



### 3.3 Grazing and Pasture Economics

#### Key Messages

- Increasing the perennial grass content of pastures is the main influence on grazing enterprise profitability in the New South Wales temperate areas.
- Increased perennial grass composition is associated with a number of sustainability and environmental benefits such as reduced recharge of the watertable and dryland salinity.
- Well managed improved pastures generate long-term profits under most environments in the New South Wales high rainfall areas.
- Perennial native pastures based on good quality species can be an attractive economic proposition in parts of the New South Wales tablelands.
- Conservation offsets yield higher economic returns than extensive grazing in the Southern Mallee region of the New South Wales Western Division.
- The use of native forage shrubs is preferred to tactical grain feeding for managing seasonal variability in mixed farming systems in central western New South Wales.

#### Economists Involved

David Vere, Randall Jones, and Salahadin Khairo.

#### Background

Pastures are the economic basis of the New South Wales grazing industries, particularly in the high rainfall areas and the semi-arid rangelands where cropping is limited. The two major pasture types are the permanent systems based on introduced perennial grasses and legumes or good quality native species that are found in the higher rainfall and the semi-arid rangelands non-crop regions, and the legume-based annual pastures that are usually grown in rotations with crops. Improved pastures are a relatively small part of rural land use but they support a much larger proportion of the livestock populations. New South Wales has about 23% of Australia's improved pastures and two-thirds of these occur in the temperate eastern and southern regions. The total area of improved pastures on the central and southern tablelands was about 740,000 hectares in 1996-97.

In the high rainfall areas, pasture improvement involves replacing poor quality pastures with introduced perennial grasses and legumes with the objective of increasing pasture quality and livestock production, improving soil fertility and weed control and protecting against soil erosion, salinity and acidity. Under favourable soil fertility and rainfall conditions, improved pastures support 10-15 dry sheep equivalents (DSEs) per hectare compared to less than five DSEs per hectare on native pastures. However, these pasture systems have been the focus of concern about their long-term sustainability. Pasture surveys in the state's temperate areas have found many previously improved pastures now have high proportions of undesirable species which have reduced pasture quality. For example, unproductive annual grasses formed an average 26% of the biomass of tablelands pastures and comprised up to 80% of the pasture biomass in some areas (in a 1999 survey). Only 10% of the areas surveyed in the latter study contained the 50% improved perennial

grass content that is required to maximise pasture production. The biological aspects of improved pasture decline have emerged over long periods and include soil salinity, acidity and weeds.

In the semi-arid rangelands, maintaining productive perennial pastures involves managing total grazing pressure with the objective of keeping desirable native pasture species in the landscape and implementing strategies to manage woody weed encroachment. Total grazing pressure is the term used to describe the aggregation of native, feral and domestic animals that graze the semi-arid rangelands. The inclusion of native and feral animals is in recognition that the pasture utilised by these animals is significant and that traditional techniques to set stocking rates for domestic animals may lead to overgrazing, reduced persistence of desirable perennial species and when seasons permit woody shrub encroachment. Strategies designed to maintain desirable perennials include rest periods at critical times, by controlling watering points, alternative techniques to calculate and manage total grazing pressure, alternative enterprises such as goats that utilise shrub, mechanical intervention and locking up to build a fuel load for fire, the desired mechanism for young shrub control.

Economists in NSW Agriculture have recently undertaken several economic studies of pasture systems and pasture problems. In the temperate non-crop regions, these studies have concerned the economics of the main types of permanent pasture systems; change in the long-term species composition, sustainability and economic productivity of these systems; the economics of the major native pasture types; and the problems of weeds and rabbits. In the semi-arid rangelands, these studies have concerned the economics of alternative enterprises for woody weed dominant landscapes; the economics of introducing desirable native perennial pastures and shrubs on cropping land; and evaluating proposed conservation offsets in return for increased cropping area.

### **Research Objectives**

- Economics of improved temperate pasture systems.
- Economic productivity of temperate pastures.
- Economics of native pasture systems on the tablelands.
- Economic models of tablelands grazing systems.
- Economics of sustainable grazing.
- Economics of alternative semi-arid rangelands enterprises.

### **Industry Outcomes**

- Perennial grass based pastures have a long-term economic superiority over legume dominant and other pasture types in a range of soil fertility-rainfall environments on the south-eastern tablelands of New South Wales.

- The economic productivity of pastures based on introduced perennial grasses on the New South Wales tablelands has grown strongly over time. The productivity of pastures based on introduced legumes has declined significantly in comparison.
- High-quality and well managed native pasture systems yield good economic returns and are economically superior to legume pastures in most New South Wales tablelands environments.
- Conservation offsets in return for increased cropping area have the potential to return higher levels of net income than extensive grazing in the Southern Mallee region of the New South Wales Western Division.
- Forage shrubs, in particular Old Man Saltbush, utilised as a strategic tool for managing seasonal variability are preferred to tactical grain feeding for mixed livestock and cropping farms based on annual crops and pastures in the central west of New South Wales.

### **Future Directions**

- Further development of linear and dynamic programming models of sustainable temperate pasture and grazing systems.
- Economic analysis of acid soil problems on the tablelands and slopes.
- Economic analysis of aerial pasture establishment.
- Development of simulation models of pasture and grazing systems for the mixed livestock/cropping and arid zones of New South Wales.
- Economic analysis of role of pastures in mixed livestock/cropping farms in the central west of New South Wales.

### **External Funding**

CRC for Weed Management Systems (completed).

### **Significant Publications**

Dowling, P.M., Jones, R.E., Kemp, D.R. and Michalk, D.L. (2001). 'Valuing the pasture resource – importance of perennials in higher rainfall regions of south eastern Australia'. Contributed paper, International Grassland Congress, Brazil.

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### 3.4 Integrated Weed and Pest Management Economics

#### Key Messages

- Pests and weeds in agricultural systems impose significant costs upon producers and consumers. As an example, weeds in annual winter crops across the Australian wheat-belt cost \$1.2 billion per annum, and the total cost to Australian agriculture from weeds has been conservatively estimated at \$3.3 billion a year.
- Managing lower vertebrate and invertebrate (ie. insect) pests, as well as weed, populations has the potential to generate significant long-term economic benefits to crop and pasture systems.

#### Economists Involved

Randall Jones, David Vere, Bob Farquharson and Ziaul Hoque.

#### Departmental Program Linkages

Pastures and Rangelands Program; Agricultural Protection Program; Field Crops - Plant Fibres Program

#### Background

Farmers identify weeds as being the most important production and natural resource management problem in Australian cropping systems. In all regions across the Australian wheat-belt, weeds and pests were ranked as being a greater problem than soil salinity, soil acidity and soil erosion. It has been estimated that the cost of weeds (mostly annual ryegrass, wild oats and wild radish) in the winter cereal, oilseed and pulse crops is \$1.2 billion a year. Management options that have been determined to yield significant long-term economic benefits involve technologies that reduce seed input to the weed seed bank and result in a decline in weed populations over time.

Weeds are also a major economic problem in grazing systems in the high rainfall temperate perennial zone of south-eastern Australia. Economic costs of up to \$200 per hectare can result from undesirable pasture weed species such as annual grasses such as *vulpia* spp. and barley grass, broadleaf weeds such as Paterson's curse and thistles, perennial grass weeds such as serrated tussock and African lovegrass, and woody weeds such as blackberry and lantana. In addition to production losses due to weeds, there are range of environmental problems associated with the replacement of deep rooted perennial grasses with shallow rooted annual species such as salinity, acidity and excessive runoff containing high levels of soil sediment, nitrates and phosphates. Various management options are being developed to improve the perennial grass composition of these grazing systems, including reduced stocking rates, tactical grazing rests, manipulation of soil condition through fertilisers and lime, herbicides and revegetation with trees.

The Australian cotton industry faces serious insect pest problems, particularly *Heliothis* moths, which require large volumes of pesticides for control, resulting in significant industry costs. In addition, the development of insecticide resistance by insect populations imposes substantial costs on the cotton industry as it leads to reduced insecticide efficacy and potentially the complete loss of a chemical. Evaluation of Integrated Pest Management strategies within the Cotton industry and the use of Area Wide Management are also important. Other important pest issues facing agriculture include the management of a

range of vertebrate pest that impact upon the grazing industries. These include rabbits, feral pigs, foxes, feral goats, kangaroos and wild dogs. All pests result in economic costs from production losses, quality reduction, grazing competition, livestock predation, damage to farm infrastructures and resources, costs of control and the external costs of pest spread.

### **Research Objectives**

- Determine the economic benefits from reduction in weed seed banks in cropping systems.
- Determine optimal management strategies involving combinations of stocking rate, tactical grazing rests, fertiliser, lime and herbicides to manipulate pasture species composition and maximise long-term benefits from improved resource use.
- Investigate farm-level financial impacts of alternative insect spray strategies – mainly 'softer' chemicals targeted at *Heliothis* (which maintain the beneficial/predator insect populations) versus traditional harder' broad-spectrum chemicals which target all insects.
- Specify alternative management strategies involving the use of Tracer® (a Spinosyn chemical), to which insects have recently shown signs of resistance.
- Use entomological and agronomic simulation models to predict likely outcomes for insect density, resistance characteristics and yield loss, under the alternative strategies.
- Use a dynamic programming formulation to economically evaluate a long-term strategy to maintain susceptibility to Tracer® in *Heliothis* populations.

### **Industry Outcomes**

- Reduction in the \$1.2 billion per annum cost to grain growers from weeds in winter crops.
- More sustainable use of vegetation, land and water resources used in temperate perennial grazing systems.
- Improved returns to grazing industries from quantification of the benefits of technologies to manage vertebrate pests.
- Greater benefits to the cotton industry from development of better IPM strategies dealing with insects and insecticide resistance.

### **Future Directions**

- Further development of biological and economic models of weeds in cropping systems.
- Development of a bio-economic modelling framework for evaluating sustainability issues in temperate perennial grazing systems.

- Extension of the Beneficial Disruption Index concept to insect pests in cotton.
- Investigation of an approach evaluating insecticide resistance in cotton.

**External Funding**

Part of the weeds work is funded by the CRC for Australian Weed Management. The cotton work is funded through the Cotton CRC and the Cotton Research and Development Corporation.

## Significant Publications

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- Hoque, Z., Farquharson, B., Dillon, M. and Kauter, G. (2000). 'An economic evaluation of an on-going IPM program within the Australian cotton industry.' Proceedings, 10<sup>th</sup> Australian Cotton Conference, Brisbane.
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- Vere, D.T., Jones, R.E., Dowling, P.M. and Kemp, D.R. (2002). 'Economic impact of *Vulpia* in temperate pasture systems in south-eastern Australia.' *Australian Journal of Experimental Agriculture* 42 (4), 465-472.



### 3.5 Farming Systems Economics

#### Key Messages

- NSW Agriculture seeks changes in farmer behaviour towards the adoption of more profitable technologies with favourable environmental outcomes.
- It is important to evaluate the farm level profit and environmental impacts of new technologies and resource management strategies being developed and promoted by NSW Agriculture.
- Program economists have developed and reported whole farm models representative of key farming systems throughout New South Wales as an aid in this process.

#### Economists Involved

All Program Economists

#### Background

There is a strong appreciation within NSW Agriculture that research and extension should be undertaken in a farming systems context. It is important to demonstrate the biological and financial impacts of technologies to farmers and research and extension staff at a whole farm level, whether assessing traditional production technologies or management strategies to ameliorate adverse environmental effects. The on-farm impacts of land use policy changes have to be similarly assessed. To fulfil this requirement, Program Economists have continued to provide information from a whole farm systems perspective.

Farm management information in the form of enterprise gross margins budgets across the State and whole farm budgets for specific regions are available to industry and research and extension staff. This information has been developed in collaboration with farmer groups and research and extension staff, and makes reference to the significance of the interactions between enterprises and with the scarce resources that may be available.

Evaluations of farming systems also often employ more complex modelling techniques including simulation, stochastic dominance, linear programming and dynamic programming to consider important biological and economic interactions that cannot be fully accounted for by annual whole farm budgets.

#### Research Objectives

- Provision of farm management information in the context of farming systems; identify and define key farming systems in terms of resource requirements and opportunities in the context of a representative farm.
- Develop whole farm models that are representative of key farming systems in New South Wales in cooperation with the Farming Systems Program.

## **Industry Outcomes**

- Monitor the performance of farming systems over time.
- Provide a common framework in which research and extension staff can discuss farming system issues.
- Provide a means of presenting the impact on farm profit from more complex modelling of new technologies and resource management strategies being promoted by NSW Agriculture.
- Allow research and advisory staff with Program Economists to do 'back of the envelope' analyses of changes in these farming systems that have whole farm implications.
- Provide 'building blocks' for analyses of technologies that require more sophisticated modelling either because of important time dimensions or because of significant interactions with other enterprises.

## **Future Directions**

The evaluation of new technologies and alternative management practices will remain a significant component of the work plans of Program Economists.

In addition, an R&D initiatives grant has been received to:

- Enhance the cooperation between economists and the new Farming Systems Program in planning the direction of that Program.
- Expedite the work currently being undertaken by Program Economists in developing whole farm models of significant farming systems in NSW.
- Encourage the use of these models by research and advisory staff in NSW Agriculture through close cooperation with the Farming Systems Program and other Programs involved in pasture and livestock activities.

## **External Links**

Close relationships have developed with research and advisory officers and other economists around Australia and the world. Links with ABARE, other government organisations, universities, specialised farm media providers and farmers to collect and extend information.

## **External Funding**

Funding for farming systems research has been received from:

The Grains Research and Development Corporation  
 The CRC for Plant-Based Management of Dryland Salinity  
 The Beef CRC  
 The Rice CRC  
 NSW Agriculture's R&D Initiatives Account.

However, much of the farming systems economics has been and is likely to be funded as a multi-disciplined research program or as in-kind contributions to a specific research project.

### **Significant Publications**

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### 3.6 Soil, Water and Vegetation Economics

#### Key Messages

##### *Soil economics:*

- It is theoretically possible to halt and reverse soil organic carbon (SOC) declines by using best-management practices (applying enough nitrogen fertiliser to grow large biomass crops, retaining stubble and minimising tillage). Monitoring SOC precisely is difficult with current technology but may lead to more profitable resource-use decisions.

##### *Water economics:*

- There appear to be many opportunities for the traditional long-fallow wheat rotation to be improved in terms of both increased profits and reduced deep drainage.

##### *Vegetation economics:*

- Credits for carbon sequestration in trees may provide incentives for landholders to invest in farm-forestry projects, depending on the timing of payments, the profitability of alternative land uses and the transaction costs of participating in the carbon market.
- Liming is a profitable strategy to manage acidity for most farmers in cropping regions. Liming is a far less profitable strategy in high-rainfall predominantly livestock-based farming systems.
- The benefits and costs of strategies to conserve or rehabilitate natural resources need to be carefully considered. Some patterns of sustainable resource use are likely to impose high costs on future as well as present generations through diminished endowments of man-made capital and/or knowledge.
- Increasing the perennial grass composition of pasture systems results in increased long-term economic benefits to landholders and a number of sustainability and environmental benefits such as reduced recharge of water tables, better quality run-off to streams, and reduced soil erosion.

#### **Economists Involved**

Bob Farquharson, Robyn Hean, Randall Jones, John Mullen, Rajinder Pal Singh and Fiona Scott

#### **Departmental Programs Involved**

Agricultural Resource Management, Agroforestry Unit, Economic Services Unit and Farming Systems, Pastures and Rangelands.

#### **Background**

Land use in agriculture is associated with a number of resource-management problems that are of increasing concern to the community. These problems include loss of biodiversity, weed incursions, soil acidity and sodicity, excessive watertable recharge with the related

soil-health problem of salinity, as well as ground and surface water-quality problems. Some of these resource-management problems are not confined to the farms where they arise but impact on the broader community, and result in off-site effects called externalities which are usually in the form of costs. There is also a dynamic element to many of these problems in that agricultural practice today will impact on future stocks of natural resources, which in turn may constrain future agricultural practice.

Program economists are conducting research into various aspects of the economics of managing natural resources. A common component of this research is analysis of the role of perennial pastures and tree crops in key farming systems in NSW. In the north of NSW, opportunity cropping may be an important strategy to manage watertable recharge.

Land-use decisions are generally made by farmers, hence it is critical to understand the impacts of alternative land-use strategies on farm-level profitability. Program economists are engaged in modelling the farm-level impacts of technologies to manage natural-resource problems such as salinity and acidity. The representative farm models reported under 'Farming System Economics' are important building blocks. Optimal-control techniques are also being applied to evaluate the contribution of perennial-pasture technologies.

There is a divergence between the interests of farmers and the community in managing some natural resources. Program economists are engaged in farm- and catchment-level analysis, particularly with respect to salinity, to measure the significance of this divergence, and thereby evaluate whether government intervention to encourage land-use change is justified and test mechanisms designed to align the incentives of farmers with community expectations.

Program economists have also contributed to the debate about the meaning of sustainability and the application of this concept to agriculture.

## **Research Objectives**

### *Soil economics:*

- Evaluate the impact on farm-level profitability of alternative cropping and pasture strategies to manage soil-health issues including salinity, acidity, sodicity, compaction, and nutrient status.
- Evaluate indicators of soil health and investigate whether they are useful in making on-farm decisions.
- Evaluate the profitability of different agronomic and farming-systems practices for managing shallow crop-rooting depths caused by sub-soil constraints.

### *Water economics:*

- Investigate whether the recommended change towards opportunity cropping produces a 'win-win' situation, that is increases profitability while at the same time reduces groundwater recharge that contributes to the spread of dryland salinity.

- Evaluate alternative irrigation layouts for rice-wheat farming systems to increase yield, resource-use efficiency and profitability through improved soil, water and nutrient management.

*Vegetation economics:*

- Estimate the long-term, farm- and catchment-level benefits and costs of alternative approaches to plant-based management of dryland salinity in different catchment types.
- Identify differences between optimal salinity-management strategies suggested by farm- and catchment-level analyses, and the policy consequences of those differences.
- Determine the most appropriate farm-forestry systems for capturing carbon-sequestration credit payments and meeting other landholder and community goals, and investigate how the design of carbon-sequestration projects effects incentives at the individual producer level.
- Estimate the long-term economic benefits of increased perennial grass composition in grazing systems.

**Industry Outcomes**

*Soil economics:*

- The adoption of profitable crop- and fallow-management practices to address soil-health problems.
- Policy interventions that account for incentives faced by farmers.

*Water economics:*

- Improved knowledge of opportunity-cropping systems in terms of profitability, run-off and drainage.
- Development of irrigation layouts and crop sequences for rice-based farming systems that increase profitability, productivity, cropping flexibility and water-use efficiency, and also reduce groundwater recharge.

*Vegetation economics:*

- New knowledge about the economics of dryland-salinity management at the farm and catchment level, and how this varies between different catchment types.
- New knowledge about the economics of land-use change and forestry systems in the presence of carbon-sequestration credit payments, and prescriptions for the design of efficient carbon-sequestration projects.

- Understanding of the management strategies and economic policy that results in a more socially optimal mix of pasture species at a catchment level.

### **Future Directions**

The general direction of future research is to evaluate the potential for increased use of perennial pastures and tree crops to use water in ways that protect biodiversity, soil health and water quality, while maintaining farm profitability. Important issues to be addressed are the interrelationships between many natural-resource management problems and their dynamic (ie. time-dependent) nature.

More specific research opportunities include:

#### **Soil economics:**

- Conduct economics research into how to manage soil acidity and consequent higher rates of watertable recharge in the high-rainfall livestock predominant farming systems.
- Investigate whether inadequate knowledge of sub-soil constraints in crop-management planning has led to environmental problems such as nitrate leaching to groundwater, which have imposed economic costs on grain growers and the community.

#### **Water economics:**

- Continue research into the potential of perennials to manage groundwater recharge in cropping and livestock systems without significantly reducing farm profit.
- Analyse the economic performance of alternative irrigation methods and layouts for rice-wheat systems.

#### **Vegetation economics:**

- Investigate how farm-level incentives diverge from community expectations in the management of dryland salinity.
- Develop the capability to link research results on water use/recharge at local scale to economic consequences at catchment scale.
- Develop economic models for farm- and catchment-level analysis of dryland-salinity management and identify priority catchments for government policy intervention.
- Determine the most appropriate farm-forestry systems for capturing carbon-sequestration credit payments, and investigate cost-minimising project designs.

### **External Links**

Agricultural Production Systems Research Unit (CSIRO Sustainable Ecosystems)  
 Center for Socio Economic Research on Forestry and Estate Crops (Indonesia).  
 Center for International Forestry Research (Indonesia).  
 CSIRO Land and Water  
 CSIRO Sustainable Ecosystems



International Center for Research in Agroforestry (Indonesia)  
 Punjab Agricultural University (India)  
 Queensland Department of Primary Industries and Natural Resource Management  
 University of Melbourne  
 University of New England  
 University of Western Australia  
 University of Western Sydney  
 Victorian Department of Primary Industries  
 WA Department of Agriculture

### **External Funding**

Australian Centre for International Agricultural Research  
 CRC for Plant-based Management of Dryland Salinity  
 CRC for Sustainable Rice Production  
 Grains Research and Development Corporation.  
 Rural Industries Research and Development Corporation

### **Significant Publications**

Cacho, O.J., Hean, R.L. and Wise, R.M. (2003). 'Carbon-accounting methods and reforestation incentives.' *Australian Journal of Agricultural and Resource Economics*, 47(2), 153-179.

Farquharson, R.J., Schwenke, G.D. and Mullen, J.D. (2003). 'Should we manage soil organic carbon in Vertosols in the northern grains region of Australia?' *Australian Journal of Experimental Agriculture*, 43(4), 261-270.

Hean, R.L., Cacho, O.J. and Menz, K.M. (2003). 'Farm forestry: carbon-sequestration credits and discount rates.' Proceedings, Pre-conference Workshop, 47<sup>th</sup> Annual Australian Agricultural and Resource Economics Society Conference, Dryland Salinity: Economic Issues at Farm, Catchment and Policy Levels, Fremantle.

Mullen, J.D. (2001). 'An economic perspective on land degradation issues', *Economic Research Report* No. 9, NSW Agriculture, Orange, available at <http://www.agric.nsw.gov.au/reader/10550>.

Mullen, J.D. and Bathgate, A. (2002). 'Sustainable resource custody and agricultural research policy: the case of dryland salinity in Australia.' Invited paper, John Dillon Commemorative Day, University of New England, Armidale.

### **3.7 Provision of Farm Management Information**

#### **Background**

The provision of farm management information through advisory media has been a traditional activity of Program economists. Much of this information is a product of the research activities described elsewhere in this report. Farming Systems Economics for example, has a strong farm management focus as can be seen from the publications listed there. However Program Economists have also taken responsibility for providing a wide range of farm management information to meet the needs of the Department's research and advisory staff, and its farmer and other clients. The farm management information provided by Program Economists is wide ranging in nature and responsive to topical issues, however some important classes of information perennially in demand include enterprise budgets, decision support aids particularly those related to livestock feeding and other costs associated with drought, and a range of widely used publications related to leasing and sharefarming agreements, and contract rates and machinery costs. These are discussed in turn below. Increasingly this material is being disseminated on the Department's website.

#### **Economists Involved**

Lloyd Davies coordinates the provision of much of the farm management material across the Department. Contributions also come from Fiona Scott, Rajinder Pal Singh, Dean Patton and Salahadin Khairo but all Program Economists contribute within their own Programs.

#### **Program Linkages**

All Programs.

#### **Some Significant Classes of Farm Management Information**

##### *Enterprise budgets on NSW Agriculture's Website*

Program Economists prepare each year enterprise or gross margin budgets for dryland and irrigated, winter and summer crops in the northern, central and southern parts of New South Wales. Enterprise budgets for sheep and cattle and for perennial crops such as citrus and forestry are revised less frequently. All can be found on the Department's web site.

The Internet hit rates of the farm budgets and costs pages continue to be amongst the highest of all NSW Agriculture's folders. The hits report from July 2001 to May 2003 is as follows.

Hits reports for selected budget categories on the NSW Agriculture website:

	Farm budget menu page	Winter crops	Summer crops	Vegetables	Beef	Sheep	Machinery
July 2001	564	158	245	76	217	140	54
August 2001	1073	346	519	174	407	290	149
September 2001	894	368	492	167	413	226	117
October 2001	1061	290	401	205	409	261	187
November 2001	908	269	299	179	680	271	174
December 2001	669	237	279	159	383	186	125
January 2002	755	294	223	206	420	197	133
February 2002	859	354	290	231	427	283	147
March 2002	1212	474	402	215	557	317	172
April 2002	1003	573	302	264	568	353	225
May 2002	1246	621	473	405	668	417	176
June 2002	1038	343	327	206	448	290	163
July 2002	1166	372	423	254	620	332	195
August 2002	1340	517	646	321	508	460	266
September 2002	1383	543	716	424	607	438	271
October 2002	1476	577	687	367	717	498	383
November 2002	1307	556	564	329	693	577	284
December 2002	800	343	389	279	448	316	168
January 2003	1054	455	455	265	597	403	236
February 2003	1118	500	345	253	708	347	252
March 2003	1457	709	489	264	928	491	300
April 2003	1424	724	490	325	823	508	282
May 2003	1783	761	532	624	1139	654	342
<b>Average hits</b>	<b>1113</b>	<b>451</b>	<b>434</b>	<b>269</b>	<b>582</b>	<b>359</b>	<b>209</b>

### *Drought Economics Information*

Lloyd Davies has been responsible for assembling the economic components of a wide range of publications and decision support aids to assist farmers in managing the drought. Many of these are found on the Department's website and are briefly described below.

StockPlan is a suite of computer decision support tools that enable cattle and sheep producers explore management options in the early stages of drought and during drought. The main aim of these decision tools is to assist producers make management decisions, which minimise the environmental and financial impacts of drought. StockPlan will be made available on a CD to advisory officers and ultimately farmers.

Management options are explored through three StockPlan tools: Drought Pack, the herd and flock model (Im Pack) and the feed, sell, Agist model (FSA Pack); and helpful advice through seven StockPlan links: Introduction, Decision-making Process, Drought and Over Grazing Issues, Animal Health and Welfare, Climate, Bob's Story and 'Where to get help'. An optional hot key is also available to connect users to the NSW Agriculture Drought Website.

Drought Pack is designed to help beef and sheep producers to develop effective drought strategies. It is a computer-based decision aid that provides a 'user-friendly' snapshot of the financial consequences of management and feeding strategies for sheep and cattle enterprises through a projected period of limited pasture. A feature is the calculation of nutritional requirements of livestock based on their energy needs to predict the amount and cost of conserved fodder that would be needed to meet target weight gain (or loss).

The Herd and Flock Model is a dynamic model that can plan and track for up to 10 years, herd or flock numbers that can be bred, bought and sold and their impact on the cash flow. This model has other applications beyond drought, especially in identifying long term implications of debt repayment on the enterprise or applying a disease control strategy.

This model looks at the likely financial consequences of feeding, selling and agisting a specific class of stock. Generally, it is used when Drought Pack indicates that the option of retaining all stock would incur a very high feed cost and the user wants to focus on removing stock from the property.

A number of business management articles related to drought can be accessed from the NSW Agriculture's website. These include

Davies, L. (2000). 'Financial considerations for selling stock in drought.' *Agnote DAI/185*, NSW Agriculture, Orange. <http://www.agric.nsw.gov.au/reader/2211>

Davies, L. (2000). 'Financial considerations of feeding stock in drought.' *Agnote DAI/186*, NSW Agriculture, Orange. <http://www.agric.nsw.gov.au/reader/2219>

Davies, L. (2000). 'Financial considerations of leasing land for your stock in drought.' *Agnote DAI/187* NSW Agriculture, Orange. <http://www.agric.nsw.gov.au/reader/2241>

Davies, L. (2000). 'Financial considerations of agisting stock in drought.' *Agnote DAI/188*, NSW Agriculture, Orange. <http://www.agric.nsw.gov.au/reader/2254>

Davies, L. (2000). 'Tax treatment of forced livestock sales due to pasture and fodder loss.' *Agnote DAI/189* NSW Agriculture, Orange. <http://www.agric.nsw.gov.au/reader/2260>

Davies, L. and Sell, I. (2000). 'Agistment guidelines.' *Agnote MI.6*, NSW Agriculture, Orange <http://www.agric.nsw.gov.au/reader/6026>

Davies, L. and Mackay, B. (2000). 'Feed cost calculator.' *Agnote DAI-201*, NSW Agriculture, Orange <http://www.agric.nsw.gov.au/reader/4448>

Mullen, J.D. (2002). 'Farm management in the 21st century.' *Australian Agribusiness Review*, Vol. 10, Paper 5 at <http://www.agribusiness.asn.au/Review/2002v10/Index.htm>

#### *Other computer-based decision aids*

A number of web based decision aids that can be accessed from the NSW Agriculture Website have been developed and are maintained by Program economists. Popular sites and the number of monthly hits include:

Month	Feed cost calculator	Livestock transport calculator	Sheep transport calculator	Farm Forms	Irrigation cost calculator
July 2001	178	93	69	167	
August 2001	191	114	76	351	
September 2001	205	125	87	280	
October 2001	171	126	64	319	
November 2001	226	136	82	385	
December 2001	250	150	98	279	
January 2002	312	153	76	380	
February 2002	262	383	100	345	
March 2002	250	238	107	423	
April 2002	213	157	81	456	
May 2002	414	221	112	454	
June 2002	411	167	101	494	
July 2002	770	215	159	520	
August 2002	1211	338	212	538	
September 2002	706	264	189	517	
October 2002	892	282	214	556	
November 2002	1090	313	248	571	30
December 2002	704	232	183	391	151
January 2003	771	311	249	519	206
February 2003	542	213	139	404	168
March 2003	444	245	176	652	229
April 2003	553	284	219	599	280
May 2003	519	303	192	653	280
<b>Av. hits per month</b>	<b>491</b>	<b>220</b>	<b>141</b>	<b>446</b>	<b>192</b>

In addition a number of spreadsheet based decision aids have been developed for advisory and client use. These include the Beef-N-Beans package developed by Fiona Scott, the Forage systems model developed by Lloyd Davies and the Trial & Calculator developed by John Brennan to economically rank wheat varieties.

#### *Other Farm Management Publications*

Program economists provide farm management information through a range of media but prominent amongst these are the newspaper supplement, *Agtoday*, and the Department's *Agfact* series now generally available on the Department's website.

Lloyd Davies coordinates farm management contribution to the *Agtoday* supplement. Articles have included.

December 2001 issue:

Griffith G.R. and Alford, A., *More on the US cattle cycle*

Hoque, Z., and Farquharson, R., *Spray soft to increase profits*

Scott, F., *Comparing crop options*

Patton, D., *Economics of rotations*

Cross, A., *Get Advice on sharefarming*

June 2002 issue:

Patton, D., *Machinery upgrades and enterprise change. Will you be better off?*  
 Patton, D., *Contracting and machinery ownership.*  
 Hean, R., *Can carbon credits provide an incentive for farm forestry?*  
 Davies, L., *GST two years on.*  
 Davies, L. and Patton, D., *Leasing: An option that should be used more*  
 Scott, F., *Useful Websites for economic and business information*  
 Patton, D., *Changed payment system for wheat grades.*  
 Davies, L., *Fodder: the cheapest often not the best value*

Key Agfacts include:

Davies, L. and Sell, I. *Agistment guidelines.* Agfact M1.6, second edition November 2000.  
<http://www.agric.nsw.gov.au/reader/6026>

Davies, L. and Patton, D. *Calculating machinery costs and contract rates* Agfact M2.6,  
 May 2000. <http://www.agric.nsw.gov.au/reader/2274>

Patton, D. *Evaluating enterprise change and capital investments* Agfact M1.2, second  
 edition 2001. <http://www.agric.nsw.gov.au/reader/10215>

Davies, L., Mortenson, K. and Patton, D. *Leasing land – calculating a rental* Agfact  
 M1.10, revised March 2003. <http://www.agric.nsw.gov.au/reader/2266>

Scott, F., Sell, I. and Mortenson, K. *Sharefarming agreements for growing crops.* Agfact  
 M3.8, April 2001. <http://www.agric.nsw.gov.au/reader/7398>

### **Other Significant Publications**

Mullen, J.D. (2002). 'Farm management in the 21st century.' Invited paper, 46th  
 Annual Conference of the Australian Agricultural and Resource Economics  
 Society, Canberra, <http://www.agribusiness.asn.au/Review/2002v10/Index.htm>.

Patton, D. and Brennan, J.P. (2002). 'Changed payment system for wheat grades:  
 consequences for farming systems in the Central West of NSW', *Australian  
 Agribusiness Review*.

Davies, B.L. (2002). 'Decision aid to evaluate a change in feeding systems. a dairy case  
 study on maize silage.' *Proceedings of the 2002 Australian Agribusiness Forum -  
 Sydney*, Agribusiness Association of Australia.

Davies, B.L. (2002). 'StockPlan - a drought decision tool for graziers.' *Proceedings of 2002  
 Australian Agribusiness Forum - Sydney*, Agribusiness Association of Australia

Wood, K.P. and Davies, B.L. (2003). 'Minimising the impact of drought: beef breeding  
 replacements versus buying in.' *The Beef Products Program: Technology Our Future*  
 (Wilkins, J.J., Ed.), NSW Agriculture, Tocal.

### **3.8 Research and Extension Evaluation and Policy**

#### **Key Messages**

- Productivity growth in Australian broadacre agriculture since 1977 has averaged 2.7% per year (ABARE). The value of agricultural production in New South Wales has shown little trend, varying around \$8 billion (in today's dollars) since 1953. 70% of the value of agricultural production in New South Wales can be attributed to productivity growth since 1953.
- The return to Australia from public sector investments in agricultural research has been in the range of 15-40%.
- Producers capture a larger share of the benefits from traditional on-farm production research than they do from processing R&D and promotion.
- Economists in NSW Agriculture regularly conduct benefit cost analyses at a project level. From a sample of over 50 such evaluations the estimated benefit cost ratio been greater than five.

#### **Economists Involved**

All Program Economists have contributed to evaluation activities and this involvement is likely to continue. Some of this work is undertaken as part of the broader areas already reported above.

#### **Background**

NSW Agriculture uses public funds to enhance productivity growth in agriculture subject to environmental and social goals by conducting research, advisory, education and regulatory activities. In real (year 1998) terms total expenditure by NSW Agriculture rose from \$115 million in 1953 to \$572 million in 1998. Research expenditure has accounted for almost half of this, with a third to extension and the rest to regulatory activities. As a percentage of the gross value of agricultural production in New South Wales, research and extension activities were as high as 3.8% in 1974 and have since declined to about 2.0%. For much of this period, New South Wales governments have provided a much higher level of support to agriculture than their counterparts in other states.

NSW Agriculture is accountable for the efficient use of these resources. While NSW Agriculture has not had a formal program of evaluation of its activities, economists within NSW Agriculture have regularly been involved in evaluation activities. With the requirements for accountability growing it is likely that NSW Agriculture will have to devote more resources to these activities.

The contributions of past and present economists have ensured that NSW Agriculture shares in a worldwide reputation for economic analyses of agricultural research. As a consequence economists have regularly been funded to evaluate research and extension programs in international, national and industry research organisations.

## Research Objectives

The ultimate objective of economic analyses of agricultural research and extension is that resources be used more efficiently in these activities. Under this overarching objective there have been three broad areas of research pursued by Program Economists:

### (i) Evaluation of specific research programs

- Ex post evaluations of research programs to support renewed CRC funding, particularly with respect to the Beef, Sheep, Weeds, Rice and Salinity CRCs.
- Ex post evaluations of research programs for international agencies such as ACIAR, ICRISAT and UC, Davis.
- Ex ante evaluations of research programs to support RDC funding submissions.

### (ii) Understanding how the benefits of R&D are distributed.

- Analysing how the gains from new technologies and levies to fund research are shared between consumers, processors and producers in the wool, beef, lamb pig and feed grains industries;

### (iii) Estimating the returns from public R&D in Australian agriculture

- Estimating public expenditure on research and extension activities in Australian agriculture.
- Estimating the rate of productivity growth in Australian agriculture.
- Estimating the rate of return from public investment in agricultural research in Australia.

## Research Outcomes

### (i) Evaluation of specific research programs

Program Economists have conducted over 50 evaluations of specific research programs since 1996 and many of these have been instrumental in attracting external funds. Generally the benefit cost ratios have exceeded 5:1.

### (ii) Understanding how the benefits of R&D are distributed

The key finding from research in this area has been that the share of benefits to farmers is larger from on-farm research activities than from off-farm activities such as processing R&D and promotion. Australian farmers get a larger share of benefits from on-farm efficiency gains in Australia if their supply is less responsive to price changes than is the demand for the product and if the degree to which farm and non-farm inputs (including the farm product from other countries) are substitutable in processing is high.



Specific findings include:

- Australian woolgrowers capture 58% of the benefits of farm level research but only about 25% of the benefits of wool processing research.
- Australian beef producers also generally share more in the benefits from on-farm R&D although export promotion does deliver a higher share of benefits than some 'farm' level R&D in the feedlot sector.

(iii) Estimating the returns from public R&D in Australian agriculture.

- In Australian broadacre agriculture, total factor productivity has grown at the rate of about 2.5% per year since 1953.
- In 1994 dollars, expenditure by the public sector on agricultural R&D in Australia grew from \$119m in 1953 to \$530m in 1994. In 1994 about 20% of public R&D was financed by the RDCs.
- The return on investment by the public sector in agricultural R&D in Australia was in the range of 15-40%.

### **Future Directions**

The evaluation of new technologies and of research and extension evaluation activities will remain a significant component of the work plans of Program Economists. It is likely that significant areas of investment in research, extension and regulation within Programs will be subject to evaluation for their economic, environmental and social impacts in coming years. Such evaluation processes will assist in developing projects that align with the Department's goals and earn high rates of return to the community and also assist the Executive in meeting accountability requirements. There is likely to be a continuing demand from external agencies such as ACIAR for Program Economists to undertake evaluations of projects they have funded.

Program Economists have ongoing evaluation commitments to a range of CRCs including:

The Beef CRC

The Rice CRC

The Cotton CRC

The CRC for Weeds Management Systems and its successor

The Australian Sheep Industry CRC

The CRC for Plant-Based Management of Dryland Salinity.

## External Links

### External Funding

In addition to the CRCs listed above funding for evaluation activities has been received from:

The Grains Research and Development Corporation  
 Meat and Livestock Australia  
 Pig Research and Development Corporation  
 Rural Industries Research and Development Corporation  
 Wool International  
 Viticultural CRC  
 Australian Centre for International Agricultural Research  
 University of California, Davis.

### Significant Publications

#### *Evaluation of specific research programs*

Brennan, J.P., Aw-Hassan, A., Quade, K.J. and Nordblom, T.L. (2002). *Impact of ICARDA Research on Australian Agriculture*. Economic Research Report No. 11, NSW Agriculture, Wagga Wagga.

Brennan, J.P., Godden, D., Meng, E. and Smale, M. (1999). 'Genetic diversity and Australian wheat breeding programs.' Proceedings, 11<sup>th</sup> Australian Plant Breeding Conference, Volume 2: Contributed Papers, 21-22.

Brennan, J.P., Singh, I.P. and Lewin, L.R. (1997). 'Identifying international rice research spillovers in New South Wales.' *Agricultural Economics* 17(1), 35-44

Brennan, J.P., Singh, R.P. and Singh, I.P. (1999). 'Economic issues in assessing research priorities in feed grains nutrition.' Contributed paper, 43<sup>rd</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Christchurch.

Farquharson, R.J., Griffith, G.R., Barwick, S.A. and Banks, R.G. (2002). 'Estimating the returns from investment into beef cattle genetics technologies in Australia.' Contributed paper, 7<sup>th</sup> World Congress on Genetics Applied to Livestock Production, Montpellier.

Hill, D.J., Piggott, R.R. and Griffith, G.R. (1998). 'Profitability of incremental generic promotion expenditure by Australian dairy farmers.' *Agricultural Economics* 26(3), 249-262.

Holloway, G. J., Peyton, L.J. and Griffith, G.R. (2000). 'Was the Australian Meat and Livestock Corporation's advertising efficient?' *Australian Journal of Agricultural and Resource Economics* 44(1), 55-81.

Marshall, G.R. and Brennan, J.P. (2001). 'Issues in benefit-cost analysis of agricultural research projects.' *Australian Journal of Agricultural and Resource Economics* 45(2), 195-213.

Mullen, J.D., Alston, J.M., Sumner, D.A., Kreith, M. and Kuminoff, N. (2003). *The Benefits from Agricultural Pest-Management Research Conducted by the University of California*, University of California Agricultural Issues Center Publication.

*Understanding how the benefits of R&D are distributed*

Mullen, J.D., Alston J.M. and Wohlgenant M.K. (1989). 'The impact of farm and processing research on the Australian wool industry', *Australian Journal of Agricultural Economics* 33(1), 32-47.

Zhao, Z., Griffiths, W.E., Griffith, G.R. and Mullen, J.D. (2000). 'Probability distributions for economic surplus changes: the case of technical change in the Australian wool industry.' *Australian Journal of Agricultural and Resource Economics* 44(1), 83-106.

Zhao, X., Griffith, G. and Mullen, J. (2001). 'Farmer returns from new technologies in the Australian beef industry: on-farm research versus off-farm research.' *Australian Agribusiness Review* 9(1).

Zhao, X., Mullen, J.D. and Griffith, G.R. (1998). 'Functional forms and economic surplus changes.' *American Journal of Agricultural Economics* 79(4), 1243-1251.

*Estimating the returns from public R&D in Australian agriculture*

Alston, J.M., Harris, M., Mullen, J.D. and Pardey, P. (1999). 'Agricultural R&D policy in Australia', in Alston, J.M., Pardey, P.G., Phillips, M. and Smith, V. (Eds), *Paying for Productivity*, published by the International Food Policy Research Institute by John Hopkins University Press.

Brennan, J.P. and Mullen, J.D. (2000). 'Australia's research levy system.' Invited paper, Mini-symposium on Emerging Issues in Agricultural Research Policy and Funding: Lessons from Case Studies, XXIV International Conference of Agricultural Economists, Berlin.

Cox, T.L., Mullen, J.D. and Hu, W. (1997). 'Non-parametric measures of the impacts of public research expenditure on Australian broadacre agriculture', *Australian Journal of Agricultural and Resource Economics*, 41(3) 333-360.

Mullen, J.D. and Cox, T.L. (1995). 'The returns from research in Australian broadacre agriculture', *Australian Journal of Agricultural Economics*, 39(2), 105-128.

Mullen, J.D. and Cox, T.L. (1996). 'Measuring productivity growth in Australian broadacre agriculture', *Australian Journal of Agricultural Economics*, 40(3), 189-210.

Mullen, J.D., Vernon, D. and Fishpool, K. (2000). 'Agricultural extension in Australia: public funding and market failure.' *Australian Journal of Agricultural and Resource Economics*, 44(4):629-646.

Scobie, G.M., Mullen, J.D. and Alston, J.M. (1991). 'The returns to investment in research on Australian wool production', *Australian Journal of Agricultural Economics*, 35(2), 179-195.

## 4 Publications By Economists In Programs (since 1997)

### Book chapters

1. Alston, J.M., Harris, M., Mullen, J.D. and Pardey, P. (1999). 'Agricultural R&D policy in Australia.' In Alston, J.M., Pardey, P.G., Phillips, M. and Smith, V. (Eds.), *Paying for Productivity*, International Food Policy Research Institute, John Hopkins University Press.
2. Brennan, J.P. and Morris, M.L. (2001). 'Economic issues in assessing the role of physiology in wheat breeding programs.' In Reynolds, M.P., Ortiz-Monasterio, J.I. and McNab, A. (Eds.), *Application of Physiology to Wheat Breeding*, International Maize and Wheat Improvement Center, Mexico, D.F., 78-86.
3. Brennan, J.P. and Mullen, J.D. (2002). 'Joint funding of agricultural research by producers and government in Australia.' In D. Byerlee and R.G. Echeverria (Eds.), *Agricultural Research Policy in an Era of Privatization*, CABI International, Wallingford, 51-65.
4. Campbell, M.H., Milne, B.R., May, C.E., Vere D.T. and McGowen, I.J. (1997). 'The Biology of Australian Weeds; 22. *Cassinia arcuata* R.Br.' In Panetta, F.D., Groves, R.H. and R.C.H. Shepherd (Eds.), *The Biology of Australian Weeds, Volume 2*, R.G. and F.J. Richardson Publishers, Melbourne.
5. Cox, P.G., Jones, R.E. and Medd, R.W. (1998). 'The economics of site-specific weed management: implications for policy.' in Medd, R.W. and Pratley, J.E (Eds.) *Precision Weed Management in Crops and Pastures*, CRC for Weed Management Systems, University of Adelaide, Adelaide.
6. Davies, B.L. (2003). 'Assessing the economics of silage production' In Kaiser, A.G., Piltz, J.W., Burns, H.M. and Griffiths, N.W. [Eds.], *TopFodder - Successful Silage Production*, NSW Agriculture, Orange and Dairy Research and Development Corporation, Melbourne.
7. Griffith, G.R. and Vere, D.T. (2000). 'Forecasting agricultural commodity prices.' In Abelson, P. and Joyeux, R. (Eds.), *Economic Forecasting*, Allen & Unwin, St. Leonards.
8. Jones, R.E. (2000). 'The economics of weed control.' In Sindel, B.M. (Ed.), *Australian Weed Management Systems*, R.G. and F.J. Richardson Publishers, Melbourne.
9. Rew, L.J., Medd, R.W. and Farquharson, R.J. (1998). 'The scope for precision weed management in on-farm decision making.' In Medd, R.W. and Pratley, J. (Eds.), *Precision Weed Management in Crops and Pastures*, CRC for Weed Management Systems, University of Adelaide, Adelaide.

### Refereed journal papers

1. Alemseged, Y., Jones, R.E. and Medd, R.W. (2001). 'A farmer survey of weed management and herbicide resistance problems of winter crops in Australia.' *Plant Protection Quarterly* 16(1), 21-25.
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2. Brennan, J.P., Aw-Hassan, A., Quade, K.J. and Nordblom, T.L. (2002). *Impact of ICARDA Research on Australian Agriculture*. Economic Research Report No. 11, NSW Agriculture, Wagga Wagga.
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7. Gandhi, V.P., Zhou, Z-Y. and Mullen, J.D. (2000). 'Wheat economy of India: development, nature and trade prospects', [http://www.agribusiness.asn.au/Perspectives/Ghandi/Ghandi\\_Wheat.htm](http://www.agribusiness.asn.au/Perspectives/Ghandi/Ghandi_Wheat.htm)
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15. Mullen, J.D. (1997). *Returns to Agriculture from Public Research between 1953 and 1994*. Rural Industries Research and Development Corporation, Research Paper 97/8.
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## Conference Papers

### Proceedings

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2. Beecher, G., Thompson, J., Dunn, B., Humphreys, L., Mathews, S., Johnston, D., Christen, E., Timsina, J., Smith, D., Singh, R. and Xevi, E. (2003). 'Alternative Irrigation Methods for Rice-based Cropping Systems: Permanent Beds and Sub-Surface Drip', Proceedings, 3<sup>rd</sup> Temperate Rice Conference, Punta Del Este, Uruguay.
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15. Dillon, M. and Hoque, Z. (2000). 'An analysis of pest pressure in an area wide management group.' *Proceedings, 10<sup>th</sup> Australian Cotton Conference, Australian Cotton Growers' Research Association, Brisbane*, 74-83.
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19. Griffith, G., Nightingale, J. and Piggott, R. (2001). 'Resource-advantage theory: a new way of understanding farm business behaviour?' Proceedings, NSW Agriculture Beef Products Conference, Dubbo.
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### Invited and contributed conference papers

1. Ambarawati, A., Griffith, G.R. and Chang, C. (2001). 'Issues in developing the Bali cattle industry.' Contributed paper, 45<sup>th</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Adelaide.
2. Ambarawati, A., Griffith, G.R. and Chang, H-S. (2002). 'Assessment of beef cattle development policies on farm performance in Bali.' Contributed paper, 46<sup>th</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Canberra.
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5. Ayres, J.F., Lloyd-Davies, H., Farquharson, R.J. and Murison, R.D. (2000). 'The contribution of pasture research to animal production from legume-based pastures in temperate Australia.' Contract paper, International Congress of AAAP/ASAP, Animal Production for a Changing World, Sydney.
6. Barwick, S.A., Griffith, G.R. and Henzell A.L. (2001). 'Effects of feed cost level and method of feed cost calculation on selection rankings in beef cattle.' Contributed paper, 14<sup>th</sup> Conference of the Association for the Advancement of Animal Breeding and Genetics.
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9. Brennan, J.P. Godden, D., Smale, M. and Meng, E. (1999). 'Variety choice by Australian wheat growers and implications for genetic diversity.' Contributed paper, 43<sup>rd</sup> Annual Conference of the Australian Agricultural and Resource Economics Society, Christchurch.
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