# Farming Systems in the Murrumbidgee Irrigation Area of NSW: An Economic Analysis

**Rajinder Pal Singh**
Economist, Systems Research Branch
NSW Department of Primary Industries, Yanco

**John Mullen**
Research Leader, Economics Coordination and Evaluation
NSW Department of Primary Industries, Orange

**Rohan Jayasuriya**
Economist, Industry Analysis Branch
NSW Department of Primary Industries, Orange

**Economic Research Report No. 10**
**May 2005**

RICE CRC

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

ABSTRACT:

This report presents a description of rice based irrigated farming systems in the Murrumbidgee Irrigation Area of NSW. Three common farming systems were identified and whole farm models representative of these systems were developed. The farming systems were described in terms of biological and financial characteristics and whole farm budgets were developed. A key issue of concern to the MIA irrigators is the availability of water and hence the financial sensitivity of these farming systems to changes in water availability has been assessed. Factors influencing water availability include the water reforms, in particular the development of water trading, and the run of dry seasons experienced in NSW from 2002 to 2004.

Key Words: rice, water allocation, farming systems, economics, water trade, WUE

JEL Classification: Q160

ISSN 1442-9764

ISBN 0 7347 1343 6

***Authors' Contact Details***

*Rajinder Pal Singh*
NSW Department of Primary Industries,
Yanco Agricultural Institute, Private Mail Bag, Yanco NSW 2703
Telephone: (02) 6951 2618    Facsimile: (02) 6955 7580
Electronic Mail: rajinder.pal.singh@dpi.nsw.gov.au

***Citation:***

Singh, R.P., Mullen, J.D., and Jayasuriya, R.T., 2005, *Farming Systems in the Murrumbidgee Irrigation Area in NSW*, Economic Research Report No. 10, NSW Department of Primary Industries, Yanco. http://www.agric.nsw.gov.au/reader/10550.

# Farming Systems in the Murrumbidgee Irrigation Area in NSW

## Table of Contents

# List of Figures



# List of Tables

**ACKNOWLEDGMENTS**

The authors would like to acknowledge the financial assistance provided by the Cooperative Research Centre for Sustainable Rice Production for this project (Rice CRC Project 6201: Economic Evaluation of Alternative Resource Management Strategies in a Risky Environment).

The authors would like to thank Greg Brown (Whitton), Graham Menzies (Wilbriggee), Ian Dahlenburg (Murrami), Mike Hedditch (Ricegrowers Cooperative Ltd, Leeton), and Murrumbidgee Irrigation Limited, Leeton, for their valuable help in developing the representative whole farm model. The authors acknowledge the valuable assistance from a number of staff at NSW Department of Primary Industries such as Mary-Anne Lattimore, Rachael Whitworth, John Lacy, Marcus Wright, Geoff Beecher, John Brennan, and Laurie Lewin, Alison Bowman and Leonie Napier.

**LIST OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT**

| | |
|---|---|
| % | percent |
| ABS | Australian Bureau of Statistics |
| ABARE | Australian Bureau of Agricultural and Resource Economics |
| Coop | Cooperative |
| CRC | Cooperative Research Centre |
| DLWC | Department of Land & Water Conservation |
| dS | deciSiemens |
| DSNR | Department of Sustainable Natural Resources |
| DSE | Dry Sheep Equivalent |
| ERR | Economic Research Report |
| GM | Gross Margin |
| ha | hectare |
| hd | head |
| km | kilometre |
| LWMP | Land & Water Management Plan |
| LCD | Local Consensus Data |
| LP | Linear Programming |
| m | metre |
| MDBC | Murray-Darling Basin Commission |
| MIA | Murrumbidgee Irrigation Area |
| MIA&D | Murrumbidgee Irrigation Area & Districts |
| MIL | Murrumbidgee Irrigation Limited |
| ML | megalitre |
| mm | millimetre |
| No. | number |
| NSW | New South Wales |
| RWU | Rice water use |

# Farming Systems in the Murrumbidgee Irrigation Area in NSW

## Executive Summary

The objective of this report has been to describe the farming systems in the Murrumbidgee Irrigation Area (MIA) of southern NSW, in general, and the rice-based farming systems in the MIA, in particular. Describing the rice based farming systems gives some insights into current financial performance and the role of water trading in these farming systems at a time when the contribution of rice income to total farm income has been lower due to reduced water allocations.

A representative whole-farm model of the MIA rice-based farming systems was developed with the help of rice growers and staff from NSW Department of Primary Industries. The typical farm was 220 ha in size and had a water allocation of 1400 ML. While farms and farming systems vary considerably across the MIA, it was possible to group the majority of them into three common systems. An estimated of 20-30 percent of farmers follow a pasture-based rotation, 30-50 percent follow a cereals-based rotation, and 5-10 percent follow a split-farm rotation ie. continuous crops.

Using the whole farm model, the business return on owner's equity with water trade from these three systems was estimated to be 6.7, 6.8 and 7.7 percent respectively, suggesting that MIA rice-based farming systems compare favourably in terms of return on investment with other farming systems in NSW. Farm operating surplus was $100,300, $102,000 and $114,000 respectively.

These farm operating surpluses and business returns to equity are for a scenario in which the irrigators receive 100 percent of their water entitlement and are allowed to operate in the water market. The last time irrigators received their full entitlement was 1996/97. Allocations have been as low as 30 percent as in 2003/04. A reduction in allocation to 80 percent is likely to cause some farmers to apply less water to wheat and barley. However more severe reductions in allocation area likely to cause some irrigators to reduce the area of medium grain rice they grow and to switch to more dryland barley.

When allocations fall from 80 percent to 30 percent, farm operating surplus for the pasture based system falls from $91,900 to $5,900 assuming some water purchasing. For the cereals based system farm, operating surplus falls from $93,600 to $8,900 and for the split system, farm operating surplus declines from $98,400 to $13,400.

In all cases farm operating surplus increased when farmers were allowed to trade water.

The results indicated that although it was the most lucrative, the split-farm system tended to be the riskiest of the three cropping systems in the MIA especially with water availability becoming a risk factor. There is also concern about possible long-term environmental and sustainability consequences associated with this more intensive farming system.

The whole farm model was used analyse the impact of water trading, with different levels of water allocation, on different crop rotations in the MIA. The model can also be used to provide a snapshot of how farm income might respond to by the introduction of new technology such as permanent beds for growing rice, a new enterprise such as an opportunistic wheat crop immediately after rice, or an alternative management practice. The

importance of considering the interactions between enterprises or new technologies in a whole-farm context analysis has been emphasised. Often these interactions through time mean that more sophisticated techniques must be used to fully analyse such questions.

This work was done prior to the formation of the NSW Department of Primary Industries (on July 1, 2004) through an amalgamation of NSW Agriculture, NSW Fisheries, State Forests of NSW and the NSW Department of Mineral Resources.

# 1. Introduction

## 1.1 Overview

In this report a 'broad brush' picture of farming in the Murrumbidgee Irrigation Area (MIA) of NSW is presented. The region is defined and described in terms of its resources, its climate and the nature of the agriculture. The main enterprises that farmers choose between are described and gross margin budgets for each of these enterprises are presented.

The choice of enterprises is influenced not only by their profitability as independent enterprises but also by their contribution to other enterprises or to the whole farming system. The labour and capital resources of the farm also have an influence on the choice and size of enterprises.

These interrelationships between enterprises require examination in a whole farm context. Hence an important part of this report is the presentation of a model farm that represents common large area rice-based farming systems in the MIA. This representative farm is described in terms of its land, labour, availability of water and machinery resources and its enterprises and their rotation. This information together with the gross margins information and information on overhead costs have been used to develop a whole farm budget.

In the final section of this report a whole farm budget is used to examine how the profitability of the farm responds to changes in irrigation water availability, which cause shifts in the cropping rotations.

The enterprise and whole farm budgets are all available as spreadsheet models that can be manipulated by users with reasonable skills in operating the Microsoft® Excel software.

## 1.2 Use of representative farm analysis

This report presents a description of large area farming in the MIA and an indication of its profitability. The representative farm model and associated gross margin and whole farm budgets can be used as a template allowing variations from the representative farm model to be examined. Some farmers may wish to adapt this template for their own farms.

The whole farm budget provides a snapshot at a particular point in time of a farm with a particular set of resources. Hence while this report may give a broad indication of what is happening on many farms in the MIA in a particular year, it may be misleading for farms with markedly different soil type, climate, rotations and resources to those of the representative farm.

Additionally while the whole farm budget can be manipulated to indicate the change in farm income from a new technology or resource management strategy, again we only get before and after pictures. If the change in technology has an impact on soil fertility for example, that takes many years to work through the system, then a simple before and after comparison of whole farm budgets is an inadequate basis for such an important investment decision. In such cases, more sophisticated budgeting tools that allow the impact of such changes over many years to be estimated and aggregated are required.

In writing this report and developing this representative farm model we have benefited greatly from discussions with the MIA rice farmers and with the extension and research staff of the region.

# 2. Agriculture in the MIA

## 2.1 Description of the Region

The MIA is located in the Riverina region of south-west NSW, Australia. It includes the Yanco and Mirrool Irrigation Areas, which are centred on Leeton and Griffith respectively (Figures 2.1 and 2.2).

**Figure 2.1: Geographic Location of the MIA in Australia.**

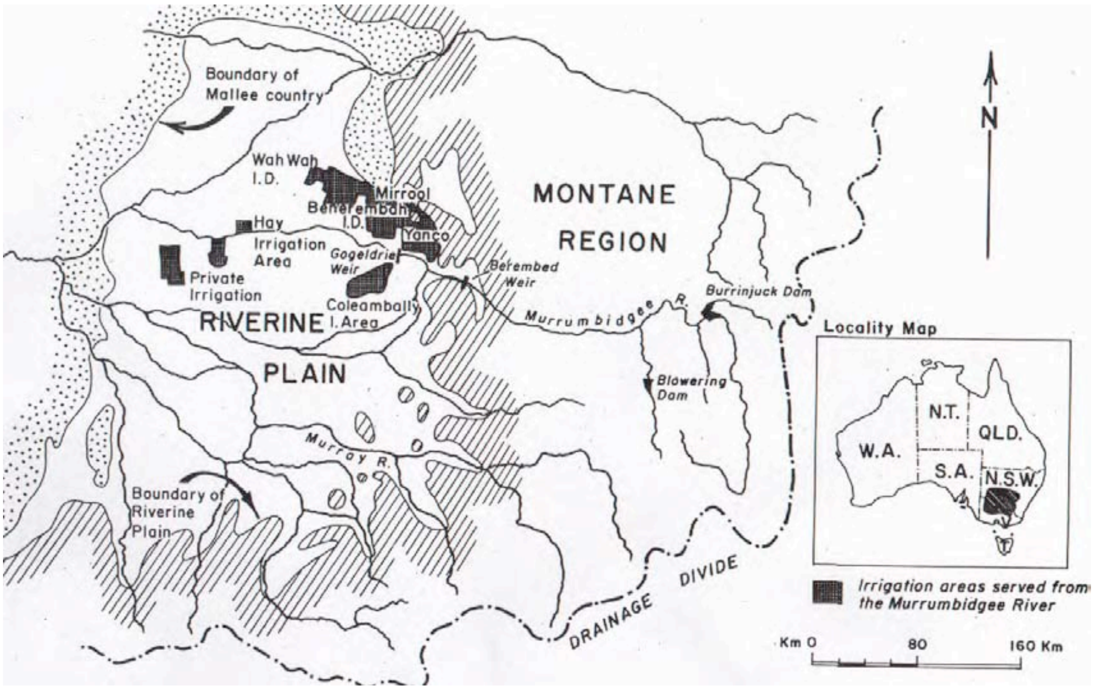
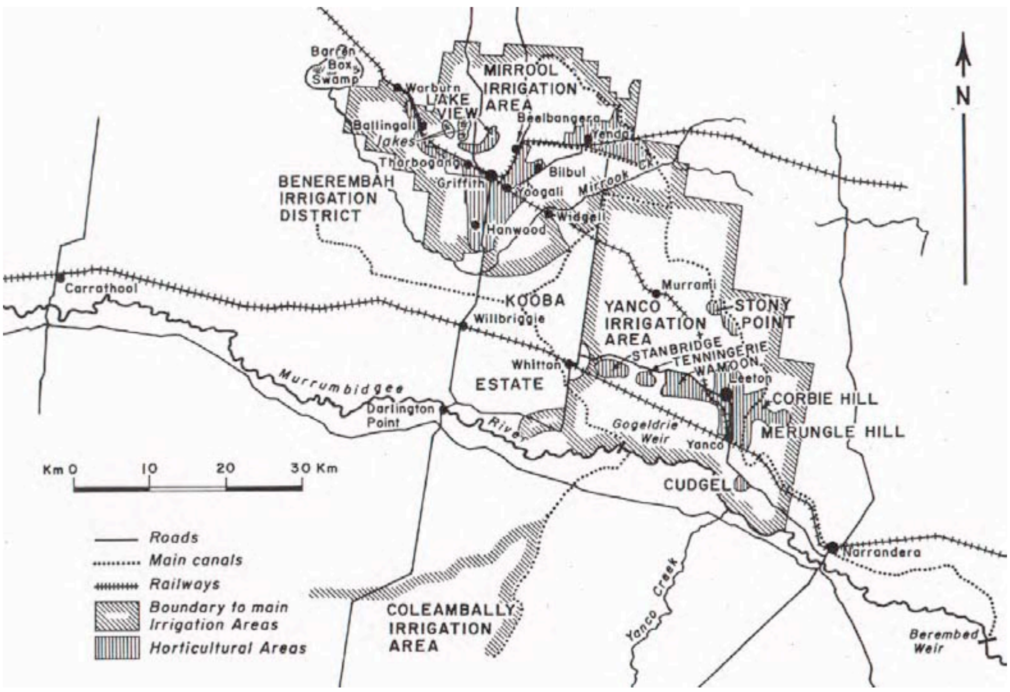



**Figure 2.2: A Close-up of the MIA**



The MIA comprises the land between the Palaeozoic massif of eastern Australia and the Cainozoic deposits of the Murray Basin. Rock outcrops rising up to 305 m above the plain cover the area. The Yanco (Round Hill; 248 m), Robertson (239 m), Brobenah (361 m), and Moura (173 m) trig. stations form an extension of discontinuous outcrops and the Cocoparra Range. Rock outcrops comprise the Leeton Hills with Merungle trig. station (184 m), (NSW Agriculture, 1998).

The MIA has a Mediterranean climate which is highly suitable for production of rice, other summer crops, pastures, winter crops, vegetables, grapes and citrus. The climate in the MIA ranges from hot and dry in summer to cold and moist in winter. In summer the MIA has an average maximum of 31.5°C for January, with extended periods above 35°C, and seasonal peak temperatures above 40°C. In winter the MIA has an average minimum of 2.7°C for July, with significant chill and frost factors.

The annual average rainfall in the MIA is around 410 mm. Rainfall between June and October, is more reliable than in summer. This period fits well with the moisture demands of winter crops. Summer rainfall occurs occasionally as heavy storms between October and March. It is usually of short duration and high intensity, hindering some of the farming operations.

Annual average evaporation in the MIA is 1869 mm. The mean monthly evaporation peaks at 294 mm (9.5 mm/day) in January and drops to 43 mm (1.5 mm/day) in June (NSW Agriculture, 1998).

## 2.2 History

Aboriginal people have inhabited the Riverine Plain for around 40,000 years. European settlement during the early 1800's opened the area for the grazing industry. Irrigation development commenced in the early 1900s.

With the passing of the Barren Jack and Murrumbidgee Canals Act in 1907, closer settlement in the Murrumbidgee irrigated areas began. Burrinjuck Dam was constructed between 1906-1927. The government resumed a large area of pastoral holdings, and divided them into small areas of uniform size farms. After making arrangements for water supply and drainage, these farms were allocated to the new settlers as freehold land. The primary aim of settlement of irrigated areas in the MIA at that time was to achieve rapid regional development.

Between 1912 and 1914, 622 farms covering 9,639 ha were settled. World War I then had an important effect on the land holdings in the MIA. Around half of the land was taken up by inexperienced ex-servicemen. Many large holdings were fragmented at that time into farms too small to remain viable.

Rice was first grown in the area in 1924. In the beginning, rice was grown on poor layouts, without field levelling and without testing the suitability of the soil or understanding the water requirements of the crop. Poor channel systems at that time also resulted in losses of water.

Following World War II, extensive immigration into the MIA took place from Southern Europe, the Middle East, Asia, and Pacific countries. A fairly large section of the MIA population today is Italian or of an Italian origin.

In the 1960s rice farmers with the help of surveyors adopted the contour bay layout system for more efficient use of available water. By this time farmers were sowing rice with combines.

The average area under rice was 24 ha per farm. In 1965 the construction of Blowering Dam allowed the average area under rice to gradually increase to the current limit of 66 ha per farm.

With further expansion of irrigated areas, more land was allocated to the ex–servicemen and migrants under closer settlement schemes. By 1971, holdings within the MIA covered 164,659 ha, excluding roads and channels.

In the 1970s laser levelling was introduced followed by the adoption of aerial sowing. These technologies led to more efficient use of water, better rice plant establishment and better weed control, resulting in increases in productivity of rice, although water use efficiency and soil suitability still remained problems.

Within the MIA two major classes of farms have been created, namely “horticultural farms”; i.e., farms designed for intense culture of fruit trees and vines, and “large area farms” for a wide range of broadacre crops and livestock raising. There were also two other classes, “dual purpose farms” and “residential farms”. Residential farms are farms of such size and potential that the holder is not anticipated to obtain full income from them, but might supplement this with income from other activities. Dual-purpose farms are considered suitable for a combination of mixed farming and horticultural farming. However they have mainly resulted from reconstruction schemes and are now rarely set apart.

Today, cropping on large area farms is based on rice, wheat and pasture. Sheep, feedlot beef and poultry are the dominant livestock enterprises in the MIA. These industries rely strongly on irrigated agriculture in the area.

## 2.3 Natural Resources

### *2.3.1 Groundwater*

The groundwater in the MIA in general is highly saline and is not suitable for agriculture. It used to be around 20 m below surface before irrigated agriculture came into practice. Largely because of irrigation practices, the groundwatertables in many locations are now close to the surface. This is the case especially near depressions, and rice paddocks. Currently, the highest watertables are less than 1m from the surface near Murrami, Widgelli/Bilbul, and south and west of Hanwood. In areas towards Gogeldrie Weir and near Willbriggie, the groundwater tends to be around 1-2 m from the surface, whereas in areas towards Koonadan, the groundwater tends to be deeper. Seasonally, groundwatertables tend to be higher in March than in September, except when there is high rainfall in winter.

**Table 2.1: Percent Land Area with Depth to Groundwater in the MIA in 2001**

| Depth to Groundwater (metre) | Percent* area |
|---|---|
| <1m | 7.9 |
| <1.5m | 30.0 |
| <2m | 50.5 |
| <3m | 83.0 |
| <4m | 95.2 |
| **Av depth** | **2.3 metre** |

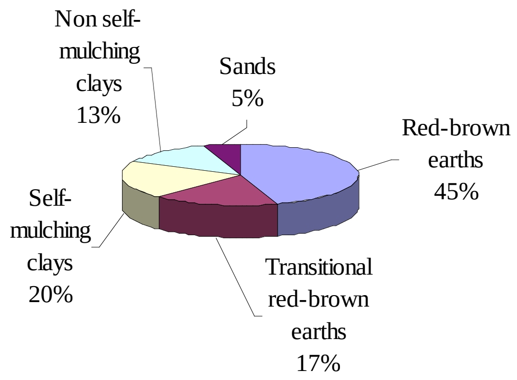
*Area expressed as percent of contoured area of 125,000ha,
Source: 'Working for you with you', Murrumbidgee Irrigation Limited

Salinity of groundwater in the MIA tends to decrease from north-west to the south. For example, to the west of the Mirrool Irrigation Area, groundwater salinity is over 20 dS/m. Near horticultural areas around Leeton, groundwater salinity is as low as 1 dS/m.

### *2.3.2 Soil types*

Soils in the MIA can be classified into the categories shown in Figure 2.3 Around 20 percent of the MIA soils are self-mulching clay soils. These are more suitable for crops such as vegetables, maize, and soybeans. The non-self mulching clays and transitional red brown earths are most suitable for rice. However red-brown earths and some sandy soils are most suitable for horticultural crops. The prior streams comprise sand and gravel deposits. Hill slopes contain colluvial soils. The aeolian clay material which these soils contain makes them permeable with good physical characteristics.

**Figure 2.3: Soil Types and Distribution in the MIA**




**Reference:** Geoff Beecher, 2004

# 3. Irrigation

## 3.1 Irrigation Infrastructure

The MIA surface water comes from the Burrinjuck and Blowering Dams. Burrinjuck Dam which started providing irrigation water in 1912, has a total capacity of 1.03 million ML whereas the Blowering Dam built on the Tumut River in 1968 has a capacity of 1.63 million ML. The combined storage capacity of both these dams is 2.66 million ML. Water is diverted to the MIA from the Murrumbidgee River at the Berembed Weir, which is 386 km downstream from the Burrinjuck Dam. From Berembed Weir water moves into Bundidgery storage and to the irrigation system that is owned and maintained by Murrumbidgee Irrigation Limited (MIL). The Main Canal feeds water to the 2,350 km of irrigation channels that bring water to the farm gate in the MIA. At the Yanco regulator the major irrigation system splits into two. Gegelderie Branch Canal diverts from the Main Canal. From Gogeldrie Weir water is moved into Stuart Canal that supplies water to farms on the western side of the MIA. In most cases, water flows to farms by gravity (MIL, 2001).

The Department of Infrastructure Planning and Natural Resources (DIPNR) regulates the Murrumbidgee River through the Burrinjuck and Blowering Dams to meet the needs of the MIA and other major irrigation areas and districts in the catchment. These needs include those of the irrigators, in-stream requirements (eg wetlands) and town water supplies for domestic, recreational, and industrial uses.

Murrumbidgee Irrigation Limited (MIL) is responsible for providing irrigation water to farmers in the MIA. The MIL is also responsible for water pricing, the development and maintenance of infrastructure, and pollution control. The MIL purchases water in bulk from DIPNR and supplies water to individual farmers according to their entitlements. Water supply to each farm is measured at the farm gate mechanically by Dethridge wheels. Water accounts are collected at the end of each season. All MIA farms now have volumetric entitlements. The MIA has one of the most reliable water supply systems in NSW.

## 3.2 Water Allocation Policy

There are essentially two broad categories of licences for the regulated river system in the MIA: high security licences and general security licences.

The irrigation licences used for permanent plantings such as fruit trees and grape wines are high security licences for which MIL charges a higher price compared to the price charged for the general security licences. Holders of high security licences are guaranteed their full entitlements at all times except for the most severe drought periods. High security entitlements are also provided to groups of users such as trusts.

With the introduction of water reforms and environmental allocations to rivers, high security entitlement holders will retain a maximum of 95 percent their licensed base allocations and the remaining 5 percent is to be diverted to environmental flows (DIPNR, 2004-05).

Rice farms have general security entitlements to a maximum allocation of 1,400 ML per year based on a farm size of 220 ha (Table 3.1). The allocations are worked out on a per hectare basis for the total irrigable area of a large area farm. Water is allocated at 6 ML per hectare up to 120 hectares, for 120-180 ha, 720ML plus 10ML for each irrigable area in excess of 120 ha, and for areas in excess of 180ha, 1320ML plus 2 ML for each irrigable hectare in excess of 180ha (WRC, 1983).

**Table 3.1: Criteria Followed for Allocation of Water Based on a Typical Farm Size of 220 ha in the MIA**

| Allocation categories | Area (ha) | Total water entitlement (ML/ha) | Total water entitlement (ML/farm) |
|---|---|---|---|
| First 120 ha | 120 | 6 | 720 |
| Between 120 and 180 ha | 60 | 10 | 600 |
| Between 180 and 220 ha | 40 | 2 | 80 |
| **Total** | | | **1400** |

Source: WRC (1983).

The entitlements on large area farms, however do not guarantee the receival of the designated volume of water. The annual water allocation varies depending on the stored water volumes in the Burrinjuck and Blowering Dams. The water entitlements do help to work out the share of an individual irrigator from total water available in a particular year. Irrigators are advised of their initial allocation, as a percent of their licensed base allocation in the middle of July. Annual allocations are revised every month based on the total water stored in the dams, minimum inflows into the storage system, the amount of water that is currently available in the river system and could be used for irrigation, and the additional water made available due to rainfall in the upper catchment areas. The revised allocations are announced in the middle of every month up to June the following year. The allocation procedure is structured conservatively so that allocations do not need to be subsequently reduced during an irrigation season unless the resulting conditions are more severe than the driest recorded. The reliability of irrigation supplies in the MIA and the historically conservative nature of allocation announcements by the DIPNR are likely to have significant effects on the way in which irrigators respond to allocation announcements. The farmers would be unlikely to base their farm plans solely on announced allocations at the beginning of the season.

General security license holders are also permitted to extract supplementary (off-allocation) water when dams overflow, high flows enter the river system downstream of a storage, or flows exceed consumptive demands and those specifically reserved for the environment. They are allowed to access off-allocations if the announced allocations are at or below 70 percent. Access to this water depends on a policy decision and is not licensed. Usage of this water does not count against the license holder's annual allocation but does attract usage costs. Access to off-allocation flows is not available to high security license holders (DSNR, 2003).

Holders of general security licenses are now allowed to carry-over up to 15 percent of their allocation to the following year if the water was available to the license holder and is unused in the current water year. Unused allocations from the current year are automatically transferred into the next year's entitlement but the sum of carryover and announced allocation can not exceed 100 percent of the licensed base allocation. Carry-over is progressively forfeited as the announced allocation plus carry-over exceeds 100 percent (DSNR, 2003). With the introduction of the water reforms and environmental allocations to rivers in the Murray Darling Basin (MDB), the entitlements of general security licensees are being restricted. Carryover is not available to any other category of water access licenses.

An irrigator can borrow up to a maximum of 5 percent of their next year's allocation to use in the current year. Borrowing is only available if statutory and NSW high security reserves and commitments are met, water is available in the storage and the MDB cap can not be exceeded.

The volume of water is automatically debited against the irrigator's next year's allocation (DIPNR 2004-05).

Until the early 80s, the allocation of water for irrigation was based on an authorised area. There was no limit on the use of water for rice production. Farmers were growing rice on soils that required up to 27 ML/ha of water. However, as the demand for available water increased, management of water by area based allocation limits became less effective in meeting the needs of water users and protecting the river health. Moreover, the area-based system did not provide strong incentives for efficient use of water because the limiting factor was the area to be irrigated and not the volume of water. The excessive use of water also led to rising watertables causing serious problems of waterlogging and soil salinity in the irrigated areas and poor water quality downstream. Therefore, the existing water licences that specified authorised areas were converted to licences specifying maximum annual volumes of water or annual volumetric entitlements in 1984. The volumetric allocations have helped in encouraging the adoption of technologies that use water more efficiently.

## 3.3 Water Price Policy

In 1999, for the MIA as well as the neighbouring districts, the NSW Government in the new Rural Water Pricing Policy announced removal of cross subsidies for irrigation services, full recovery of the costs of all service operations, the operation of a balanced budget, and the establishment of an asset replacement fund.

Under the new arrangements, horticultural as well as large area farms now pay fixed and variable water charges using two separate systems of water pricing. Each system reflects its respective farm type. The Irrigation Management Board developed these pricing systems for the MIA and its surrounding districts. The information given in Table 3.2 shows the fixed and variable water costs on a typical large area irrigation farm in the MIA in year 2004 (Singh & Whitworth, 2004). Based on 100 percent water allocation, a large area farmer with an irrigation entitlement of 1500 ML paid a fixed price of $ 6.37/ML. It is unrelated to the volume of water used and it includes charges like administrative fees, bulk water charges, asset levy, entitlement fee, Land and Water Management Plan charges etc. The variable cost related to volume of water used was $12.66/ML (Table 3.2).

Horticultural farmers with high security allocations also pay both fixed costs (unrelated to water used) and variable costs. Based on 100 percent allocation, in year 2004 high security water users on a 10 ha horticultural farm would pay a fixed price of $10.16/ML and variable costs of $21.49/ML (Watson, R., 2004, Pers. comm.).

## 3.4 Regulation of Rice Growing

At present the criteria being used to regulate the rice industry are (1) soil suitability, (2) water use, and (3) hydraulic loading.

Rice is a water intensive crop and for optimal growth it needs permanently flooded conditions for about four months of its growing season. Therefore rice can only be grown on heavy textured soils where water losses through seepage are minimal. The transitional red brown soils with a heavy clay horizon are most suitable for rice growing because they are less permeable compared to all other soils in the area.

In the 1970s agricultural engineers classified the rice growing area into three different categories of soils on the basis of suitability for rice production. The first category was ***Suitable Land,*** with a layer of heavy to medium clay soil greater than 2.1 metre thick. The second was ***Marginal Land,*** with a layer of heavy to medium clay soil between 1.5 m to 2.1 m thick. The third one was ***Unsuitable Land,*** with a layer of heavy to medium clay soil less than 1.5 m thick**.**

In order to prevent excessive deep percolation of water, DIPNR imposes soil suitability limits to rice growing. All the land intended for rice growing must be first tested for soil suitability. Rice soil suitability is assessed today on the basis of targeted soil sampling for ECa (bulk soil electric conductivity) values in the field. The targeted soil sampling is either assessed for depth of clay intervals (as above) with boundaries related to the ECa map or by assessing the sodicity (ESP) of the soil to a depth of 1.5 m. If ESP is >6 (0-60cm) or > 16 (60-150cm) the soil is considered suitable for rice production. The validity of the suitability classification is checked at the end of each rice growing season by analysing water consumption figures to ensure that there has not been excessive percolation.

**Table 3.2: MIA General Security Allocation Water Charges**

| | | | | |
|---|---|---|---|---|
| **Fixed Water Costs (i.e. unrelated to volume of water used)** | | | | |
| - Administration/service fee | | $285.00 /farm | | |
| - Rice environment monitoring charge | | $145.00 /farm | | |
| - LWMP fixed charge | | $145.19 /farm | | |
| - Asset Levy on Outlet | - large wheel | $65.00 | | |
| | - small wheel | $50.00 | | |
| | - pipe or door | $10.00 | | |
| - Total Allocation Charges | Based on 100 % allocation | | | |
| - Bulk Water Charge – Fixed | | $2.82 /ML | | |
| - Asset Levy | | $1.78 /ML | | |
| - NSWIC/LWRRDC | | $0.07 /ML | | |
| - Entitlement Fee | | $1.20 /ML | | |
| - LWMP Charge | | $0.50 /ML | | |
| | | **$6.37 /ML** | | |
| **Variable Water Costs (i.e. Related to volume of water used)** | | | | |
| - Water Usage Price | | | $11.62 /ML | |
| Based on Area/District water use of 750,000ML | | | at 50% of Allocation | |
| - Bulk Water Charge – Usage | | | $1.04 /ML | |
| **TYPICAL ACCOUNT** | For customer growing rice and using 50% of Allocation | | | |
| Allocation Fixed Charges | | $6.37 /ML | 1500 ML | $9,555.00 |
| Admin Fee & Rice EMC & LWMP | | | | $430.00 |
| Asset Levy for 2 large wheels | | | | $130.00 |
| Envirowise levy | | | | 145.19 |
| Usage Charge | | $11.62 /ML | 750 ML | $8,715.00 |
| Bulk Water usage Charge | | $1.04 /ML | 750 ML | $7,80.00.00 |
| | | | | **$19,755.19** |
| **TOTAL FARM CHARGES** | | | | |
| **Variable Water Costs** | | | | **$12.66 /ML** |
| **Total Water Costs** | | | | **$26.34 /ML** |

Source: Watson, R., (2004), *Pers. Comm., MIL*, Leeton

In the 1970s the acceptable water use by rice was 27 ML/ha and paddocks that required more water were considered unsuitable. In 1985 the rice water use limit of 18 ML/ha was introduced in the MIA. This was further reduced to 16 ML/ha. Today, RWU limit = "(Et-R+4)" Ml/ha i.e; evapo-transpiration requirements of crop – rainfall + 4 Ml of water losses though seepage or surface run off, has been adopted as the benchmark which allows seasonal adjustments for rainfall and evaporation to be applied to determine the annual water use target. Land not meeting this target water use may be removed from rice growing.

DIPNR has a responsibility to ensure that irrigators use water efficiently and without harm to the environment. In accordance with this objective, a rice area policy was negotiated with the Rice Industry Coordinating Committee effective from the 1990/1991 season. Hydraulic loading limits were introduced. The term "hydraulic loading" describes the intensity of rice growing on land found suitable for rice cultivation on each farm. Under this policy 30 percent of the total rice-approved area of the farm, or 65 ha which ever is greater, is the area of rice permitted to be grown in any year in the MIA.

Rice growing is not permitted within 150 m of the nearest bank of any watercourse. It is also not permitted within a nominal distance of 100 m from where rice farms and horticultural farms join. Rice can only be grown within this distance if specific permission is granted to the rice grower by the horticulturist. The purpose of this restriction is to eliminate the chance of damage to the permanent planting from the lateral movement of water. Drainage from rice is not permitted to enter into the watercourses outside the Irrigation Areas and Districts.

## 3.5 Drainage System

The MIA is linked to a drainage system that is centred on the Barren Box Swamp. The natural drainage of the area is by the Mirrool Creek which discharges drainage water into Barren Box Swamp. The stored drainage water is then used for irrigation, stock, and domestic water supply downstream.

The development of the rice industry in the MIA resulted in a massive growth in irrigated land area and in water usage for irrigation. This growth now exceeds the MIA drainage network's ability to retain surface run-off. As a result, excess water is released to the Mirrool Creek Floodway more often, which may not always be convenient to farmers downstream.

All new horticultural developments on the large area farms are required to obtain approval for such developments and meet conditions attached to such developments by Murrumbidgee Irrigation Limited including meeting land suitability, buffer zones, efficient irrigation technologies and disposal of surface and subsurface drainage water requirements.

The land holders with both high and general security water entitlements are allowed to use both allocations for irrigating horticultural crops but have to first use the high security allocations. Those farmers with only general security entitlements have to ensure they have enough allocation to meet the irrigation requirements of the horticultural crops. Otherwise, based on the area under horticultural crops, these farmers are allowed to convert some of their general security entitlements to the high security entitlements. Under normal conditions, new developments with general security entitlements would not get any preference in the supply of water. These farms would also be able to access off-allocations and environmental surplus flows as available under normal rules (Murrumbidgee Irrigation Limited, 2003).

New horticultural developments are required to adopt more efficient irrigation technologies like drip, sub surface drip or overhead sprinklers that help to minimise surface run-off and loss of water through deep drainage. To prevent water seepage that may eventually lead to a rise in watertables, all the new horticultural developments are required to install a sub-surface drainage system, especially on farms where the land is flat. All farms developed after 1984 are required to dispose of the sub surface drainage water on their own property using evaporation disposal ponds on soils with minimum leakage to prevent losses through seepage. They are not allowed to use the existing tile drainage system being managed by Murrumbidgee Irrigation Limited and being used by the gazetted horticultural holdings or land holdings with horticultural plantings existing before 1984 because forty percent of the annual salt load in the Barren Box Swamp comes from the tile drainage system. New horticultural planting areas are required to leave about 10 percent of the proposed area for the on-farm disposal of the drainage water where the tile drainage is less than 1 ML/ha/year from the area proposed for horticultural development, (Murrumbidgee Irrigation Limited, 2003).

# 4. Farming Systems in the MIA

## 4.1 Major Farming Systems in the MIA

The soil types, climate, and well-developed irrigation infrastructure in the MIA make it one of the most efficient irrigated agricultural areas in Australia. The MIA is suitable for three types of irrigated farming systems: horticulture, vegetable, and broadacre farms. Horticulture plantation farms are known for their grape and citrus production. Vegetable farms mainly grow onions, carrots, tomatoes, and melons. Rice is the predominant crop grown on broadacre farms. It is difficult to assemble value of production data for subregions in a particular year. For the years around 2003- 2004, the farm gate value of total agricultural production in the MIA was about $404 million which included $150 million from horticultural production, $24 million from the vegetable production and $230 million from broadacre (Table 4.1).

**Table 4.1: Area and Value of Output of Different Agricultural Industries in the MIA**

| Category | Area (ha) | Proportion (%) | Value of production ($ million) | Percentage value of production (%) |
|---|---|---|---|---|
| Horticulture | 24,800 | 13 | 150 | 37 |
| Vegetable | 3,000 | 2 | 24 | 6 |
| Broadacre agriculture including pasture | 157,000 | 85 | 230 | 57 |
| Total | 184,800 | 100 | 404 | 100 |

Sources: NSW Agriculture (1998), CRC Rice (2003), Horticultural Board (2004), and National Vegetable Industry Centre (2004)

## 4.2 Horticultural Farms

Areas with well-drained soil such as those around Yanco, Leeton and Griffith are suitable for horticultural farms. Water allocations are smaller and the price of water is higher compared to rice farms, but water supply is assured for high security horticultural farms. A typical 20ha horticulture farm at 95% of their licenced based water allocations would be entitled to 228 ML at 12 ML/ha.

In 1971 there were 935 horticultural farms in the MIA. The total area of permanent planting on these farms was 10,405 ha (Kennedy, 1973). In 2003 there were more than 1,000 horticultural farms with a total area of 24,800 ha. Grapes and citrus are the two major horticultural enterprises that accounted for 97 percent of the total area under fruit crops with 37 percent under citrus and 60 percent area under grapes.  The rest of the area was under prunes and other fruits like apricots, peaches, plums nectarines, nuts etc.

Ninety percent of the NSW citrus crop was produced in the MIA and this accounted for 30 percent of the Australian crop. Approximately 70 percent of the Valencia and 20 percent of the Navel crop became fresh fruit juice, with remainder sold as fresh fruit. The MIA produced almost 20 percent of the total Australian red and white wine grape production and 70 percent of NSW production (To-days Harvest, MIL, 2001).

The total production of citrus in 2003 was estimated at 182,000 tonnes with a farm gate value of $40 million. Total production of grapes was 230,000 tonnes and the farm gate value was $107 million (Moorie, S., 2004, pers. comm.).

In recent years, because of the development of the wine and citrus juice industries in Australia, and increased demand for Navel oranges in overseas and fresh local markets, the area under these high valued horticultural crops has increased from 22,000 ha in 1999-2000 to almost 24,800 ha in 2003-04 (Table 4.2).

**Table 4.2: Break-Up of the Major Fruit Types in the MIA During 2003–2004**

| Fruit Crop | Area (ha) | Value of Production ($ million) |
|---|---|---|
| ***Citrus*** | | |
| Valencia | 5,320 | |
| Navel | 3,680 | |
| Total area under citrus | 9,000* | 40.0 |
| ***Grapes*** | | |
| Red wine grapes | 7,588 | |
| White wine grapes | 7,337 | |
| Total area under grapes | 14,925** | 107.0 |
| ***Prunes*** | 550 | 4.0 |
| ***Other*: apricots, nectarines, nuts, etc.** | 300 | 0.8 |
| **Total area** | **24,775** | |
| **Total value of production** | | **151.8** |

*This includes all citrus including other than oranges
**This includes area under table grapes and other varieties of grapes if any
Source: MIA Horticultural Board, (2004); Harry Creecy (2004), pers. comm.

## 4.3 Vegetable Farms

The MIA is a major producer and supplier of fresh vegetables to different markets nationally. A well developed irrigation supply system, warm climate, and highly productive soils are some of the key factors in the development of vegetable industry in the region. Onions, pumpkins, gherkins, melons, and tomatoes are the major vegetables being grown in the MIA. Vegetable farms are relatively small, requiring specialised and highly mechanised farming operations, but in terms of water allocations, water security and water pricing, these farms are treated as large area farms with general security licences.

In 1990 the total area under vegetables was 2,681 ha. The establishment of the National Vegetable Industry Centre at the Yanco Agricultural Institute in 1997 has helped in the further growth of the vegetable industry in the MIA. In year 2002-2003 2,940 ha were under vegetable crops with a total value of production of $24.3 million. The average value of production from vegetable growing was $8,300 per hectare in 2002-03 (Table 4.3).

**Table 4.3: Area Under Different Vegetable Crops in the MIA During 2002-03**

| Crop | Area (ha) | Value of Output ($Million) | No. of farms |
|---|---|---|---|
| Sweet corn | 300 | 0.6 | 2 |
| Potatoes | 150 | 1.0 | 5 |
| Tomatoes | 300 | 2.6 | 1 |
| Onions | 550 | 8.3 | 17 |
| Carrots fresh market | 160 | 1.3 | 5 |
| Melons | 450 | 5.4 | 16 |
| Pumpkins | 500 | 1.2 | 15 |
| Lettuce | 30 | 0.4 | 1 |
| Gherkins | 500 | 3.5 | 1 |
| **Total** | **2940** | **24.3** | **63** |

Source: National Vegetable Industry Centre, YAI, Yanco, 2004

## 4.4 Broadacre Farms

The information in Table 4.4 reveals that rice in summer and wheat in the winter are the most important crops on large area farms. Area under these crops increased significantly from 1991 to 2001. Although rice growing on mixed irrigated farms in the MIA produces the highest returns per hectare, due to problems of rising water tables and soil salinity, annual rice acreage allocations and the permission to grow rice are strictly controlled. The permitted acreages are also varied annually depending on market requirements.

Canola is another winter crop which is grown on the broadacre farms. In the 1990's with an increase in demand and better market prices, the area under canola and soybean increased sharply in the MIA. Further increasing water costs have resulted in farmers aiming to improve water use efficiency.

**Table 4.4: Trends in Area under Different Farm Enterprises in the MIA during 1999-2000**

| Crop | Unit | Year | | | |
|---|---|---|---|---|---|
| | | 1990 | 1994 | 1998 | 2000 |
| Wheat | ha | 12,704 | 22,382 | 33,525 | 26,853 |
| Rice | ha | 32,607 | 42,170 | 43,310 | 53,000 |
| Canola | ha | 226 | 2,149 | 2,968 | 1,598 |
| Soybeans | ha | 279 | 257 | 1,521 | 1,023 |
| Vegetables | ha | 2,681 | 3,774 | 3,760 | 4,030 |

Sources: ABS (1998) and previous issues, CRC Rice (2003).

In the past, the sheep and lamb enterprises were the major activities on the large area farms in the MIA. The number of sheep dropped by about 50 percent from 1990 to 1998 (i.e. 600,000 sheep in 1990 to 300,000 sheep in 1998) due to a decline in wool and lamb prices. Farmers moved away from the sheep-based farming systems (ABS, 1998, CRC Rice, 2000). Now farmers keep a minimum area under pasture and enough sheep to fit in with the crop rotations, for control of weeds and for cleaning of channels. The high prices for lamb in 2004 however may encourage a re-expansion of the lamb industry.

The area under rice increased significantly from 27,000 ha in 1991 to 66,000 ha in 2001. Severe drought conditions and very low levels of water allocations during the last few years have led to a sharp decline to 22,000 ha in 2003 and 23,000 ha in 2004 (Table 4.5). Although the rice varieties grown in the area have high yield potential, low temperature conditions especially during the early pollen microspore period have led to a variation in yield in different years.

**Table 4.5: Trends in Area, Production and Yield of Rice in the MIA from 1999 to 2004**

| Year | 1991 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| Area ('000 ha) | 27 | 38 | 53 | 66 | 52 | 22 | 23 |
| Production ('000 t) | 251 | 349 | 453 | 479 | 236 | 211 | 214 |
| Yield (t/ha) @ 14% moisture | 9.3 | 9.3 | 8.5 | 9.5 | 9.2 | 10.7 | 9.3 |

Sources: CRC Rice (2004).

# 5. Key Management Issues

## 5.1 Current Issues Affecting Large Area Farms in the MIA

Rice cultivation in the MIA has brought both prosperity as well as problems. The conditions listed below are becoming a serious threat for sustainable agriculture in the MIA.

***Low levels of water allocations / water availability***

A key issue that is of concern to the rice growers during the last few years is associated with the very low levels of water allocations on the large area rice farms in the MIA. Water allocations were 40 percent and 30 percent of the full entitlements during 02-03 and 03-04 respectively (Table 7.2). Severe drought conditions during the past few years with very low levels of water allocations have seriously affected the profitability and economic viability of rice farms and the rice industry.

***Rising watertables***

Before the introduction of rice farming in the 1920s, the groundwater watertable in almost all of the MIA was about 20 m below the surface. In 2001 the watertable for around 85 percent of the MIA was within 2m of the surface. Rising watertables and rice cultivation in some of the areas are leading to waterlogged soils. These problems increase whenever rainfall higher than usual occurs. This ultimately affects the performance of some of the winter crops.

The target of the Murrumbidgee Land and Water Management Plan (LWMP) was to reduce watertables by 1-2 metres by 2010. This target is presently being met partly because of the severe drought during the last few years. Most environmentalists and hydrologists feel that the drop in the watertable is the combined effect of drought and better management practices by farmers and MIL. With the present level of information it is hard to identify the relative contribution of management and drought to the drop in the watertable. In the long term, better management of land and water resources are required to prevent rising watertables.

In the 1980’s salinity in the MIA was estimated at under 20 dS per metre but by 2000 the level was over 20 dS per metre, and is predicted to be in the high 20 dS range within the next fifteen years (NSW Agriculture, 1998). This would affect crops like Lucerne and canola that are sensitive to salinity.

The MIA drainage system and the Barren Box Swamp act as a reservoir for salts, nutrients, pesticides, and chemicals released upstream. This results in deteriorating water quality downstream in Mirrool Creek. At present water supplied to the downstream water users contains an average annual salt load of 51,753 tonnes (NSW Agriculture, 1998) which is also leading to losses in productivity of the different salt-sensitive crops in the area.

***Climate/Temperature variability***

Although the Riverina region in Australia is among the highest yielding rice-growing regions in the world, rice production is still subject to climatic risk. The occurrence of low night temperatures during reproductive development in rice is one of the principal yield-limiting factors of rice growing in this region. Yield losses due to low temperatures are the result of incomplete pollen formation and subsequent floret sterility. Yield losses occur when the temperature falls to 18° C and lower. Researchers have found that in 75 percent of years, rice farmers suffer losses of between 0.5 and 2.5 t/ha due to cold (Singh et al., 2002).

## 5.2 Water Reform Process

Over-exploitation of the irrigation resources has had an adverse effect on river health. There are signs of stress within water resources that include loss of wet lands, decline in the native fish population, continuing occurrence of blue green algal blooms, carp infiltration, high bacterial levels, increased river salinity etc.

For the Murrumbidgee River, which runs from its source in the Snowy Mountains to its junction with the Murray River, the construction of Burrinjuck Dam, and also Blowering Dam on the Tumut River, has altered the volumes and pattern of flows in the river system with adverse effects on the environmental health of the river and its wetlands and on water quality (DSNR, 2003).

To address these issues the Australian Industry Commission (1992) made a number of important recommendations that have had a significant bearing on irrigated agriculture. These recommendations included:

- Privatisation of irrigated areas;
- Rural water charges based on full cost recovery;
- Introduction of permanent transferability in all irrigation systems;
- Allowance for the transfer of water between schemes, and between users; and
- Formalising water entitlements for environment purposes with a provision that any additional water for environment should be purchased.

The Council of Australian Governments (COAG) in 1994 considered all these recommendations and agreed to a national level approach to a number of important reforms for the water industry. Some of the key agreements reached were:

- The introduction of water pricing based on consumption and full cost recovery;
- Declaration of formal allocations for water, including allocations for the environment as a legitimate user of water;
- The introduction of trading arrangements once entitlement arrangements have been settled.

The establishment of the COAG water reform framework provided a boost to the progressive reforms of the NSW water industry. As a consequence, the state government through the former Department of Land and Water Conservation (DIPNR) and the former Environment Protection Authority (EPA) introduced a wide range of water reforms involving the re-balancing of consumptive and environmental uses mainly through the introduction of the environmental flow rules.

Although the reforms introduced by COAG and the NSW government would lead to environmental benefits, these water policy reforms would also have direct impact on farmers, through the lower availability of water for irrigated agriculture. Other key reform areas include the clarification of property rights to water; the adoption of greater water trading arrangements; full cost recovery and removal of cross subsidies; and institutional and organisational reforms. Implementation of these reforms would have wide implications for the sustainable growth of irrigated agriculture.

In 1997, the NSW government endorsed the recommendation that environmental flow rules be developed and applied in all major regulated rivers, including the Murrumbidgee River. The purpose of the river flow rules was to provide an environmental allocation package which halts, then reverses, the decline in the health of rivers, wet lands and estuaries by water and catchment management, and to provide equity between the environment and other users.

An inter-agency Water Reform Policy and Technical Committee developed a set of indicative flow rules for each river valley in Australia. These rules were developed to address river health needs with a limit on the impact on water users of no more than 10 percent of annual diversions. For the Murrumbidgee this limit is 5 percent of annual diversions because of the uncertainty about the impact of the Snowy Water Inquiry.

River Management Committees, with members including growers, environmentalists, local governments, Aboriginal organisations and state and federal government were formed for the regulated rivers of the NSW. In 1997, a Murrumbidgee River Management Committee was also set up to advise on the environmental flow rules for the Murrumbidgee River.

In March 1998, the NSW Government accepted a set of environmental flow rules recommended by the Murrumbidgee River Management Committee and incorporated these rules into the management of the Murrumbidgee River. In 2001, these rules, with some revisions were built-in to the Water Sharing Plan for the Murrumbidgee Regulated River Water Source. The aim of the flow rules was to meet the environmental needs whilst providing some security to the irrigators.

## 5.3. The Murrumbidgee Water sharing plan

In 2001, the Murrumbidgee River Management Committee was asked by the Minister for Land and Water Conservation to recommend water sharing rules for inclusion in a statutory water management plan. Based on the recommendations of the Committee and agreed Government Policy, the final water sharing plan was announced by the Minister in December 2002. It is a legal document developed under the Water Management Act 2000 and applies for a period of 10 years from 1 July 2003 to June 2013 (DSNR, 2003).

The aim of the water sharing plan is to protect river health, and river based ecosystems and clearly establish rules for sharing of water between the environment and other users (See Table 5.1). It clearly defines the rights and conditions attached to different licence holder's access rights.

Since rice growing is the most predominant irrigation activity on the large area farms in the Murrumbidgee Valley, it is important to know the impacts of water reforms such as environmental flows, water pricing, and water trading on the future growth of the rice industry.

The plan applies to about 1200 km of the regulated reaches of the Murrumbidgee River from the upper reaches of Burrinjuck Dam to where it joins with the Murray River; the Tumut River from the upper limit of Blowering Dam to where it meets the Murrumbidgee River and the Yanco / Billabong Creek system (DSNR, 2003).

In the new water sharing plan, there is provision for domestic and stock rights and native title rights to extract some water from the river without an access licence under the basic land holder's rights. The plan specifies the share of total extractions for different types of access licences issued to different categories of water users (Table 5.1). No water extraction other than occurring under basic landholder's rights is allowed without an access licence.

**Table 5.1: Share of Total Extractions to Different Categories of Licences in the Murrumbidgee River under the Water Sharing Plan 2003-2013**

| Access Licence Category | Total share component (%) |
|---|---|
| General security | 68.3 |
| High security | 10.0 |
| Domestic and stock | 1.2 |
| Local water utility | 0.8 |
| Murrumbidgee Irrigation (conveyance) | 8.0 |
| Coleambally Irrigation (conveyance) | 4.3 |
| Supplementary water | 7.4 |
| **Total water (ML)** | **2,993,428** |

Source: DSNR, 2003

Although the share for general security access licence holders accounts for more than 68 percent of the total volume of water available for extractions to different categories of licences, water made available to the general security licences will vary from year to year depending upon the amount of water held in the Burrinjuck and Blowering Dams and whether more water becomes available during the year.

Maximum water allocation to the high security access licence holders is 95 percent of their share component in all years and 100 percent in years when general security access licences also receive 100 percent of their share component.

Access to 'off- allocations' that were allowed to the general security access licence holders under the old system has been replaced with Supplementary Water Access Licences. Under these new sharing arrangements, the general security access licence holders with a history of using off-allocation quota, are issued supplementary water access licenses when general security allocations are below 70 percent of the normal allocation. Access to supplementary water will only be allowed when flows are in excess of those required for environmental needs, domestic and stock and native title basic rights, higher security access licence requirements and specified replenishment flows (DSNR, 2003). The total volume of supplementary water made available to the general security water users is worked out in the beginning of each year. Horticultural farmers with high security have no access to the supplementary access licences.

***Access Licence dealing rules***

Access licence dealings include conversion of water access licence categories, water trade and changes in the location of water extraction.

Irrigators, under the new water sharing plan, are allowed to convert their access licence categories from general security to high security, or from high security to general security licences, subject to conversion factors and other rules designed to ensure that other licences are not affected as a result of the dealing (DSNR, 2003).

The expansion of water markets is another key feature of the water sharing program. Under the new arrangements, farmers in the irrigated areas in the Murray Darling Basin are now able to trade water on both permanent and temporary bases.

The government's policy on water trading encourages farmers to use water efficiently and earn income by selling surplus water in the open market. Those farmers who have capacity to use water on more profitable enterprises can buy water from the open market. This helps in diverting the use of water from low value enterprises to higher value enterprises and would encourage irrigators to use their water more efficiently. Whether farmers buy or sell water depends on the value of the change in production from a one unit change in water use relative to the price of one unit of water.

# 6. Representative Farm Model

A representative whole farm model was developed to illustrate the interrelationships from a whole farm viewpoint between different enterprises on a typical rice-based farm in the MIA. In developing the model, the local consensus data (LCD) approach, based on discussions with a group of farmers, research and extension staff from NSW DPI and DIPNR, and local irrigation agencies, was used. These discussions provided details about a typical farming system. Together with information from other sources, such as the ABS and the Rice CRC, the discussions assisted in developing a model that represents rice farming in the area in terms of farm size, resources, irrigation infrastructure, and other physical and financial features.

## 6.1 Farm Resources

Within the MIA, farm size largely varies because of adaptations of the concept of a home maintenance area under closer settlement or soldier settlement schemes. In the original MIA the size of farms varied from 35 ha to 400 ha, whereas in more recently developed subdivisions, the size of the farms varied from 160 to 200 ha. In the MIA today, 60 percent of the 634 rice farms are in the size range of 160 - 225 ha. It is common for families to own and manage a number of these farms.

The size of the representative farm developed here is 220 ha (Table 6.1). Of this, the area set for irrigation is 200 ha and the remaining area is under channels, drains, structures and on-farm approach roads. The area normally irrigated is 180 ha and each year 20 ha is kept fallow to fit in with the crop rotation.

The typical farm is a single, family-owned unit where the owner/operator works full time on the farm. Family labour handles all the farm operations during the year except for a period of 10 -12 weeks when casual labour is employed to complete time-bound sowing and harvesting operations during winter and summer seasons.

Sheep are the main form of livestock on irrigated large area farms. The complementary nature of sheep comes from their use of crop residues and pasture. With the decline in the prices of wool and lamb during the 90s, farmers shifted away from sheep to cereals, oilseeds or pulse crops. The number of sheep stocked on a typical farm in the MIA today varies from about 200 head on a pasture-based farm to nil on a farm that adopts non-pasture rotations (Table 6.1).

The irrigation layout of a typical rice farm in the MIA of 220 ha is 150 ha of landformed contour bay and 50 ha of non-landformed natural contour (Table 6.1). Irrigation infrastructure on the typical farm includes an on-farm recycling system. Around 70 percent of farms have recycling structures installed and up to 10 percent of farm water is recycled. A typical farm in the MIA depends on regulated water supplies. Under normal conditions a typical farm has an allocation of 1400 ML of water each year.

**Table 6.1: Physical Characteristics of a Representative Rice Farm in the MIA**

| Farm areas | Unit | | |
|---|---|---|---|
| - Total farm area | Ha | 220 | |
| - Area set up for irrigation | Ha | 200 | |
| - Area normally irrigated | Ha | 180 | |
| - Sheep | Hd | 0-200 | ewes (0-460 DSE) |
| - Area under rice | Ha | 66 | (30% of farm area) |
| Farm labour | | | |
| - Owner/manager | No. of weeks | 50 (1 unit) | |
| - Casual labour | No. of weeks | 10 -12 | |
| Irrigation layout/ method | | | Irrigation Efficiency (%) |
| - Land formed - contour and border check | Ha | 150 | 80 |
| - Non land formed - natural contour | Ha | 50 | 65 |
| Water supplies | | | |
| - Regulated water irrigation entitlement | ML | 1400 | |
| Water resource costs | | | |
| - Variable cost | $/ML | 12.66 | |
| - Fixed cost | $/ML | 6.37 | (based on 100% allocation) |
| - On-farm recycling system | Yes / No | Yes | 70% farms have recycling structure installed and up to 10% water is recycled |
| - Closest rainfall site | Location | Griffith | |
| - Closest temperature site | Location | Yanco & Griffith | |

## 6.2 Main Enterprises in Rice Based Farming Systems

Farmers in the MIA can choose from a wide range of crop and livestock enterprises. In setting up the model farm below we have concentrated on the most widely adopted enterprises. These include medium and long grain rice, wheat, barley, canola, soybeans and lambs. Gross margins budgets for these enterprises can be found in Appendix A1 to A8. Key economic parameters assumed in this analysis such as price, yield and gross margin per hectare are listed in Table 6.2

**Table 6.2: Price, Yield and Gross Margin Assumed for Key Enterprises in MIA Representative Farm**

| Enterprise | Price ($/t) | Yield (t/ha) | Gross Margin ($/ha) |
|---|---|---|---|
| Medium grain rice | $300.00 | 10.0 | $2189 |
| Long grain rice | $315.00 | 9.0 | $2047 |
| Wheat (ASW) | $150.00 | 5.0 | $364 |
| Wheat biscuit | $175.00 | 5.5 | $537 |
| Barley (Dryland) | $140.00 | 3.5 | $135 |
| Canola | $375.00 | 2.6 | $432 |
| Soybeans | $450.00 | 3.0 | $645 |
| Lambs (mixed sex lamb) | $80.00* | 12.0** | $301 |

* price per lamb, ** DSE/ha

## 6.3 Typical Cropping Rotations

There is no one rotation that is suitable for every rice-based farm in the MIA. The choice of farm enterprises varies across the region and over years based on individual farmer's capabilities, skills and personal preferences; the resources available on the farm; the prices of outputs and inputs; and on crop sequence constraints. Since rice is the most important and profitable summer crop, farmers are left with few choices and select only those enterprises that fit in with rice. Using the LCD approach, this study has identified three crop rotations that are currently being followed by farmers. The model is structured in such a way that allows a comparison of the three rotations without requiring alterations in the farm capital structure.

The traditional rotation is the **Pasture-Based Rotation**, consisting of rice, winter cereals, and a relatively high proportion of pasture. This rotation may include three years of rice, followed by a fallow, then two of wheat, and then three years of pasture; i.e., RRRFWWPPP. The analysis considered only wheat as the winter cereal. However, winter cereals may also include barley, canola, triticale and oats. Around 20-30 percent of farmers in the MIA follow this rotation.

The most typical rotation is the **Cereals-Based Rotation**, consisting of rice, winter cereals, and a smaller proportion of pasture. This rotation may comprise three years of rice, followed by a fallow, a wheat crop, a canola crop, another wheat crop, and then two years of pasture; i.e., RRRFWCWPP. Around 30-50 percent of farmers in the MIA follow this rotation.

The third typical rotation is the **Split-Farm Rotation**, consisting of rice, summer crops, winter cereals, no pasture, and no fallow. In this rotation, the farm is split into two sections. The first section, which is a third of the total farm area, has three years of continuous rice. The second section of the farm area is either on beds or border check, with a rotation of wheat, followed by canola, then wheat, and then three years of intensive cropping of barley in winter and soybean in summer; i.e., RRRWCW(B/S)(B/S)(B/S). A short fallow takes place while swapping the two areas. Around 5-10 percent of farmers in the MIA follow this rotation.

### *Pasture- based rotation*

The features of a typical pasture-based farm are shown in Table 6.3. The table shows that rice is the only crop grown in summer. Of the total area grown under rice each year, approximately two thirds is grown under medium grain and one third under long grain varieties. In the case of wheat, although biscuit wheat is more profitable compared to ASW, farmers grow this variety only on a contract basis because of its limited demand. On average, one third of the total area under wheat is put under biscuit wheat. There is more pasture (40 ha) and sheep (200 ewes) in this rotation. With respect to water use, rice uses 70 percent of the total compared to around 20 percent by wheat. The farm as a whole uses around 92 percent of the total water entitlements for growing different crops in a year. The rest is either sold or is carried forward for next year's use.

**Table 6.3: Irrigated Enterprises in a Pasture-Based Farming System**

| Enterprise | Area (ha) | Yield (t/ha) | Water Used (ML/ha) | Total Water Usage (ML)* |
|---|---|---|---|---|
| WINTER CROPS | | | | |
| - ASW wheat | 50 | 5.0 | 3.5 | 175 (13.7%) |
| - Biscuit wheat | 24 | 5.5 | 3.5 | 84 (6.6%) |
| - Annual pasture/Sheep (sub clover / DSE / ha) | 40 | 12.0 | 3.0 | 120 (9.4%) |
| - Winter water usage | | | | 379 (29.6%) |
| SUMMER CROPS | | | | |
| - Medium grain rice | 44 | 10.0 | 14.0 | 616 (48.1%) |
| - Long grain rice | 22 | 9.0 | 13.0 | 286 (22.3%) |
| - Summer water usage | | | | 902 (70.4%) |
| Total water usage | | | | **1281** |
| **Total Water Available (100% allocation)** | | | | **1400** |
| **% Total Water use** | | | | **91.5%** |

* The figures in parentheses are the percentages of the total water used on the farm.

### *Cereals-based rotation*

The features of a typical cereals-based farm are shown in Table 6.4. There is less pasture (20 ha) and sheep (100 ewes) in this rotation. In addition to wheat, canola (20 ha) is another winter crop included in this rotation. Rice uses 70 percent of total water compared to around 30 percent by winter crops. The farm as a whole uses around 91 percent of the total water allocations per year. The rest is either sold or is carried forward for next year's use.

**Table 6.4: Irrigated Enterprises in a Cereals-Based Farming System**

| Enterprise | Area (ha) | Yield (t/ha) | Water Used (ML/ha) | Total Water Usage (ML)* |
|---|---|---|---|---|
| WINTER CROPS | | | | |
| - ASW wheat | 50 | 5.0 | 3.5 | 175 (13.7%) |
| - Biscuit wheat | 24 | 5.5 | 3.5 | 84 (6.6%) |
| - Canola | 20 | 2.6 | 2.9 | 58 (4.5%) |
| - Annual pasture/sheep (sub clover) | 20 | | 3.0 | 60 (4.6%) |
| - Winter water usage | | | | **377 (29.5%)** |
| SUMMER CROPS | | | | |
| - Medium grain rice | 44 | 10.0 | 14.0 | 616 (48.2%) |
| - Long grain rice | 22 | 9.0 | 13.0 | 286 (22.4%) |
| - Summer water usage | | | | **902 (70.5%)** |
| **Total Water Usage** | | | | **1279** |
| **Total Water Available (100% allocation)** | | | | **1400** |
| **% Total Water use** | | | | **91.4%** |

* The figures in parentheses are the percentages of the total water used on the farm.

### *Split-farm rotation*

The features of a typical split-farm are shown in Table 6.5. There are no pasture or sheep on this farm. In addition to rice, summer crops include soybeans (40 ha). Soybeans are followed by dryland barley (40 ha) as a winter crop. In addition to wheat and barley, canola (20 ha) is another winter crop included in this rotation. Rice uses 57 percent of total water in this rotation, compared to around 16 percent by wheat. The whole-farm water usage is 113 percent of the total water entitlements per year. The extra 13 percent is purchased from the market at $30/ML in years when the supply of irrigation water is not constrained.

**Table 6.5: Irrigated Enterprises in a Split-Farm System**

| Enterprise | Area (ha) | Yield (t/ha) | Water Used (ML/ha) | Total Water Usage (ML)* |
|---|---|---|---|---|
| WINTER CROPS | | | | |
| - ASW wheat | 50 | 5.0 | 3.5 | 175 (11.1%) |
| - Biscuit wheat | 24 | 5.5 | 3.5 | 84 (5.3%) |
| - Barley Dryland | 40 | 3.5 | 0 | 0 (0%) |
| - Canola | 20 | 2.6 | 2.6 | 58 (3.7%) |
| - Winter water usage | | | | 317 (20.2%) |
| SUMMER CROPS | | | | |
| - Medium grain rice | 44 | 10.0 | 14.0 | 616 (39.0%) |
| - Long grain rice | 22 | 9.0 | 13.0 | 286 (18.1%) |
| - Soybeans | 40 | 3.0 | 9.0 | 360 (22.8%) |
| - Summer water usage | | | | 1262 (79.9%) |
| **Total Water Usage** | | | | **1579** |
| **Total Water Available (100% allocation)** | | | | **1400** |
| **% Total Water use** | | | | **112.8%** |

* The figures in parentheses are the percentages of the total water used on the farm.

## 6.4 Financial Characteristics

The income, costs, assets and liabilities of the three systems for the representative farm are detailed in Tables 6.6 – 6.11. For each farming system there is one table that describes the farm's assets and liabilities and one table that sets out an annual operating budget.

A typical rice based farmer in the MIA owns total assets worth about $1.5 million, or $6,812 per hectare which includes the value of land and development (including water), machinery, equipment, livestock and liquid assets like bank deposits, shares, equity in the Rice Cooperative Limited, rice bonds and rice marketing equity. Total liabilities include bank overdraft, HP/ lease and farm loans totalling $300,000 or $1,364 per ha.

The rice farmers in the MIA have very high farm equity. Farm equity is computed by subtracting from the value of the farm assets the total of the farm's outstanding liabilities. The information given below shows that a typical rice-based farm has around 80 percent equity. This is high compared to a farm of the same size and structure in adjoining irrigation districts. One of the reasons for the high equity could be that most farms in MIA are inherited farms with their equities built over time.

Most income from these rice farms comes from crops and to a much smaller extent from livestock. Rice growers are shareholders of the Ricegrowers' Cooperative Limited and hence also earn cash income from their rice bonds and shares.

Farm costs can be split into two broad categories: variable costs and overhead costs. Variable costs are those costs which can be pinned to one particular enterprise and which vary directly with the level of output of that enterprise. Examples are seed, fertiliser, water and machinery operating costs. Overhead costs are the costs that are relatively fixed and vary little with the level of production of any one enterprise. These remain roughly the same no matter what the mixture of enterprises on the farm. These costs can not be assigned to a particular enterprise. Examples are rates, permanent labour, depreciation and rent.

In this analysis, we have not accounted for the value of operator's own labour. The total finance costs include interest on total capital borrowed i.e. interest on the over draft, HP/lease and mortgage.

**Table 6.6: Assets and Liabilities in a Typical Pasture-Based Farm**

| | | | Value ($) | Total value ($) |
|---|---|---|---|---|
| Assets | | | | |
| Land | 220 Hectares @ | $2,000/acre including water | $1,086,800 | |
| | Total value of land | | | $1,086,800 |
| Livestock | 10 Rams @ | $50 per Ram | $500 | |
| | 200 Ewes @ | $70 per Ewe | $14,000 | |
| | Total value of livestock | | | $14,500 |
| Plant and Equipment | | | | |
| | Machinery (average value) | | | |
| | Tractor and machinery | | $148,000 | |
| | Implements | | $43,000 | |
| | Vehicles (car, ute, truck) | | $40,000 | |
| | Others (structures, sundries) | | $20,000 | |
| | Total value of plant and equipment | | | $251,000 |
| Liquid Assets | | | | |
| | Bank/ off farm investments | | $25,000 | |
| | Shares/equity (RGA) | | $9,240 | |
| | Rice bonds | | $35,728 | |
| | Rice marketing equity | | $76,560 | |
| | Total value of liquid assets | | | $146,528 |
| Total assets | | | | $1,498,828 |
| Liabilities | | | | |
| | Bank overdraft | | $50,000 | |
| | HP / Lease | | $200,000 | |
| | Mortgage -farm loan | | $50,000 | |
| Total liabilities | | | | $300,000 |
| Equity (assets-liabilities) | | | | $1,198,828 |
| **Equity ratio (equity / total assets)** | | | | **80%** |

## Table 6.7: Annual Operating Whole Farm Budget in a Typical Pasture-Based Farm

| | | | |
|---|---|---|---|
| **Annual operating budget** | | | |
| 220 ha | Total farm | | |
| 200 ha | Area arable | | |
| 9 | rotation years | | |
| **Enterprise gross margin(RRRFWWPPP)** | | GM ($/ha) | Total GM ($) |
| 50 ha | ASW wheat | $364 | $18,194 |
| 24 ha | Biscuit wheat | $537 | $12,879 |
| 40 ha | Annual pastures / Sheep (under sown with wheat) | $301 | $12,037 |
| 44 ha | Medium grain rice | $2,189 | $96,307 |
| 22 ha | Long grain rice | $2,047 | $45,041 |
| 119 ML | Sale of water ($/ML) | $30 | $3,570 |
| | Other farm income from RGA shares and bonds | | $4,389 |
| **Total Farm Gross Margin ($)** | | | **$192,416** |
| **Overhead costs** | | | |
| Administrative expenses (telephone, stationary, accounting, bank charges) | | $3,300 | |
| Fuel and oil (farm vehicles) | | $4,800 | |
| Registration (rego, licences) | | $2,500 | |
| Insurance | | $5,000 | |
| Electricity | | $1,200 | |
| Repair & maintenance (plant, equipment, structures) | | $16,500 | |
| Depreciation @6.8% of value of plant and equipment | | $17,068 | |
| Casual labour | | $4,615 | |
| Weed control | | $0 | |
| Total overhead expenses | | | $68,401 |
| **Net farm business income ($)** | | | **$124,015** |
| Operators allowance | | | $0 |
| **Operating profit ($)** | | | **$124,015** |
| Total finance costs | | | $23,750 |
| **Business returns ($)** | | | **$100,265** |
| **Business returns on equity (%)** | | | **8.36** |

## Table 6.8: Assets and Liabilities of a Typical Cereals-Based Farm

| Assets | | | Value ($) | Total value ($) |
|---|---|---|---|---|
| Land | 220 Hectares @ | $2,000/acre including water | $1,086,800 | |
| | Total value of land | | | $1,086,800 |
| Livestock | 10 Rams @ | $50 per Ram | $500 | |
| | 100 Ewes @ | $70 per ewe | $7,000 | |
| | Total value of livestock | | | $7,500 |
| Plant and Equipment | | | | |
| | Machinery (average value) | | | |
| | Tractor and machinery | | $148,000 | |
| | Implements | | $43,000 | |
| | Vehicles (car, ute, truck) | | $40,000 | |
| | Others (structures, sundries) | | $20,000 | |
| | Total value of plant and equipment | | | $251,000 |
| Liquid Assets | | | | |
| | Bank/ off farm investments | | $25,000 | |
| | Shares/equity (RGA) | | $9,570 | |
| | Rice bonds | | $35,728 | |
| | Rice marketing equity | | $76,560 | |
| | Total value of liquid assets | | | $146,858 |
| Total assets | | | | $1,492,158 |
| Liabilities | | | | |
| | Bank overdraft | | $50,000 | |
| | HP / Lease | | $200,000 | |
| | Mortgage -farm loan | | $50,000 | |
| Total liabilities | | | | $300,000 |
| Equity (assets-liabilities) | | | | $1192,158 |
| Equity ratio (equity / total assets) | | | | 80% |

## Table 6.9: Annual Operating Whole Farm Budget in a Typical Cereals Based Farm

| | | | |
|---|---|---|---|
| **Annual operating budget** | | | |
| 220 ha | Total farm | | |
| 200 ha | Area arable | | |
| 9 | rotation years | | |
| | | GM ($/ha) | Total GM ($) |
| **Enterprise gross margin(RRRFWWPPP)** | | | |
| 50 ha | ASW wheat | $364 | $18,200 |
| 24 ha | Biscuit wheat | $537 | $12,888 |
| 20 ha | Canola | $432 | $8,640 |
| 20 ha | Annual pastures / sheep (under sown with wheat) | $301 | $6,020 |
| 44 ha | Medium grain rice | $2,189 | $96,316 |
| 22 ha | Long grain rice | $2,047 | $45,034 |
| 121 ML | Sale of water | $30 | $3,630 |
| | Other farm income from RGA shares and bonds | | $4,389 |
| Total Farm Gross Margin | | | **195,102** |
| **Overhead costs** | | | |
| Administrative expenses (telephone, stationary, accounting, bank charges | | $3,300 | |
| Fuel and oil (farm vehicles | | $4,800 | |
| Registration (rego, licences) | | $2,500 | |
| Insurance | | $5,000 | |
| Electricity | | $1,200 | |
| Depreciation @6.8 % of value of plant and equipment | | $17,066 | |
| Repair & maintenance (plant, equipment, structures) | | $16,500 | |
| Rates (stock charges, land and water) | | $13,418 | |
| Casual labour | | $5,538 | |
| Weed control | | $0 | |
| Total overhead expenses | | | $69,322 |
| **Net farm business income** | | | **$125,780** |
| Operators allowance | | | $0 |
| **Operating profits** | | | **$125,780** |
| Total finance costs | | | $23,750 |
| **Business returns** | | | **$102,028** |
| **Returns on equity** | | | **8.56%** |

**Table 6.10: Assets and Liabilities in a Typical Split-Farm**

| Assets | | | Value ($) | Total value ($) |
|---|---|---|---|---|
| Land | 220 Hectares @ | $2,000/acre including water | $1,086,800 | |
| | Total value of land | | | $1,086,800 |
| Plant and Equipment | | | | |
| | Machinery (average value) | | | |
| | Tractor and machinery | | $148,000 | |
| | Implements | | $63,000 | |
| | Vehicles (car, ute, truck) | | $40,000 | |
| | Others (structures, sundries) | | $20,000 | |
| | Total value of plant and equipment | | | $271,000 |
| Liquid Assets | | | | |
| | Bank/ off farm investments | | $25,000 | |
| | Shares/equity (RGA) | | $9,570 | |
| | Rice bonds | | $35,728 | |
| | Rice marketing equity | | $76,560 | |
| | Total liquid assets | | | |
| | Total value of liquid assets | | | 146,858 |
| Total value of liquid assets | | | | $1,504,658 |
| Liabilities | | | | |
| | Bank overdraft | | $50,000 | |
| | HP / lease | | $200,000 | |
| | Mortgage -farm loan | | $50,000 | |
| Total liabilities | | | | $300,000 |
| Equity (assets-liabilities) | | | | $1,204,658 |
| Equity ratio (Equity / total assets) | | | | **80%** |

## Table 6.11: Annual Operating Whole Farm Budget in a Typical Split-Farm

| | | | |
|---|---|---|---|
| **Annual operating budget** | | | |
| 220 ha | Total farm | | |
| 200 ha | Area arable | | |
| 9 | rotation years | | |
| | | GM ($/ha) | Total GM ($) |
| **Enterprise gross margin (RRRWCW(B/S)(B/S)(B/S))** | | | |
| 50 ha | ASW wheat | $364 | $18,1947 |
| 24ha | Biscuit wheat | $537 | $12,879 |
| 20 ha | Canola | $432 | $8,644 |
| 40 ha | Barley (dryland) | $135 | $5,394 |
| 44 ha | Medium grain rice | $2,189 | $96,307 |
| 22 ha | Long grain rice | $2,047 | $45,041 |
| 40 ha | Soybeans (permanent beds) | $645 | $25,795 |
| -179 ML | Buying of water | $30 | -$5,370 |
| | Other farm income from RGA shares and bonds | | $4,389 |
| Total Farm Gross Margin | | | **$211,273** |
| **Overhead costs** | | | |
| Administrative expenses (telephone, stationary, accounting, bank charges | | $3,300 | |
| Fuel and oil (farm vehicles | | $4,800 | |
| Registration (rego, licences) | | $2,500 | |
| Insurance | | $5,000 | |
| Electricity | | $1,200 | |
| Repair & maintenance (plant, equipment, structures) | | $16,500 | |
| Depreciation @6.8% of value of plant and equipment | | $18,428 | |
| Casual labour | | $5,538 | |
| Weed control | | $2,500 | |
| Total Operating Overhead Expenses ($) | | | $73,184 |
| **Net Farm business income** | | | **$138,089** |
| Operators allowance | | | $0 |
| **Operating Profit** | | | **$138,089** |
| Total finance costs | | | $23,750 |
| **Business returns** | | | **$114,338** |
| **Returns on Equity (%)** | | | **9.49** |

## 6.5 Comparison of three systems

A comparison between the three typical rice-based rotations demonstrates that at 100 percent water allocations the split-farm rotation returned the highest farm business return ($114,300) and return on equity (9.5 percent). The pasture-based rotation returned the lowest business returns of $100,300 or 88 percent of the split-farm rotation's business return. It also returned the lowest return on equity of 8.4 percent. The cereal-based rotation returned a farm business return of $102,000 or around 89 percent of the split-farm rotation's farm business return. It returned a return on equity of 8.6 percent.

These measures of financial performance were based on an assumption that the farms received all of their entitlements and could trade water. The last time irrigators received their full entitlement was 1996/97 and it would seem prudent for irrigators to base their plans on receiving an allocation of about 80 percent of their entitlement in normal years. Allocations have been as low as 30 percent in 2003/04, a drought year. The impact on farmers of these lower water allocations is examined in more detail in the next section. However in brief, for the pasture based systems, business return falls from $91,900 to $5,900 assuming some water purchasing when allocations fall from 80 percent to 30 percent. For the cereals based system, business return falls from $93,600 to $8,900 and for the split system, income declines from $98,400 to $13,400.

The reason of such a difference in financial performance between the pasture and cereal based farming systems compared to the split farm system is that the split system followed intensive cropping with a net sown area of 200 ha and total cropped area of 240 ha. Instead of annual pastures, the split system includes 40 ha of double cropping with soybean in summer followed by barley in the winter. The other pasture and cereal based rotations include 40 ha and 20 ha respectively under pasture (a low value option) and 20 ha each of fallow to fit their rice wheat rotation. To meet irrigation water requirements the split system bought extra water from the market. Even by buying extra water from the market, farmers with the split system earned higher returns compared to the other two systems that sold surplus water in the market. The cereals system was relatively more profitable than the pasture based system because it had a proportion of the higher valued canola crop in place of pastures.

# 7. Analysis of the Impact of Water Trading and Water Availability on Farm Income

## 7.1 Objectives

Key issues of concern to rice growers in the MIA, for the last few years, are the impact of current water reforms on farming systems in the MIA and the reduced availability of water due to drought. Under the new Water Sharing Plan, there has been a reduction in entitlements to allow more water for environmental flows. The water availability is not reliable because water allocations to the general security licence holders depend upon the volume of water that is available in a particular year. A component of the water reform process has been the creation of a market for water to allow more water to be allocated in higher valued uses. The extent of water trading both internal and external over 2001-02 to 2003-04 is shown in Table 7.1. The internal sale of water, that is water sold to customers within the MIA and Districts, increased in 2002-03 and 2003-04 due to severe drought and low water allocations, whereas the net out-transfer, that is the difference between the water sold to customers outside the MIA and Districts (External-out) and the water purchased from costumers outside the MIA and Districts (External-in), declined sharply from 61,213ML in 2001-02 to only 6,400 in 2003-04. The reduced water allocations and the increased opportunity for water trading encourage the adoption of technologies and management practices that use water more efficiently.

**Table 7.1: Temporary Water Transfers for the MIA and Districts**

| Temporary Transfer | | Total Water Traded (ML) | | |
|---|---|---|---|---|
| | | 2001-02 | 2002-03 | 2003-04 |
| Internal | | 20,715 | 33,463 | 29,304 |
| External | Out | 77,196 | 37,736 | 17,514 |
| | In | 15,983 | 4,061 | 11,114 |
| Net Out | | 61,213 | 33,675 | 6,400 |

Source: Rice CRC (2000), MIL (2004).

In the analysis in this section the representative farm models described above were used to examine some simple water entitlement and water trading options. Recall that the representative farm models are not designed to necessarily represent the most profitable use of the farm's resources. Rather they represent situations felt to be typical of the MIA. Similarly the scenarios we present below do not necessarily represent the most profitable way in which the model farms respond to changes in water resources and their ability to trade in water. These scenarios represent the benefits and costs of some simple water resource scenarios. In particular little attempt is made to consider the changes in the areas of irrigated crops that farmers might follow in response to changes in water entitlements and water trading opportunities.

In part this inflexibility comes from the nature of the farming systems the models represent. For the pasture and cereals based systems their water allocations of 1,400 ML are more than they can profitably use on farm. They are constrained to irrigating 180 ha and they can earn more by selling the last portion of their allocation (when they receive 100 percent of their allocation) than they can by applying it to their existing rotation. In other words, if they were to apply more water in excess of about 1280 ML, the average total farm gross margin of $150 and $153 per ML (Table 7.3) would fall.

On the other hand for the split system, up to 179 ML of water can be profitably purchased and used on farm. Irrigable land rather than water is the binding constraint for the pasture and cereals based systems. One way to alleviate this constraint is to move to a split farming system which allows some double cropping but requires more intensive management.

A key issue that is of concern to the rice growers during the last few years is associated with the impact of very low levels of water allocations on the large area rice farms in the MIA. (Table 7.2)

**Table7.2: Announced Allocations as a Percentage of Entitlement in the MIA for 1995 - 2004**

| Year | Announced allocation as % of entitlement |
|---|---|
| 1995-96 | 105 |
| 1996-97 | 100 |
| 1997-98 | 90 |
| 1998-99 | 85 |
| 1999-00 | 78 |
| 2000-01 | 90 |
| 2001-02 | 72 |
| 2002-03 | 40 |
| 2003-04 | 30 |

Source: Murrumbidgee Irrigation Limited, 2004

Due to drought conditions, the farmers during the 2004 season received about 30 percent of their entitlement. In the MIA, most irrigators expect that in the future the maximum water allocation is unlikely to be more than 80 percent of their entitlement and the average annual allocation may only be around 50 percent of their total annual water entitlement (John Lacy, 2004, pers. comm.).

In the following scenarios we examine the impact on farm income for the three different farming systems of changes in the amount of water available – for entitlements of 80, 50 and 30 percent - when water trading is allowed and when it is not allowed.

It is assumed that with trade, a farmer would be able to buy up to 20 percent of their water allocations from the open market. The water trading price considered for this analysis varied inversely with water availability from $30/ML when water allocation was up to 80 percent, to $50/ML at 50 percent availability and $70/ML at 30 percent availability (John Lacy and Brian Dunn, pers. comm., 2004).

It is possible to grow winter cereals, especially wheat and barley, applying different levels of irrigation which would, in turn, lead to different levels of yield and gross margins. Therefore, we have introduced more cropping options for growing wheat and barley with different rates of irrigation in the winter season. During low water allocation years, at the whole farm level, this would help farmers to save some water from winter cropping to enable them to grow more rice, a more profitable summer crop, and increase their income.

## 7.2 Results

The results of the whole farm financial impacts of water trade are presented in Table 7.3. The study has compared the net farm business income of the three rice based rotations at 100 percent of water allocations both with and without water trading.

With water trading, net farm business income from the pasture-based and cereals-based rotations increased by $3,570 and $3,650 through the respective sales of around 119ML and 121ML of surplus water. On the other hand, by buying water the split farm system was able to increase the area double cropped with barley and soybean from 20 to 40 ha. This required purchasing 179ML of extra water from the market on top of the farm's water allocation at a cost of $5,370. By purchasing this extra water, net farm business income for the split system increased by about $7,500 that is 4.8 percent of the net whole farm business income (Table 7.3).

As noted above the pasture and cereals system represented here do not have the flexibility to change rotations in this way because land is the limiting constraint rather than water.

The study also analysed the impact of different levels of water availability on the selected cropping rotations in the MIA both 'with and without' water trading. Under the 'with' water trading scenario, the three farming systems were able to enter the water market to sell surplus water or to buy extra water so as to allow farmers to expand different crops. This may help to increase the whole farm cash income or minimise losses, especially at lower levels of water allocation.

Recall again that in this simple analysis no attempt is made to identify the area of each crop that is economically optimal for each farming system. As the price of water changes in response to its availability no doubt the optimal area of crop also changes – as does the optimal rotation. We have simply estimated the changes in net farm business income, business return and return on equity arising from different levels of water allocations both with and without water trading activities, allowing only minor changes in the crop rotation.

The financial impacts of different levels of water allocation both 'with and without' water trading on the pasture based, cereal based and split farms are presented below in Table 7.4, 7.5 and 7.6 respectively. The study has compared the loss of income at a 30 percent water allocation with the income at 50 percent and 80 percent of water allocation. For this analysis we assumed that at lower levels of water allocation, the farmers using the pasture and cereals based rotations would reduce irrigation to the wheat crop and would grow dryland barley in the winter. The farmers would prefer to use the saved water to grow more rice in the summer season. The farmers in the case of the split system, would reduce the area under soybean as well before reducing the area under rice at lower allocations.

Further, farmers of all the three farming systems would not employ any casual labour to meet the peak period whole farm labour requirements until water allocation exceeded 50 percent.

The results presented in Table 7.4 show that in the case of the pasture-based rotation, at 30 percent water allocation with water trading, the net farm business income declined by 74 percent compared to the net farm business income at 80 percent water allocation with trade. The farmer suffers business losses of $17,000 and return on equity of -1.55 percent unless he buys in some water. Under the water trading scenario at 30 percent water allocation, buying extra water even at a higher price helped farmers to increase the net farm business income. In this scenario business return is $6,000 and return on own capital is 0.5 percent. Without water trading the farmer reduced the amount of water applied to his wheat crop but as the allocation fell further the area sown to medium grain rice was reduced and the area sown to barley increased. A limit on the extent of water trading meant that the area of rice grown fell under the thirty percent allocation scenario.

In case of the cereals based rotation, as water allocation declined, farmers adopted similar strategies to the pasture based system. They reduced the water applied to wheat and barley crops and as water became even more limiting, they shifted land and water from medium grain rice crops to dryland barley. Business returns fell to a loss of $14,000 and the return to equity fell to -1.3 percent for the 30 percent allocation scenario (Table 7.5).

Buying extra water helped farmers to increase their business returns to $8,900 and their return to equity to 0.6 percent for this 30 % water allocation scenario.

For the split system, water is always limiting and hence the net farm business income increased by about 9 percent, 55 percent and 56 percent at 80 percent, 50 percent and 30 percent allocations with water trading compared to respective farm cash income without water trading (Table 7.6).

Reduced water allocations meant that as for the cereal and pasture based systems, less water was applied to wheat and barley and, as water became even more restricted, the area of medium grain rice was sacrificed for barley. Soybeans were no longer an option once water allocation fell below 80 percent.

The return on equity at 30 percent allocations were -0.7 percent without and 0.9 percent with trade compared to 5.9 percent without trade and 6.5 percent with trade at 80 percent allocations (Table 7.6).

The results presented in Table 7.4, 7.5 and 7.6 further show that on average, at 30 percent water allocations with trade, the total gross margins from the three typical farming rotations declined by $91,000 per farm or $414/ha compared to the with trade gross margins at 80 percent water allocation. With the average total area of 170,000 ha under the rice-based farming systems, the rice industry in the MIA might suffer a loss in the order of $70 million per year in total farm gross margins due to lower levels of water availability.

**Table 7.3: Impact of Water Trading on Water Usage and Financial Returns on Rice Based Farming Systems in the MIA**

| Crop option | Water use (Ml/ha) | Gross margins ($/ha) | Area under different crops @ 100 % allocation: Pasture based *Without* | *With* | Cereals based *Without* | *With* | Split based *Without* | *With* |
|---|---|---|---|---|---|---|---|---|
| - Wheat - Biscuit (ha) | 3.5 | $537 | 24 | 24 | 24 | 24 | 24 | 24 |
| - Wheat - Biscuit (ha) | 2.5 | $425 | | | | | | |
| - Wheat - Biscuit (ha) | 1.5 | $335 | | | | | | |
| - Wheat - ASW (ha) | 3.5 | $364 | 50 | 50 | 50 | 50 | 50 | 50 |
| - Wheat - ASW (ha) | 2.5 | $306 | | | | | | |
| - Wheat - ASW (ha) | 1.5 | $258 | | | | | | |
| - Barley (ha) | 0 | $135 | | | | | 40 | 40 |
| - Canola (ha) | 2.9 | $432 | | | 20 | 20 | 20 | 20 |
| - Annual pasture /sheep (ha) | 3 | $301 | 40 | 40 | 20 | 20 | | |
| - Medium grain rice (ha) | 14 | $2,189 | 44 | 44 | 44 | 44 | 44 | 44 |
| - Long grain rice (ha) | 13 | $2,047 | 22 | 22 | 22 | 22 | 22 | 22 |
| - Soybeans (ha) | 9 | $645 | | | | | 20 | 40 |
| Total cropped area (ha) | | | 180 | 180 | 180 | 180 | 220 | 240 |
| Total water used (ML) | | | 1281 | 1281 | 1279 | 1279 | 1400 | 1579 |
| Income from water ($'000) | | | | 3.6 | | 3.7 | | - 5.4 |
| Other farm income ($'000) | | | 4.4 | 4.4 | 4.4 | 4.4 | 4.3 | 4.4 |
| Total farm gross margins ($'000) | | | 188.8 | 192.4 | 191.5 | 195.1 | 203.7 | 211.3 |
| Net farm business income ($'000) | | | 120.4 | 124.0 | 122.1 | 125.8 | 130.6 | 138.1 |
| Farm operating surplus($'000) | | | 120.4 | 124.0 | 122.1 | 125.8 | 130.6 | 138.1 |
| Business returns ($'000) | | | 96.7 | 100.3 | 98.4 | 102.0 | 106.8 | 114.3 |
| Returns on equity (%) | | | 8.1 | 8.4 | 8.3 | 8.6 | 8.9 | 9.5 |

With: With water trade @ 100% allocation as $30/ML
Without: Without water trade

**Table 7.4: Financial Impact of Different Levels of Water Availability 'With and Without' Water Trade on Pasture Based Farming Systems in the MIA**

| **Pasture based** | | | **Area under different crops (ha) @** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Water use** | **Gross margins** | **80% allocations** | | **50% allocations** | | **30% allocations** | |
| **Cropping options** | *(Ml/ha)* | *($/ha)* | *Without* | *With* | *Without* | *With* | *Without* | *With* |
| - Wheat - Biscuit | 3.5 | $537 | | 24 | | | | |
| - Wheat - Biscuit | 2.5 | $425 | | | | | | |
| - Wheat - Biscuit | 1.5 | $335 | 24 | | 24 | 24 | 24 | 24 |
| - Wheat - ASW | 3.5 | $364 | | 50 | | | | |
| - Wheat - ASW | 2.5 | $306 | | | | | | |
| - Wheat - ASW | 1.5 | $258 | 50 | | 50 | 50 | 50 | 50 |
| - Barley | 0 | $135 | | | 31 | 11 | 51 | 31 |
| - Canola | 2.9 | $432 | | | | | | |
| - Annual pasture /sheep | 3 | $301 | 40 | 40 | 40 | 40 | 40 | 40 |
| - Medium grain rice | 14 | $2,189 | 44 | 44 | 13 | 33 | 0 | 13 |
| - Long grain rice | 13 | $2,047 | 22 | 22 | 22 | 22 | 15 | 22 |
| - Soybeans | 9 | $645 | | | | | | |
| Total cropped area (ha) | | | 180 | 180 | 180 | 180 | 180 | 180 |
| Total water used (ML) | | | 1120 | 1281 | 700 | 980 | 420 | 700 |
| Income from water ($,000) | | | | -4.8 | | -14.0 | | -19.5 |
| Other farm income ($'000) | | | 4.3 | 4.4 | 2.3 | 3.6 | 0.9 | 2.3 |
| Total farm gross margins ($'000) | | | $176.6 | $184.0 | $113.0 | $141.4 | $70.5 | $93.4 |
| Net farm business income ($'000) | | | $108.2 | $115.6 | $44.6 | $73.0 | $6.6 | $29.6 |
| Operating profit ($'000) | | | $108.2 | $115.6 | $44.6 | $73.0 | $6.6 | $29.6 |
| Business returns ($'000) | | | $84.5 | $91.9 | $20.9 | $49.3 | -$17.1 | $5.9 |
| Returns on equity (%) | | | 7.1 | 7.7 | 1.8 | 4.2 | -1.6 | 0.5 |

**Table 7.5: Financial Impact of Different Levels of Water Availability 'With and Without' Water Trade on Cereals Based Farming Systems in the MIA**

| **Cereals based** | | | **Area under different crops (ha) @** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Water use** | **Gross margins** | **80% allocations** | | **50% allocations** | | **30% allocations** | |
| **Cropping options** | *(Ml/ha)* | *($/ha)* | *Without* | *With* | *Without* | *With* | *Without* | *With* |
| - Wheat - Biscuit | 3.5 | $537 | | 24 | | | | |
| - Wheat - Biscuit | 2.5 | $425 | | | | | | |
| - Wheat - Biscuit | 1.5 | $335 | 24 | | 24 | 24 | 24 | 24 |
| - Wheat - ASW | 3.5 | $364 | | 50 | | | | |
| - Wheat - ASW | 2.5 | $306 | | | | | | |
| - Wheat - ASW | 1.5 | $258 | 50 | | 50 | 50 | 50 | 50 |
| - Barley | 0 | $135 | | | 31 | 11 | 51 | 31 |
| - Canola | 2.9 | $432 | 20 | 20 | 20 | 20 | 20 | 20 |
| - Annual pasture /sheep | 3 | $301 | 20 | 20 | 20 | 20 | 20 | 20 |
| - Medium grain rice | 14 | $2,189 | 44 | 44 | 15 | 33 | 0 | 13 |
| - Long grain rice | 13 | $2,047 | 22 | 22 | 20 | 22 | 15 | 22 |
| - Soybeans | 9 | $645 | | | | | | |
| Total cropped area (ha) | | | 180 | 180 | 180 | 180 | 180 | 180 |
| Total water used (ML) | | | 1120 | 1279 | 700 | 980 | 420 | 700 |
| Income from water ($'000) | | | | -4.8 | | -14.0 | | -19.4 |
| Other farm income ($'000) | | | 4.3 | 4.4 | 2.3 | 3.6 | 0.9 | 2.3 |
| Total farm gross margins ($'000) | | | 179.7 | 186.7 | 115.8 | 144.5 | 73.5 | 96.4 |
| Net farm business income ($'000) | | | 110.3 | 117.4 | 46.5 | 75.1 | 9.7 | 32.6 |
| Operating profit | | | 110.3 | 117.4 | 46.5 | 75.1 | 9.7 | 32.6 |
| Business return ($'000) | | | 86.6 | 93.6 | 22.8 | 51.4 | -14.0 | 8.9 |
| Returns on equity (%) | | | 7.3 | 7.9 | 2.0 | 4.4 | -1.3 | 0.8 |

**Table 7.6: Financial Impact of Different Levels of Water Availability 'With and Without' Water Trade on Split Farming Systems in the MIA**

| **Split system** | | | **Area under different crops (ha) @** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Water use** | **Gross margins** | **80% allocations** | | **50% allocations** | | **30% allocations** | |
| **Cropping options** | *(Ml/ha)* | *($/ha)* | *Without* | *With* | *Without* | *With* | *Without* | *With* |
| - Wheat - Biscuit | 3.5 | $537 | 24 | 24 | | | | |
| - Wheat - Biscuit | 2.5 | $425 | | | | | | |
| - Wheat - Biscuit | 1.5 | $335 | | | 24 | 24 | 24 | 24 |
| - Wheat - ASW | 3.5 | $364 | | 50 | | | | |
| - Wheat - ASW | 2.5 | $306 | | | | | | |
| - Wheat - ASW | 1.5 | $258 | 50 | | 50 | 50 | 50 | 50 |
| - Barley | 0 | $135 | 40 | 40 | 66 | 46 | 87 | 66 |
| - Canola | 2.9 | $432 | 20 | 20 | 20 | 20 | 20 | 20 |
| - Annual pasture /sheep | 3 | $301 | | | | | | |
| - Medium grain rice | 14 | $2,189 | 44 | 44 | 18 | 38 | | 18 |
| - Long grain rice | 13 | $2,047 | 22 | 22 | 22 | 22 | 19 | 22 |
| - Soybeans | 9 | $645 | | 20 | | | | |
| Total cropped area (ha) | | | 200 | 220 | 200 | 200 | 200 | 200 |
| Total water used (ML) | | | 1120 | 1400 | 700 | 980 | 420 | 700 |
| Income from water ($'000) | | | | -8.4 | | -14.0 | | -19.6 |
| Other farm income ($'000) | | | 4.4 | 4.4 | 2.6 | 3.9 | 1.2 | 2.6 |
| Total farm gross margins ($'000) | | | 185.6 | 195.4 | 124.4 | 152.9 | 82.1 | 104.8 |
| Net farm business income ($'000) | | | 111.7 | 121.7 | 51.3 | 79.7 | 14.5 | 37.2 |
| Operating profit | | | 111.7 | 121.7 | 51.3 | 79.7 | 14.5 | 37.2 |
| Business return ($'000) | | | 88.6 | 98.4 | 27.5 | 55.9 | -9.4 | 13.4 |
| Returns on equity (%) | | | 7.4 | 8.2 | 2.4 | 4.7 | -0.8 | 1.2 |

# 8. Conclusions

The objective of the research reported here was to develop a representative whole-farm model of MIA rice-based farming systems. The information used in developing this model was provided by rice growers and research and extension staff from the NSW Department of Primary Industries. The model's application was demonstrated by conducting an analysis of different scenarios for water availability on crop rotations for a typical farm in the MIA.

The farm was 220 ha in size and had a water entitlement of 1400 ML. Three rice-based cropping systems representative of the MIA were identified. An estimate of 20-30 percent of farmers in the MIA follow the pasture-based rotation, followed by 30-50 percent who follow the cereals-based rotation, and 5-10 percent who follow the split-farm rotation. The return on owner's equity with water trade from these three systems were estimated to be 8.4, 8.6 and 9.5 percent respectively suggesting that MIA rice-based farming systems compare favourably in terms of return on investment with other farming systems in NSW. Business return was $100,300, $102,000 and $114,000 respectively.

These estimates of business return and return to equity were for a scenario in which the irrigators received 100 percent of their entitlement and were allowed to operate in the water market. The last time irrigators received their entitlement was 1996/97. Allocations have been as low as 30 percent in 2003/04. A reduction in allocation to 80 percent causes some farmers to apply fewer irrigations to wheat and barley. However more severe reductions in allocation are likely to cause some irrigators to reduce the area of medium grain rice they grow and to switch to more cereal watering.

For the pasture based systems farm business return falls from $91,900 to $5,900 assuming some water purchasing when allocations fall from 80 percent to 30 percent. For the cereals based system business return falls from $93,600 to $8,900 and for the split system, farm business return declines from $98,400 to $13,400. In all cases farm business return increased when farmers were allowed to trade water.

Even though the split farm system seems to be the most profitable of the three we are reluctant to make a blanket endorsement of this farming system. Many factors influence a farmers choice between these systems. From a technical viewpoint there are concerns about the long term sustainability of such a crop rotation. Additionally such an intensive rotation requires favourable soil and climatic conditions to maintain the rotation. If for example there are some years in which double cropping is not possible then the income from the system is seriously threatened. In this sense the split system may be more risky than the other systems. The split system also requires more intense management and its relative profitability depends in part on the relative profitability of crop and livestock enterprises. Should livestock enterprises become relatively more profitable then the advantages of the split system diminish.

We hope that our analyses using the representative farm models presented above may provide valuable insights to those operating similar farms in the MIA. However, precise implications for individual farms cannot be drawn because of important differences in the resources and objectives of individual farmers.

## References

Australian Bureau of Statistics, (1998), *NSW Crop Statistics*, ABS, Sydney

Beecher, G., Beale, P., and Clampett, W. (2000), *Production of Quality Rice in South Eastern Australia, chapter 4* –"Land for Rice Growing, Production of Quality Rice in South Eastern Australia", NSW Agriculture, 2002.

Cooperative Research Centre for Sustainable Rice Production (2003), *Annual Report 2000-01*, NSW DPI, CRC Rice, Yanco.

DLWC, (2002), *Annual allocation Plan-Murrumbidgee Valley (Regulated System), 2001-02*, NSW Department of Land and Water Conservation Wagga Wagga.

DSWR, (2003), *A Guide to the Water Sharing Plan for the Murrumbidgee Regulated River Water Resource*, NSW Department of Sustainable water resources, May 2003, Leeton.

DIPNR (2004), Water *Allocation Plan - Murrumbidgee Valley (regulated System)*, NSW Department of Infrastructure Planning and Natural Resources, 2004-05, Leeton.

Kennedy, J., (1973), *MIA Mixed Farming*, NSW Agriculture, Leeton.

Murrumbidgee Irrigation Limited, (2001), *Working for You with You*, Murrumbidgee Irrigation, Griffith.

Murrumbidgee Irrigation Limited, (2003), *Environmental Performance Report 2002-2003*, Murrumbidgee Irrigation, Griffith.

NSW Agriculture, (1998), *MIA & Districts LWMP*, NSW Agriculture, Yanco.

NSW Government, (2003), *Water Sharing Plan for the Murrumbidgee Regulated River Water Source*, April 2003, (Printed by) NSW Department of Sustainable Natural Resources, Sydney.

Patton, D. and Mullen, J., (2001), *Farming Systems in the Central West of NSW: An Economic Analysis*, Economic Research Report No. 7, May 2001, NSW Agriculture, Trangie.

Singh, R.P., Brennan, J., Mullen, J., Williams, R., Farrell, T., Reinke, R and Lewin, L. (2002), *Economic analysis of Improving Cold Tolerance in Rice in Australia*, Final Report, Rice CRC, Yanco

Singh, R. and Whitworth, R. (2003), *Farm Budget Handbook 2003: Southern NSW Irrigated Summer Crops*, NSW Agriculture, Yanco.

Singh, R. and Whitworth, R. (2003), *Farm Budget Handbook 2003: Southern NSW Irrigated Winter Crops*, NSW Agriculture, Yanco.

WRC (1983), *Volumetric Allocation Scheme for the Murrumbidgee Valley*, May 1983, Water Resource Commission of NSW, Sydney.

# Appendix A.1: Enterprise Gross Margin: RICE - Medium Grain

**GROSS MARGIN BUDGET:** **Murrumbidgee Valley**

| | | | | Standard Budget $/ha |
|---|---|---|---|---|
| **INCOME:** | | | | |
| 10.00 | t/ha @ | $300.00 | /t (on farm) | $3,000.00 |
| | | **A. TOTAL INCOME $/ha:** | | **$3,000.00** |
| **VARIABLE COSTS:** | | | | |
| | | Cultivation...................................................................... | | $22.82 |
| | | Sowing............................................................................. | | $60.50 |
| | | Fertiliser.......................................................................... | | $220.61 |
| | | Herbicide......................................................................... | | $181.3 |
| | | Insecticide....................................................................... | | $2.60 |
| | | Irrigation.......................................................................... | | $177.24 |
| | | Levies & insurance.......................................................... | | $21.00 |
| | | Harvest……………………….......................................... . | | $40.19 |
| | | Cartage ……………………………………………………….. | | $85.00 |
| | | **B. TOTAL VARIABLE COSTS $/ha:** | | **$811.21** |
| | | **C. GROSS MARGIN (A-B) $/ha:** | | **$2,189** |
| | | **D. GROSS MARGIN $/ML:** | | **$156.34** |

# Appendix A.2 Enterprise Gross Margin: RICE - Long Grain

| | | | | |
|---|---|---|---|---|
| **GROSS MARGIN BUDGET:** | | | | **Murrumbidgee Valley** |
| **INCOME:** | | | | **Standard Budget $/ha** |
| 9.00 | t/ha @ | $315.00 | /t (on farm) | $2,835.00 |
| | | **TOTAL INCOME $/ha:** | | **$2,835.00** |
| **VARIABLE COSTS:** | | | | |
| | | Cultivation........................................................... | | $22.68 |
| | | Sowing................................................................ | | $60.50 |
| | | Fertiliser............................................................. | | $220.61 |
| | | Herbicide........................................................... | | $183.12 |
| | | Insecticide......................................................... | | $2.60 |
| | | Irrigation............................................................ | | $164.58 |
| | | Levies & insurance............................................... | | $37.26 |
| | | Harvest……………………….............................. . | | $19.85 |
| | **B. TOTAL VARIABLE COSTS $/ha:** | | | **$787.70** |
| | **C. GROSS MARGIN (A-B) $/ha:** | | | **$2,047.30** |
| | **D. GROSS MARGIN $/ML:** | | | **$156.34** |

## Appendix A.3 Enterprise Gross Margin: SOYBEANS–ROW / BEDS

| | | Murrumbidgee Valley |
|---|---|---|
| **GROSS MARGIN BUDGET:** | | |
| **INCOME:** | | **Standard Budget $/ha** |
| **3.00** t/ha @ | $450.00 /t (on farm; edible price) | $1,350.00 |
| | **A. TOTAL INCOME $/ha:** | **$1,350.00** |
| **VARIABLE COSTS:** | | |
| | Cultivation…………………………… | $58.59 |
| | Sowing………………………………. | $130.39 |
| | Fertilizer................................................... | $138.36 |
| | Herbicide................................................... | $106.02 |
| | Insecticide................................................. | $70.25 |
| | Irrigation................................................... | $113.94 |
| | Harvest………………………………. | $37.89 |
| | Levies & Insurance ........................................ | $49.68 |
| | **B. TOTAL VARIABLE COSTS $/ha:** | **$705.12** |
| | **C. GROSS MARGIN (A-B) $/ha:** | **$ 644.88** |
| | **D. GROSS MARGIN $/ML:** | **$71.65** |

# Appendix A.4 Enterprise Gross Margin: Wheat-Biscuit

| **GROSS MARGIN BUDGET:** | | | | **Murrumbidgee Valley** |
|---|---|---|---|---|
| | | | | **Standard Budget $/ha** |
| **INCOME:** | | | | |
| 5.50 | tonnes/ha@ | $175.00 | /tonne ON FARM | $962.50 |
| | **A. TOTAL INCOME $/ha:** | | | $962.50 |
| **VARIABLE COSTS:** | | | | |
| see opposite page for details | | | | |
| | Cultivation …………………………………………… | | | $52.54 |
| | Sowing……………………………… | | | $84.97 |
| | Fertilizer & application ……………………………… | | | $146.12 |
| | Herbicide & application……………………………… | | | $36.60 |
| | Harvesting ……………………………… | | | $29.60 |
| | Levies………………………………………… | | | $9.77 |
| | Crop insurance ……………………………………… | | | $21.95 |
| | Irrigation …………………………………………… | | | $44.31 |
| | **B. TOTAL VARIABLE COSTS $/ha:** | | | **$425.86** |
| | **C. GROSS MARGIN (A-B) $/ha:** | | | **$536.64** |

# Appendix A.5 Enterprise Gross Margin: Wheat-ASW

| | Murrumbidgee Valley |
|---|---|
| **GROSS MARGIN BUDGET:** | **Standard Budget $/ha** |
| **INCOME:** | |
| 5.00 tonnes/ha@ $150.00 /tonne ON FARM | $750.00 |
| | |
| **A. TOTAL INCOME $/ha:** | **$750.00** |
| **VARIABLE COSTS:** | |
| Cultivation ………………………………………… | $44.71 |
| Sowing ……………………………………… | $84.97 |
| Fertilizer & application………………………… | $123.22 |
| Herbicide & application…………………………… | $36.60 |
| Contract harvesting……………………………… | $27.60 |
| Levies ……………………………………… | $7.61 |
| Crop insurance………………………………… | $17.10 |
| Irrigation ……………………………………… | $44.31 |
| | |
| **B. TOTAL VARIABLE COSTS $/ha:** | **$386.13** |
| **C. GROSS MARGIN (A-B) $/ha:** | **$363.87** |

# Appendix A.6 Enterprise Gross Margin: Barley-Feed

| GROSS MARGIN BUDGET: | Murrumbidgee Valley Standard Budget $/ha |
|---|---|
| **INCOME:** | |
| 3.50 tonnes/ha@ $140.00 /tonne ON FARM | $490.00 |
| | |
| **A. TOTAL INCOME $/ha:** | **$490.00** |
| **VARIABLE COSTS:** | |
| Cultivation …………………………………………… | $52.54 |
| Sowing ……………………………………………… | $79.97 |
| Fertilizer & application……………………………… | $125.47 |
| Herbicide & application……………………………… | $54.18 |
| Contract harvesting………………………………… | $21.60 |
| Levies ………………………………………………… | $10.22 |
| Crop insurance……………………………………… | $11.17 |
| Irrigation …………………………………………… | $0.00 |
| | |
| **B. TOTAL VARIABLE COSTS $/ha:** | **$355.15** |
| **C. GROSS MARGIN (A-B) $/ha:** | **$134.85** |

## Appendix A.7 Enterprise Gross Margin: Canola-Flood Irrigated

**Murrumbidgee Valley**

| | | | | Standard Budget $/ha |
|---|---|---|---|---|
| **GROSS MARGIN BUDGET:** | | | | |
| **INCOME:** | | | | |
| 2.60 | tonnes/ha@ | $375.00 | /tonne ON FARM | $975.00 |
| | | | | |
| | **A. TOTAL INCOME $/ha:** | | | **$975.00** |
| **VARIABLE COSTS:** | | | | |
| | Cultivation ………………………………………… | | | $31.12 |
| | Sowing …………………………………………… | | | $25.80 |
| | Fertilizer & application……………………………… | | | $227.53 |
| | Herbicide & application……………………………… | | | $59.96 |
| | Insecticide & application…………………………… | | | $70.50 |
| | Contract windrowing………………………………… | | | $27.50 |
| | Contract harvesting………………………………… | | | $18.00 |
| | Levies …………………………………………… | | | $13.80 |
| | Crop insurance……………………………………… | | | $31.88 |
| | Irrigation…………………………………………… | | | $36.71 |
| | | | | |
| | **B. TOTAL VARIABLE COSTS $/ha:** | | | **$542.80** |
| | **C. GROSS MARGIN (A-B) $/ha:** | | | **$432.20** |

# Appendix A.8 Enterprise Gross Margin: 2ND X LAMBS-small farms

**GROSS MARGIN BUDGET:**

| | | | | | |
|---|---|---|---|---|---|
| **Flock size:** | **209** | **Ewes** | | | **Murrumbidgee Valley** |
| | | | | | **Standard** |
| **INCOME** | | | | | **Budget ($)** |
| **Wool** | **number** | **class** | **kg /hd** | **$/kg** | |
| Shear | 200 | ewes | 4.50 | $5.19 | $4,671.00 |
| | 4 | rams | 3.50 | $4.53 | $66.18 |
| Crutch | 204 | adults | 0.30 | $1.42 | $86.98 |
| **Sheep Sales** | **number** | **class** | **$ /hd** | | |
| | 37 | CFA ewes | $50.40 | | $1,864.80 |
| | 1 | CFA rams | $50.40 | | $42.07 |
| | 230 | mixed sex lambs | $80.00 | | $18,365.22 |
| **Fodder** | **tonnes** | **type** | **value per tonne** | | |
| Hay | 0 | lucerne hay @ | $0.00 | | $0.00 |
| Fodder crop grain | 0 | oats @ | $120.00 | | $0.00 |
| | | | **A. Total Income:** | | **$25,096.25** |

# Appendix A.8 Enterprise Gross Margin: 2ND X LAMBS-(Cont.)

**VARIABLE COSTS** **2ND X LAMBS - small farms (Cont.)**

| **Sheep Health** | **number** | **class** | **cost ($)** | **reps** | |
|---|---|---|---|---|---|
| Drenching following Drenchplan | | | | | |
| Broadspectrum | 204 | adults | $0.21 | 2 | $85.75 |
| | 236 | lambs | $0.13 | 4 | $122.63 |
| Dipping | 204 | adults | $0.32 | 1 | $65.34 |
| Jetting | 204 | adults | $0.21 | 1 | $42.88 |
| Vaccination- 6 in 1 | 204 | adults | $0.34 | 1 | $69.42 |
| | 236 | lambs | $0.34 | 2 | $160.36 |
| Marking | 236 | lambs | $0.80 | 1 | $188.66 |
| Scanning | 0 | ewes | $0.80 | 1 | $0.00 |
| **Wool Selling Costs** | | | | | |
| Shearing | 200 | ewes | $5.00 | 1 | $1,000.00 |
| | 4 | rams | $5.02 | 1 | $20.95 |
| Crutching | 200 | ewes | $0.56 | 1 | $112.00 |
| | 4 | rams | $10.00 | 1 | $41.74 |
| Wool tax | | | 2.00% | | $96.48 |
| Commission, warehouse, testing charges | | | 5.25% | | $253.27 |
| Wool - cartage | 5 | bales | $10.08 | | $50.40 |
| - packs | 5 | packs | $10.46 | | $52.30 |
| **Livestock Selling Costs** | | | | | |
| Livestock cartage | 267 | sale sheep | $1.50 | | $401.10 |
| Commission on sheep sales | | | 4.50% | | $912.24 |

# Appendix A.8 Enterprise Gross Margin: 2ND X LAMBS-(Cont.)

**Fodder** **2ND X LAMBS - small farms (Cont.)**

Supplementary feed - 2 kg of oats /head / week over 12 weeks @ $120/tonne

| | | | | | |
|---|---|---|---|---|---|
| | 200 | ewes | $0.24 | 12 | $576.00 |
| Grazing crops | 0 | hectares @ | $180.00 | per Ha | $0.00 |
| Agistment | 0 | hectares @ | $0.00 | per Ha | $0.00 |
| Pasture Maintenance | 40 | hectares @ | $91.00 | per Ha | $3,640.08 |
| | | | **B. Total Variable Costs:** | | **$7,891.60** |

**REPLACEMENTS:**

| | number | class | $ /hd | | |
|---|---|---|---|---|---|
| | 1 | rams | $800.00 | | $667.83 |
| | 45 | ewes | $100.00 | | $4,500.00 |
| | | | **C. Total Replacements:** | | **$5,167.83** |

| | incl. pasture costs |
|---|---|
| **GROSS MARGIN (A-B-C)** | **$12,036.82** |
| **GROSS MARGIN /EWE** | **$57.68** |
| **GROSS MARGIN /DSE** | **$25.08** |
| **GROSS MARGIN /HA** | **$301** |

**NSW Department of Primary Industries**
**Economic Research Report Series**
(All available at http://www.agric.nsw.gov.au/reader/10550)

**Number**

**1** Brennan, J.P. and Bantilan, M.C.S. 1999, *Impact of ICRISAT Research on Australian Agriculture*, Report prepared for Australian Centre for International Agricultural Research, Economic Research Report No. 1, NSW Agriculture, Wagga Wagga.

**2** Davies, B.L., Alford, A. and Hollis, G. 1999, *Analysis of ABARE Dairy Data for Six Regions in NSW 1991-92 to 1996-97*, Economic Research Report No 2, NSW Agriculture, C.B. Alexander College, Paterson.

**3** Brennan, J.P. and Singh, R.P. 2000, *Economic Assessment of Improving Nutritional Characteristics of Feed Grains*, Report prepared for Grains Research and Development Corporation, Economic Research Report No. 3, Wagga Wagga.

**4** Zhao. X., Mullen, J.D., Griffith, G.R., Griffiths, W.E. and Piggott, R.R. 2000, *An Equilibrium Displacement Model of the Australian Beef Industry*, Economic Research Report No 4, NSW Agriculture, Armidale.

**5** Griffith, G., I'Anson, K., Hill, D., Lubett, R. and Vere, D. 2001. *Previous Demand Elasticity Estimates for Australian Meat Products*, Economic Research Report No 5, NSW Agriculture, Armidale.

**6** Griffith, G., I'Anson, K., Hill, D. and Vere, D. 2001. *Previous Supply Elasticity Estimates for Australian Broadacre Agriculture*, Economic Research Report No 6, NSW Agriculture, Armidale.

**7** Patton, D.A. and Mullen, J.D. 2001, *Farming Systems in the Central West of NSW: An Economic Analysis*, Economic Research Report No. 7, NSW Agriculture, Trangie.

**8** Brennan, J.P. and Bialowas, A. 2001, *Changes in Characteristics of NSW Wheat Varieties, 1965-1997*, Economic Research Report No. 8, NSW Agriculture, Wagga Wagga.

**9** Mullen, J.D. 2001, *An Economic Perspective on Land Degradation Issues*, Economic Research Report No. 9, NSW Agriculture, Orange.

**10** Singh, R.P., Faour, K.Y., Mullen, J.D., and Jayasuriya, R. 2004, *Farming Systems in the Murrumbidgee Irrigation Area in NSW*, Economic Research Report No. 10, NSW Department of Primary Industries, Yanco.

**11** 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.

**12** Alford, A., Griffith, G. and Davies, L. 2003, *Livestock Farming Systems in the Northern Tablelands of NSW: An Economic Analysis*, Economic Research Report No. 12, NSW Agriculture, Armidale.

**13** Alford, A., Griffith, G. and Cacho, O. 2003, *A Northern Tablelands Whole-Farm Linear Program for Economic Evaluation of New Technologies at the Farm Level*, Economic Research Report No. 13, NSW Agriculture, Armidale.

**14** Mullen, J.D. and Vere, D.T. 2003, *Research and Extension Capabilities - Program Economists in New South Wales Agriculture*, Economic Research Report No. 14, NSW Agriculture, Orange.

**15** Farquharson, R.J., Griffith, G.R., Barwick, S.A., Banks, R.G. and Holmes, W.E. 2003, *Estimating the Returns from Past Investment into Beef Cattle Genetic Technologies in Australia*, Economic Research Report No. 15, NSW Agriculture, Armidale.

**16** O'Donnell, C.J., Griffith, G.R., Nightingale, J.J. and Piggott, R.R. 2004, *Testing for Market Power in Multiple-Input, Multiple-Output Industries: The Australian Grains and Oilseeds Industries*, Technical Report for the Rural Industries Research and Development Corporation, Economic Research Report No. 16, NSW Agriculture, Armidale.

**17** Brennan, J.P., Martin, P.J. and Mullen, J.D. 2004, *An Assessment of the Economic, Environmental and Social Impacts of NSW Agriculture's Wheat Breeding Program*, Economic Research Report No. 17, NSW Agriculture, Wagga Wagga.

**18** Griffith, G.R., Davies, B.L., Alford, A.R., Herd, R.M., Parnell, P.F. and Hegarty, R.S. 2004, *An Assessment of the Economic, Environmental and Social Impacts of NSW Agriculture's Investment in the Net Feed Efficiency R,D&E Cluster*, Economic Research Report No. 18, NSW Department of Primary Industries, Armidale.

**19** Scott, J.F. and Farquharson, R.J. 2004, *An Assessment of the Economic Impacts of NSW Agriculture's Research and Extension: Conservation Farming and Reduced Tillage in Northern NSW*, Economic Research Report No. 19, NSW Department of Primary Industries, Tamworth.

**20** Scott, J.F., Farquharson, R.J. and Mullen, J.D. 2004, *Farming Systems in the Northern Cropping Region of NSW: An Economic Analysis*, Economic Research Report No. 20, NSW Department of Primary Industries, Tamworth.

**21** Crean, J., Shaw, A., Singh. R. and Mullen, J.D. 2004, *An Assessment of the Economic, Environmental and Social Impacts of NSW Agriculture's Advisory Programs in Water Use Efficiency*, Economic Research Report No. 21, NSW Department of Primary Industries, Orange.

**22** Mullen, J.D. 2004, *Evaluations in 2003 of Five Areas of Investment by NSW Agriculture: Summary*, Economic Research Report No. 22, NSW Department of Primary Industries, Orange.

**23** Vere, D.T., Jones, R.E. and Dowling, P.M. 2004, *An Economic Evaluation of Research into the Improved Management of the Annual Grass Weed Vulpia in Temperate Pastures in South-Eastern Australia*, Economic Research Report No. 23, NSW Department of Primary Industries, Orange.

**24** Jones, R.E. and Dowling, P.M. 2004, *Sustainability, Externalities and Economics: The Case of Temperate Perennial Grazing Systems in NSW*, Economic Research Report No. 24, NSW Department of Primary Industries, Orange.

**25** Brennan, J.P. and Quade, K.J. 2004, *Analysis of the Impact of CIMMYT Research on the Australian Wheat Industry*, Economic Research Report No. 25, NSW Department of Primary Industries, Wagga Wagga.