Cooperative Research Centre for Sustainable Rice Production

STUDY OF WATER USE AND ENVIRONMENTAL ASPECTS OF RICE GROWING

Prepared for the Rice CRC
by Bruce Caldwell

Rice CRC Report P0-01/01

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By: Bruce Caldwell

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1st February 2000

STUDY OF WATER USE AND ENVIRONMENTAL ASPECTS OF RICE GROWING

This Report was prepared for the Rice CRC by Mr Bruce Caldwell, B & S Consulting. The views expressed in the Report are those of Mr Caldwell and not necessarily those of the Rice CRC, although we are supportive of the general principles expressed.

The Report was commisioned to assemble data held by various agencies to provide the Rice CRC with an objective perspective on water use and significant environmental aspects associated with rice growing. The conclusion and recommendation section was prepared for the Board of the Rice CRC and has not been included in this published version.

Statistical information contained in the Report was obtained from authoritative sources, including Ricegrowers' Co-operative Limited, Irrigation Companies and the NSW Department of Land and Water Conservation. Every effort has been made to confirm the accuracy of the data but it is not possible to statistically define uncertainties associated with the data.

Significant comments that have been provided subsequently by relevant agencies have been added as a footnote.

The Rice CRC appreciates the work of Mr Caldwell in collating this information. It provides a very valuable collation of historical and trend data. The Rice CRC will endeavour to keep this information current.

Laurie Lewin
Director

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1. INTRODUCTION

The Council of Australian Governments (COAG) has agreed to a nationwide approach to water reform. The outcomes of the reform process are already having an impact on irrigation and ricegrowing and further impacts can be expected. Such changes should affect the direction of some of the future research to be undertaken by the Co-operative Research Centre for Sustainable Rice Production.

The long-term sustainability of irrigation systems in arid zones has been shown, world wide, to have technical difficulties. As ricegrowing in arid zones is absolutely dependent on irrigation it is obvious the eventual sustainability of rice is inextricably linked to the sustainability of the irrigation systems as a whole.

If irrigation systems start to fail for whatever reason (e.g. environmental degradation, water allocated to other purposes) then ricegrowing will decline.

It is recognised that ricegrowing, as an irrigation activity, contributes to the environmental problems associated with irrigation. It is thus of fundamental importance to have a full understanding of this aspect of ricegrowing. It is also important that current rice farming practices and research efforts are adequately addressing such issues.

This study examines the extent of ricegrowing as the predominant irrigation activity in the Murrumbidgee and Murray Valleys of New South Wales. Past and current policies of governments are reviewed in relation to access to water for irrigation and its use for ricegrowing. Data has been compiled on rice production, water availability, water use, ground watertables and salinity as these relate to the rice industry.

2. THE RICEGROWING REGION

Ricegrowing is almost entirely confined to the Murrumbidgee Valley and to the NSW side of the Murray Valley. Commercial production commenced in the Murrumbidgee Valley in the mid 1920's and then expanded to the Murray Valley in the 1940's as part of the World War II food production effort. Today, provided their properties have soil suitable for ricegrowing, most farmers in these two regions with access to irrigation water are growing rice depending on seasonal availability of water.

To assist with understanding past and future trends the ricegrowing region can be divided into a number of elements as shown in Table 1.

TABLE 1: The NSW Rice Industry – Ricegrowing Regions

Valley	Region	Includes	Irrigation Water Supply Agency
Murrumbidgee	MIA's & Districts (Murrumbidgee Irrigation Areas & Districts)	Yarno Irrigation Area Mirrool Irrigation Area Benerembah Irrigation District Tabbita Irrigation District Wah Wah Irrigation District	Murrumbidgee Irrigation Limited
	CIA (Coleambally Irrigation Area)	Coleambally Irrigation Area Kerarbury Channel Coleambally Outfall District	Coleambally Irrigation Corporation
	Murrumbidgee Pumpers	Licensed diverters pumping from river system (excludes most of Yarrio Creek)	Department of Land and Water Conservation
	CIA Bores	Licensed bore pumpers drawing from the Calivil formation (North West of CIA)	Department of Land and Water Conservation
Murray	Murray Irrigation Districts – East	Berriquin Irrigation District Denimein Irrigation District	Murray Irrigation Limited
	Murray Irrigation Districts – West	Deniboota Irrigation District Wakool Irrigation District Tullakool Irrigation Area	Murray Irrigation Limited
	West Corurgan	West Corurgan Private Irrigation District	
	Murray Pumpers – East	Licensed diverters on Yanco/Billabong Creek system (rice production is delivered to Eastern Murray Valley depots)	Department of Land and Water Conservation
	Murray Pumpers – West	Licensed diverters from Various Murray Valley Creek Systems (rice production is delivered to Western Murray Valley depots)	Department of Land and Water Conservation

Up until the 1980's rice growing was almost entirely confined to the government sponsored closer settlement areas, i.e. the various irrigation Areas and Districts. From the late 1980's rice has expanded to properties in the river and creek systems which obtain their irrigation water supplies as licensed pumpers.

Over the last 5 years several river pumpers in Victoria have grown small areas of rice. There have also been occasional rice crops grown in the Lachlan Valley over the last 30 years. Rice was grown in the Lachlan in the latest season and it appears more crops in the next few years can be envisaged. Production levels from Victoria and the Lachlan Valley are currently insignificant.

3. RICE PRODUCTION

Full statistics on regional rice production are included in Tables 2(a), 2(b) and 2(c).

Examination of the data show that over the last decade the growth in total production has mostly occurred through expansion of ricegrowing outside the traditional ricegrowing irrigation Areas and Districts, i.e. on to properties on the river and creek systems.

At the risk of being over-simplistic the production situation for the last 3 crops (each of which have been in excess of 1.3 million tonnes) can be approximately described as follows: -

Region	**Approximate Production (' 000 t)**
Murrumbidgee Valley Areas & Districts	500
Murray Valley Districts	500
Murrumbidgee Pumping – River and Bore	200
Murray Pumping	100
West Corurgan	25
TOTAL	1,325

At the commencement of the current decade the production from the last three regions was effectively zero.

From all the Areas and Districts the production potential for the decade has been about the same. The two main causes of variability have been area sown (governed by availability of water, particularly in the Murray Valley) and crop yield (cold temperatures at flowering, for example, being the main cause of the low yields for the 1996 crop).

It is important to recognise where current production potential lies. The above approximation shows that in the Areas and Districts the amount of rice that can be sown has peaked and total production can only grow through an increase in field yields – provided the regions' sustainability for ricegrowing is mainframed.

In the other regions there may still be potential for further growth by attracting new participants – i.e. water used for other purposes being allocated to rice. However, given the restraints on irrigation activities that have developed or are developing, as discussed later in this paper it is difficult to envisage total rice sowings exceeding the peak of 166,000 ha that occurred in 1996/97.

TABLE 2(a): **RICE CROP STATISTICS** 1994/95 to 1998/99

Region	**1994/95**		**1995/96**		**1996/97**		**1997/98**		**1998/99**	
	hectares	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**
MIA's & Districts	36,566	337,906	38,228	273,810	38,854	345,896	37,629	372,438	36,988	366,662
CIA	21,080	183,031	22,188	132,116	21,477	183,602	21,343	209,750	20,863	190,335
Total Murrumbidgee Valley Areas & Districts	*57,646*	*520,937*	*60,416*	*405,926*	*60,331*	*529,498*	*58,972*	*582,188*	*57,861*	*556,998*
Murrumbidgee Pumpers	6,718	59,744	11,766	72,544	14,604	106,196	14,302	131,597	17,019	151,150
CIA Bores	3,618	30,880	5,371	33,375	6,172	48,695	5,808	53,153	7,104	62,093
Total Murrumbidgee Valley	**67,982**	**611,561**	**77,553**	**511,845**	**81,107**	**684,389**	**79,082**	**766,938**	**81,984**	**770,241**
Murray Irrigation Districts - East	30,522	276,049	36,429	231,797	41,240	356,843	29,003	271,754	31,948	300,040
Murray Irrigation Districts - West	20,818	161,830	24,734	126,862	28,194	217,264	19,553	164,818	22,701	189,816
Total Murray Valley Districts	*51,340*	*437,879*	*61,163*	*358,659*	*69,434*	*574,107*	*48,556*	*436,552*	*54,649*	*489,856*
West Corurgan	2,647	22,936	2,976	19,500	4,304	36,242	2,184	20,700	2,485	22,125
Murray Pumpers - East	5,199	45,135	6,890	45,470	7,334	61,705	7,566	72,320	8,121	71,095
Murray Pumpers - West	2,069	16,378	2,614	15,774	3,737	24,349	2,801	25,371	3,587	28,506
Total Murray Valley	**61,255**	**522,328**	**73,643**	**439,403**	**84,809**	**696,403**	**61,107**	**554,963**	**68,842**	**611,582**
Total - Industry	**129,237**	**1,133,890**	**151,106**	**951,218**	**165,916**	**1,380,794**	**140,189**	**1,321,901**	**150,826**	**1,381,823**

TABLE 2(b): **RICE CROP STATISTICS** 1989/90 to 1993/94

Region	**1989/90**		**1990/91**		**1991/92**		**1992/93**		**1993/94**	
	hectares	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**
MIA's & Districts	36,619	315,802	26,943	250,707	36,213	340,599	35,818	296,908	35,832	299,728
CIA	23,156	180,505	17,519	151,372	23,168	209,302	21,027	160,353	21,098	174,878
Total Murrumbidgee Valley Areas & Districts	*59,775*	*496,307*	*44,462*	*402,079*	*59,381*	*549,901*	*56,845*	*457,261*	*56,930*	*474,606*
Murrumbidgee Pumpers					1,571	12,639	2,365	18,140	6,208	50,559
CIA Bores							1,646	14,507	1,826	14,952
Total Murrumbidgee Valley	**59,775**	**496,307**	**44,462**	**402,079**	**60,952**	**562,540**	**60,856**	**489,908**	**64,964**	**540,117**
Murray Irrigation Districts - East	29,785	242,772	23,906	227,060	34,732	310,933	33,299	253,604	35,631	297,318
Murray Irrigation Districts - West	19,073	142,025	14,482	120,880	22,258	175,081	21,502	147,344	21,749	161,931
Total Murray Valley Districts	*48,858*	*384,797*	*38,988*	*347,940*	*56,990*	*486,014*	*54,801*	*460,948*	*57,380*	*459,249*
West Corurgan			186	1,470	1,268	11,982	1,907	15,397	2,879	24,943
Murray Pumpers - East										
Murray Pumpers - West	1,776	12,480	1,667	14,688	3,931	33,810	5,338	37,708	7,434	57,864
Total Murray Valley	**50,634**	**397,277**	**40,241**	**364,099**	**62,189**	**531,806**	**62,046**	**454,053**	**67,693**	**542,056**
Total - Industry	**110,409**	**893,584**	**84,703**	**766,178**	**123,141**	**1,094,346**	**122,902**	**943,961**	**132,656**	**1,082,173**

Note: - *Table 2(a) and 2(b). The Murrumbidgee Region includes those who derive water from the Murrumbidgee River, Yanko and Billabong Creeks. In these tables they are separated into Murrumbidgee Pumpers and Murray Pumpers East.*

TABLE 2(c): **RICE CROP STATISTICS** 1984/85 to 1988/89

Region	**1984/85**		**1985/86**		**1986/87**		**1987/88**		**1988/89**	
	hectares	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**	**hectares**	**tonnes**
MIA's & Districts	41,481	292,507	38,318	262,884	34,267	216,091	36,308	266,681	37,876	310,452
CIA	23,528	161,372	21,074	137,537	19,898	113,669	23,102	166,637	24,243	190,422
Total Murrumbidgee Valley Areas & Districts	*65,009*	*453,878*	*59,392*	*400,421*	*54,165*	*329,760*	*59,410*	*433,318*	*62,119*	*500,874*
Murrumbidgee Pumpers										
CIA Bores										
Total Murrumbidgee Valley	**65,009**	**453,878**	**59,392**	**400,421**	**54,165**	**329,760**	**59,410**	**433,318**	**62,119**	**500,874**
Murray Irrigation Districts - East	28,168	200,242	22,326	139,779	20,110	108,547	23,612	172,600	18,921	154,514
Murray Irrigation Districts - West	22,559	189,715	22,492	133,790	18,845	92,069	21,037	136,481	18,471	132,602
Total Murray Valley Districts	*56,509*	*389,957*	*44,818*	*273,569*	*38,955*	*200,616*	*44,619*	*309,081*	*37,392*	*287,116*
West Corurgan										
Murray Pumpers - East										
Murray Pumpers - West										
Total Murray Valley	**56,509**	**389,957**	**44,818**	**273,569**	**38,955**	**200,616**	**44,619**	**309,081**	**37,392**	**287,116**
Total - Industry	**121,518**	**843,835**	**104,210**	**673,991**	**93,120**	**530,376**	**104,029**	**742,399**	**99,511**	**787,990**

4. WATER AVAILABILITY

Traditionally water availability for a particular property or license is governed by the total resource available in any particular season and the allocation attached to that property or license.

An allocation does not entitle a property or license to an absolute quantity of water; rather it defines the share of the total water available in any season.

The allocation structures are well established. In the Murray Valley the structures date back to 1964 and 1967 with a modification introduced upon the completion of the Dartmouth dam in the 1980's. In the Murrumbidgee Valley the development of the current structures commenced in the late 1970's and the allocation scheme was subsequently formally introduced in 1982/83.

In the past, water management agencies calculated seasonal allocations according to knowledge of storage levels and inflows (historical minimal or probable) combined with expectations of actual irrigation usage relative to announced levels of availability. Any residual was assigned to the river or "the environment". Generally agencies could be confident that not all of the water announced for the season would actually be used, but if actual usage was underestimated, the shortfall was offset (at least partially) by reducing water for the environment.

Other elements in the seasonal equation included access to off-allocation (that is un-regulated flow) water, the possibility of borrowing against the following season's allocation and in more recent years the opportunity to purchase water through temporary transfers.

Such allocation systems have now been in place for at least 15 years (35 in the Murray Valley districts) and agencies and irrigators have been well versed in understanding the meaning of announcements about allocations.

5. <u>WATER USE ON RICE CROPS</u>

In the Areas and Districts water usage on rice crops has been measured for many years for the purpose of environmental monitoring. Data on rice crop water use are contained in Tables 3(a), 3(b) and 3(c).

For comparative purposes an estimate of evapotranspiration during the rice-growing season (i.e. ET less rain) is included.

Broadly it can be seen for the MIA's and Districts and Coleambally that there has been a decline in unit rice crop water use. Contributors to this decline would include changes in drainage practices, better techniques for identifying leaky soils, increasing landholder awareness, farm planning and practices and higher water tables.

A similar trend is expected in the Murray districts but cannot be confirmed because of a lack of data.

There are also regional differences with the Murray Valley displaying the lowest unit use. This probably occurs because soil testing has been carried out for a longer period and farmers have always been compelled to retain all tailwater, a practice made compulsory in Murrumbidgee and Coleambally in relatively recent years.

Coleambally shows the highest unit use. This is associated with a greater proportion of the irrigated area being underlain by relatively deep watertables. Thus the equilibrium state reached in the MIA many years ago is not yet evident in much of Coleambally.

Data on rice crop water use are not collected for licensed diverters.

TABLE 3(a): **RICE CROP WATER USE**
MIA's & DISTRICTS

Year	Rice Area (ha)	Total Rice Water Use (ML)	Rice Production (t)	Yield (t/ha)	Yield (t/ML)	Water Use (ML/ha)	ET - rain (ML/ha)
1984/85	41,481	611,492	292,507	7.05	0.48	14.7	12.5
1985/86	38,318	499,733	262,884	6.86	0.53	13.0	11.0
1986/87	34,267	439,821	216,091	6.31	0.49	12.8	12.5
1987/88	36,308	515,879	266,681	7.34	0.52	14.2	14.2
1988/89	37,876	482,736	310,452	8.20	0.64	12.7	12.2
1989/90	36,619	459,156	315,802	8.62	0.69	12.5	13.2
1990/91	26,943	384,906	250,707	9.31	0.65	14.3	15.2
1991/92	36,213	540,106	340,599	9.41	0.63	14.9	13.1
1992/93	35,818	370,579	296,908	8.29	0.80	10.3	7.5
1993/94	35,832	456,901	299,728	8.36	0.66	12.8	10.2
1994/95	36,566	495,086	337,906	9.24	0.68	13.5	12.8
1995/96	38,228	446,917	273,810	7.16	0.61	11.7	10.7
1996/97	38,854	519,262	345,896	8.90	0.67	13.4	11.7
1997/98	37,629	489,363	372,438	9.90	0.76	13.0	11.0
1998/99	36,988	476,337	366,662	9.91	0.77	12.9	

TABLE 3(b): **RICE CROP WATER USE COLEAMBALLY**

Year	Rice Area (ha)	Total Rice Water Use (ML)	Rice Production (t)	Yield (t/ha)	Yield (t/ML)	Water Use (ML/ha)	ET - rain (ML/ha)
1988/89	24,046	342,486	190,422	7.92	0.56	14.2	12.2
1989/90	23,156	326,938	180,505	7.80	0.55	14.1	13.2
1990/91	17,519	265,527	151,372	8.64	0.57	15.2	15.2
1991/92	23,168	329,930	209,302	9.03	0.63	14.2	13.1
1992/93	21,027	219,740	160,353	7.62	0.73	10.5	7.5
1993/94	21,098	260,571	174,878	8.29	0.67	12.4	10.2
1994/95	21,080	297,169	183,031	8.68	0.62	14.1	12.8
1995/96	22,188	266,272	132,116	5.95	0.50	12.0	10.7
1996/97	21,477	270,447	183,602	8.55	0.68	12.6	11.7
1997/98	21,343	324,507	209,750	9.83	0.65	15.2	11.0
1998/99	20,863	300,550	190,335	9.12	0.59	14.4	

TABLE 3(c): **RICE CROP WATER USE MURRAY VALLEY DISTRICTS**

Year	Rice Area (ha)	Total Rice Water Use (ML)	Rice Production (t)	Yield t/ha	Yield (t/ML)	Water Use (ML/ha)	ET - rain (ML/ha)
1986/87	38,955		200,616	5.15			10.3
1987/88	44,618		309,081	6.93			11.7
1988/89	36,369		278,932	7.67			10.3
1989/90	48,858		384,797	7.88			10.3
1990/91	38,988		347,940	8.92			12.5
1991/92	56,990		486,014	8.53			11.4
1992/93	54,801	521,356	400,948	7.32	0.77	9.5	7.4
1993/94	57,380	614,327	459,249	8.00	0.75	10.7	8.4
1994/95	51,340	622,888	437,879	8.53	0.70	12.1	10.4
1995/96	61,163	714,499	358,657	5.86	0.50	11.7	9.8
1996/97	69,434	786,792	574,107	8.27	0.73	11.3	11.1
1997/98	48,556	561,259	436,552	8.99	0.78	11.6	12.2
1998/99	54,649		489,856	8.96			11.3

6. PROPORTION OF WATER USED ON RICE CROPS:

As indicated in the previous sections data are collected on rice crop water use in the Areas and Districts. Water use data for other activities/crops are also available to varying degrees.

These data are shown in the Tables 4(a), 4(b) and 4(c).

The data show that rice is the main user of irrigation water, consuming 50-55% in the Murray Valley districts, 65-75% in Coleambally and 45-55% in the MIA's and Districts.

Such proportions of water use have occurred for at least the last decade, despite many pressures, which might have, at least in theory, caused a decline in water use on rice. However the reality is that despite its high water use, rice has provided a consistent and satisfactory financial return to most farmers. Viable alternatives have not been discovered, or at least crops that could be grown profitably by all irrigators have not been available.

Again empirical data for river licensed diverters are not available, although estimates can be made by applying Area and District unit water use to the known areas of rice grown by licensed diverters.

Table 5 provides an estimate for water use on rice crops grown by licensed diverters on the Murrumbidgee River.

It is interesting to note how quickly a large proportion of water used by these licensed diverters has been applied to rice crops. In essence it appears that in the space of only 8 years the proportion of water used on rice has become similar to that measured in the traditional rice-growing areas. Again this is a direct reflection of the financial success achieved with growing rice, particularly when compared to other farming activities.

TABLE 4(a): **WATER USE x CROP (ACTIVITY)**
MIA's AND DISTRICTS

Water Use x Crop/Activitiy	**Irrigation Year (' 000 X ML)**										
	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Rice	**483**	**459**	**385**	**540**	**370**	**457**	**495**	**447**	**520**	**489**	**476**
	55%	*52%*	*44%*	*53%*	*55%*	*50%*	*45%*	*51%*	*49%*	*50%*	*59%*
Pasture -	**264**	**264**	**299**	**276**	**169**	**230**	**311**	**186**	**212**	**179**	**102**
Annual	*30%*	*30%*	*34%*	*26%*	*26%*	*25%*	*28%*	*21%*	*20%*	*18%*	*13%*
Horticulture	**62**	**69**	**79**	**74**	**48**	**85**	**109**	**97**	**118**	**122**	**110**
	7%	*8%*	*9%*	*7%*	*7%*	*9%*	*10%*	*11%*	*11%*	*13%*	*13%*
Other	**87**	**89**	**111**	**131**	**81**	**141**	**190**	**149**	**220**	**184**	**125**
	10%	*10%*	*13%*	*13%*	*12%*	*16%*	*17%*	*17%*	*20%*	*19%*	*15%*
Total	**880**	**881**	**874**	**1021**	**668**	**913**	**1105**	**879**	**1070**	**974**	**813**
	100%	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

Other includes perennial pasture, annual crops
(winter, summer, vegetables) stock and domestic, industrial, towns.

TABLE 4(b): **WATER USE x CROP (ACTIVITY)**
COLEAMBALLY

Water Use x Crop/Activitiy	**Irrigation Year (' 000 X ML)**									
	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Rice	**327** *81%*	**266** *70%*	**330** *69%*	**220** *69%*	**261** *68%*	**297** *66%*	**266** *67%*	**270** *51%*	**325** *70%*	**300** *74%*
Other	**75** *19%*	**113** *30%*	**150** *31%*	**98** *31%*	**121** *32%*	**156** *34%*	**128** *33%*	**255** *49%*	**136** *30%*	**107** *26%*
Total	**402** *100%*	**379** *100%*	**480** *100%*	**318** *100%*	**382** *100%*	**453** *100%*	**394** *100%*	**525** *100%*	**461** *100%*	**407** *100%*

Other includes all activities apart from rice - pasture, horticulture,
annual crops (winter, summer, vegetables) stock and domestic, industrial, towns.

TABLE 4(c): **WATER USE x CROP (ACTIVITY)**
MURRAY VALLEY DISTRICTS

Water Use x Crop/Activitiy	**Irrigation Year (' 000 X ML)**						
	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99
Rice	**521** *51%*	**614** *49%*	**623** *48%*	**714** *55%*	**787** *53%*	**561** *54%*	**626** *54%*
Pasture - Annual	**357** *35%*	**409** *33%*	**379** *29%*	**321** *25%*	**336** *23%*	**213** *20%*	**264** *23%*
Pasture - Perenniel	**97** *10%*	**145** *11%*	**171** *13%*	**152** *12%*	**192** *13%*	**151** *14%*	**158** *13%*
Other	**45** *4%*	**89** *7%*	**126** *10%*	**104** *8%*	**156** *11%*	**120** *12%*	**120** *10%*
Total	**1020** *100%*	**1257** *100%*	**1299** *100%*	**1291** *100%*	**1471** *100%*	**1045** *100%*	**1168** *100%*

Other includes horticulture, annual crops (winter, summer, vegetables)
stock and domestic, industrial, towns.

TABLE 5: **An Estimation of Total Rice Crop Water Use By Licensed Diverters on the Murrumbidgee River (excluding Yanco Creek Pumpers)**

	Rice Area (ha)	Water Use			
		Unit Rice Water Use (ML/ha)	Estimated Total Rice Water Use ('000 ML)	Total Diversions ('000 ML)	Estimated Percentage Total Diversions Applied to Rice (%)
1992	1,571	14.9	23	400	6
1993	2,365	10.3	24	259	9
1994	6,208	12.8	79	351	23
1995	6,718	13.3	89	459	19
1996	11,766	11.8	139	424	33
1997	14,604	13.3	194	480	40
1998	14,302	13.9	199	518	38
1999	17,019	13.0	221	419	53

Unit Rice Water Use: data provided by Murrumbidgee Irrigation Limited for rice crops in the MIA's and Districts.

7. NEW ARRANGEMENTS – THE CAP

In 1995 the Murray Darling Basin Ministerial Council (MDBMC) published a report that examined changes to the flow regimes in rivers within the Basin and the consequences of those changes.

The report identified increasing levels of diversions and the consequent decline in river health. From 1988 to 1994 water consumption in the Basin increased by 7.9 per cent overall.

The report examined the scope for diversions to grow further under the water allocation systems that existed at that time. The systems had evolved at a time when water managers were trying to encourage development of the Basin's water resources. Water was rationed during periods of shortage but the systems were not effective for controlling diversion during normal non-drought conditions. In the five years prior to 1994 only 63 per cent of the water that was permitted to be used was used, leaving considerable scope for further increases in consumption, without any changes in entitlements.

It was estimated that average diversions could increase by a further 14.5 per cent if expansion under 1993/94 management rules was unrestricted. This increase in diversions would reduce security of supply for existing irrigators. Increased diversions would mean that the level of reserves held in the storage's would be lower than is currently the case. This would reduce the capacity of the storages to be a reliable source of supply during long periods of drought. Under this scenario, water supplies for existing irrigators would therefore become less secure and river health problems would be exacerbated.

As a response to this report, effective from 1 July 1997, the MDBMC introduced the Cap, which in effect is the long term average volume of water that would be diverted by a valley were development not to grow beyond the maximum which existed up to and including the 1993/94 season.

The Cap in New South Wales is not the volume of water used in 1993/94. Rather the Cap is the long-term average volume of water that would be diverted by a valley were development not to grow beyond the maximum, which existed up to, and including the 1993/94 season. This means that the following elements are taken into account:

1993/94 water supply infrastructure
1993/94 management rules
1993/94 entitlements and the extent of utilisation
1993/94 underlying levels of demand
1993/94 system operating efficiency.

The Cap itself does not attempt to reduce Basin diversions, but to prevent them from increasing. The Ministerial Council decided that preventing any increase in diversions was essential to arrest further decline in both river health and the security of supply to existing water users.

The Cap should restrain diversions, not development. With the Cap in place, new developments should be allowed, provided that the water for them is obtained by improving water use efficiency or by purchasing water from existing developments.

Implementation is the responsibility of individual states and in NSW implementation is coupled with other water reform endeavors such as environmental river flow objectives. Thus the primary response to the Cap as it affects the Murrumbidgee and Murray Valleys includes the following: -

- the maximum allocation that will be announced in any year will not exceed 100%
- access to off-allocation flows will be substantially reduced
- water will be available for environmental flows.

Given that announced allocations in the years up to 1993/94 were often 120%, the implementation of the Cap heralded an immediate real reduction in water availability for many irrigators.

Whilst there is general agreement amongst water users and stakeholders on the concept of the Cap, significant issues have been raised regarding implementation arrangements. These issues relate to: -

- confusion as to what the Cap means for water users and how the Cap calculations are determined
- a perception by some water users that the Cap is not generating better environmental outcomes
- concern amongst water users as to the effect of the Cap on their businesses, and
- uncertainty from water users in regard to future Cap or other water management arrangements in the basin.

8. NEW ARRANGEMENTS – ENVIRONMENTAL FLOW RULES

Environmental flow rules are a set of operating procedures for managing river flow, aimed at restoring some of the "natural" flow regime of regulated rivers. Their objective is to improve river health while minimising the impacts on water users along the river.

To date environmental rules have applied for the Murrumbidgee River for the last two seasons. Environmental rules have yet to be developed for the Murray River.

In the Murrumbidgee river environmental rules have been developed by the Murrumbidgee River Management Committee which is made up of community members (drawn from landholder, irrigator, environmentalist, local government and Aboriginal organisations) and State and ACT Government representatives.

The Committee has developed four rules aimed at restoring some of the variability of winter flows and maximising the environmental benefit of tributary inflow for the Murrumbidgee River. The four rules: -

- protect low flows
- maintain an end-of-system flow
- release a portion of dam inflows based on natural triggers to restore some of the natural variability between April and October
- provide water for contingencies such as water quality, algae bloom suppression, fish and bird breeding.

The current operation of the rules results in a long-term average reduction of annual farm gate delivery of water of 4.3%. In individual years the impact ranges from 0% to 17% in critically dry years.

9. NEW ARRANGEMENTS – CONTINUOUS ACCOUNTING

Under the present allocation schemes individual entitlement holders forfeit any allocation they have remaining at the end of each year. The remaining allocation is returned to the general "pool" and redistributed amongst all entitlement holders when the allocation is made for the following water year.

Under a continuous accounting system there is no end of year in the sense described above. Part of any volume of water that an individual does not use one season may be carried over to the next season. There may be certain limits on carryover as defined by a set of continuous accounting rules for a particular valley.

It may also be possible to draw against water expected to be available in the next year. Once again certain limits on borrowing will be defined by the continuous accounting rules for the valley.

There are a number of beneficial outcomes of a continuous accounting system. Individual water users are able to manage their share of available water to match their business needs and are not as constrained by the seasonal vagaries of the valley supply reliability. Having such an opportunity discourages the individual to adopt a "use it or lose it" approach which could result in water being used for inappropriate purposes. The system encourages water use efficiency efforts because water saved is available for the individual's subsequent use, rather than being lost to other entitlement holders via the "pool".

A negative impact, probably slight, is that, as some unused water will be assigned to individuals, which will reduce the pool available to determine the allocation level in the following year. It is assessed that continuous accounting will reduce allocations by about 2 to 3%.

10. NEW ARRANGMENTS – SNOWY INQUIRY

The Snowy River inquiry has reviewed the water sharing arrangements between irrigation, the environment and electricity generation. A range of options that balance these interests were prepared for governments' consideration prior to the corporatisation of the Snowy Mountains Hydroelectric Scheme.

The outcomes from that inquiry were released in October 1998.

The inquiry's preferred option increases flows in the Snowy and associated rivers to improve environmental conditions in those systems.

There will be some reduction in supply to the Murrumbidgee and Murray River systems although the water supply authorities are generally of the view that the reduction will be minimal and will be able to be absorbed through improvements in operational efficiencies.

Governments have yet to make a final decision on this issue.

11. NEW ARRANGEMENTS – WATER TRANSFERS

Water transfers, particularly, on a seasonal basis have become a significant tool for many irrigators. Transfers are negotiated between private individuals but require the consent of DLWC.

The “market” has developed over the last decade or so, but has generally been described as immature and somewhat inefficient.

Data, on the extent of trading in recent years appears in Tables 6(a), 6(b) and 6(c).

Such water trading has delivered substantial benefits to individual water users. Buying water may allow crops to be finished satisfactorily, whilst the seller is receiving a financial benefit for water that was not going to be used, and just returned to the pool at the end of the season for the benefit of all in the following season.

A major inadequacy in the current situation is the lack of a “property right” attached to a water user’s allocation. As stated earlier the allocation systems are a means of sharing and do not necessarily describe absolute quantities of water.

In the eyes of irrigator organisations property rights need to be developed for all users including the environment. If this does not occur then there is a continuing opportunity for government to allocate to a environmental regime, thereby changing the reliability (and quantum) of supply to other users, without the obligation/need to consider any form of compensation.

Irrigators see recent issues such as the CAP, environmental flows, continuous accounting and the Snowy River as being the type of issue on which government/s will make a decision that will adversely affect their access to water – and in all cases they will not receive any compensation for a certain loss in income earning potential.

The issues surrounding property rights were well spelt out in October 1995, in Occasional Paper Number 1 by the Task Force on COAG Water Reform.

Unfortunately the NSW government has been slow to act and four years on there is an even more urgent need to ensure that this issue is quickly resolved.

Again transfers while having obvious positive benefits, can also have a negative impact in that the amount of unused allocation to be carried forward at the end of the season will obviously be reduced.

TABLE 6(a): **TEMPORARY WATER TRANSFERS MIA's AND DISTRICTS**

	1997/98			1998/99		
	TRADES (NO.)	TOTAL WATER (ML)	AVERAGE TRADE (ML)	TRADES (NO.)	TOTAL WATER (ML)	AVERAGE TRADE (ML)
Internal	**886**	**68,075**	**77**	**243**	**25,815**	**106**
External						
Out						
MI to River	272	74,449	273	127	50,428	397
MI to CI	68	10,304	152	75	11,856	158
MI to MV	71	12,208	172	59	23,788	403
MI to SA	4	2,480	620	6	440	73
Total	*415*	*99,441*	*240*	*267*	*86,512*	*324*
In						
River to MI	30	4,514	150	12	3,150	263
CI to MI	5	417	83	1	200	200
MV to MI	0	0	0	1	40	40
Total	*35*	*4,931*	*141*	*14*	*3,390*	*242*
Net - Out	**380**	**94,510**	**249**	**253**	**83,122**	**329**

TABLE 6(b): **TEMPORARY WATER TRANSFERS COLEAMBALLY**

	1997/98			1998/99		
	TRADES (NO.)	TOTAL WATER (ML)	AVERAGE TRADE (ML)	TRADES (NO.)	TOTAL WATER (ML)	AVERAGE TRADE (ML)
Internal	**420**	**58,931**	**140**	**112**	**24,580**	**222**
External						
Out						
CI to River	16	3,696	231	12	5,220	435
CI to MI	4	259	60	1	200	200
CI to MV	7	1,130	161	13	2,743	211
Total	*27*	*5,085*	*188*	*26*	*8,163*	*314*
In						
River to CI	25	3,980	159	9	3,446	383
MI to CI	65	11,233	173	71	11,656	164
MV to CI	2	500	250	1	300	300
Total	*92*	*15,713*	*171*	*81*	*15,402*	*190*
Net - In	**65**	**10,628**	**164**	**55**	**7,239**	**132**

TABLE 6(c): **TEMPORARY WATER TRANSFERS**
MURRAY VALLEY DISTRICTS

	1994/95	1995/96	1996/97	1997/98	1998/99
Internal					
External					
Out					
Total					
In					
Total					
Net - In	134,167	10,870	37,978	98,764	88,843

12. NEW ARRANGEMENTS – OTHER CONSIDERATIONS

The Federal Government has recently formed a Natural Resource Management Taskforce. The Taskforce is to report to Cabinet in May with proposed solutions to the Murray-Darling basin crisis as part of a broader review of natural resources management.

The Weekend Australian newspaper of 29-30 January, 2000, reported on the views of a number of experts on the basin. Those views included the following:-

- increase water use efficiency
- farming systems to be cleaner and greener
- increase environmental flows
- stop land clearing
- reduce irrigation allocations
- improve river management practices

These issues indicate a continuation of the pressure already in existence to wind back irrigation water use.

The Taskforce, being a Federal group, will come up against the States' rights that are deeply imbedded in the water argument (indeed such state rights are enshrined in the Australian Constitution), however if nothing else occurs it could be expected that there will be solid Federal Government support for the current views and initiatives of the Murray Darling Basin Ministerial Council.

Another issue arising in January 2000, was the issuing of a White Paper, which explains the elements of the NSW Government's proposed legislative framework for water management. The proposal includes the introduction of a Water Management Bill that is to provide legislation for sustainable water management in NSW.

The White Paper suggests that the current legislative framework (which dates back to 1912) needs to be updated to bring it into line with COAG reforms and other natural resources management frameworks operating in NSW. In particular the White Paper advocates the need to adequately provide for the recognition and preservation of environmental water.

Elements of the White Paper that are of particular interest to ricegrowing include the recognition of environmental water, establishment of "property rights" associated with the owning of water allocations and strengthening of water trading and transfer arrangements.

The prospect of legislation on "property rights", trading and transfers will be welcomed although whether the White Paper fairly responds to the lengthy debate that has occurred on these issues needs to be further examined. It may be that in any case time has run out for irrigators to establish a right that could attract compensation as it appears that the White Paper proposals give environmental water first ranking.

For instance it is advocated that the Minister will be able to adjust water entitlement conditions to achieve agreed environmental and public health outcomes. Whilst "agreed" will be the operative word in the political sense, it seems as if the Minister will be able to taketh in the one hand and not have to giveth with the other.

The White Paper requires the most vigilant attention from anyone who is associated with the water industry in NSW.

13. THE OVERALL IMPACT OF THE NEW ARRANGEMENTS

For the Murray Valley historical water use has been about 110% of entitlement.

Removing access to off-allocation plus the CAP are estimated to reduce the average entitlement to 92%. Other government initiatives could reduce that further e.g. Snowy 5%, other policy reforms 5%.

Despite such downward pressures on availability, at the end of the 1998/99 irrigation season many rice growers had substantial unused water allocations. Many of these same irrigators had either reduced irrigated areas or purchased water early in the season, expecting shortage. It seems there was a lack of understanding of what the new arrangements meant (i.e. some farmers assumed that the allocation announced was on a similar basis to previous years) or the expected drought was much less severe that the farmers expected (probably influenced by the new arrangements which led to initial very low announced allocations). The effect was that farmers over-estimated the actual risk and ended up with surplus allocated water.

As the arrangements change then the data that an individual uses to make his assessment on likely water availability also changes. There is an urgent need for systems to be developed that will assist the irrigator's risk assessment approaches to become more accurate.

The most critical element necessary to give such risk assessments integrity in the long term is to ensure that title to water is secured. At least then if water is to be "taken away" there will be the potential for compensation, and conversely an irrigator may seek to enter the market to purchase, and then will know exactly what is being purchased.

A number of studies have attempted to identify irrigator response predictions to substantial reductions in water supply. Not surprisingly rice, as a large unit water user, is nominated by many irrigators as an activity that might be substantially reduced. The record as shown in Tables 4(a), 4(b) and 4(c) appears to indicate that all activities will be reduced by similar amounts – that is the proportion of water allocated to a crop seems to stay roughly the same. Such a response belies again the consistent financial return that is generated by growing rice.

The overall scenario is further explored for the Murrumbidgee in Tables 7 and 8. Table 7 describes the current total allocation position while Table 8 shows deliveries of general security supplies over the last 11 years.

Verbal advice from the DLWC indicates that based on modeling of long term average diversions for the Murrumbidgee a "typical" supply year in the future can be described as follows:-

Typical Water Supply – Murrumbidgee

	Future "typical" year	Current allocations (from Table 7)
General Security	1673	2092
High Security	160	317
Supply losses	353	373
TOTAL	2186	2782

For general security, which includes water for ricegrowing, the data for a future "typical" year indicates an allocation of 80% (i.e. 1673 ÷ 2092).

However as Table 8 shows general security usage has rarely exceeded 100% of entitlements so the "real" reduction will on average be less than 20%.

TABLE 7: **MURRUMBIDGEE VALLEY - ALLOCATIONS**

Region	Allocations ('000ML)			
	Farm Entitlements		Supply Losses	Total Diversions
	General Security	High Security		
Murrumbidgee Irrigation	919	309	243	1471
Coleambally Irrigation	474	8	130	612
Licensed Diverters	699			673
TOTAL	2092	317	373	2782

TABLE 8: **MURRUMBIDGEE VALLEY - GENERAL SECURITY DELIVERIES ('000ML)**

	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
MIA	702	852	952	772	986	828	620	953	795	812	818
CIA	407	461	525	396	453	382	379	480	379	402	415
PUMPERS	543	672	622	550	595	455	336	519	407	333	236
TOTAL	1651	1985	2099	1716	2034	1665	1335	1952	1660	1547	1459

Note: 100% allocation = 2092

14. ENVIRONMENTAL ISSUES – WATER TABLES

Large parts of the irrigation Areas and Districts are underlain by shallow watertables. Tables 9(a) to 9(f) present data on areas at particular Watertable depths. (Note that along the river the intensity of irrigation carried out by licensed diverters is less and shallow groundwater is unlikely to be a problem. Whilst the DLWC has some piezometers this aspect is not monitored as it is not deemed necessary.[1])

In all regions the data shows that in recent years there has been a decrease in areas with groundwater levels in the 0-2 metre range.

There are a number of reasons suggested for this decrease. These include drier climatic conditions in 1997 and 1998, better identification and isolation of leaky paddocks and improved water management practices adopted by landholders to reduce recharge.

Despite the recent favourable trends with water table levels the prevailing view remains that in the long term the areas underlain by shallow water tables will continue to increase. For instance it has been estimated that by 2020 the area of water table at depth 0-2 metre in the Berriquin and Denimein Irrigation Districts would reach 200,000 ha, up from the 1998 level of 44,124 ha.

Whether such an expansion of shallow water tables will result in a significant decline in production potential will depend on the salinity and sodicity levels of the groundwater, the extent to which irrigation activities can be used to successfully leach the top soil, and whether or not groundwater and salinity extraction works are implemented. In relation to using irrigation to leach topsoil, growing rice can be an important tool, because flooding the soil ensures that leaching occurs. In areas where degradation is occurring it is possible for rice to be used as a pioneer crop with the leaching of the topsoil improving the production potential of following crops.

The Land and Water Management Plans focus significantly on reducing accessions to the groundwater. Issues generally addressed by all of the Plans include: -

- Sealing the supply systems
- Improving surface drainage
- Groundwater pumping[2]
- Improving on farm practices.

The extent to which the principles of the LWMP's have been embraced by all participants and put into practice has exceeded expectations. It is important that this impetus is maintained, particularly in a period when farm incomes are under pressure because water supplied has actually been reduced (because of dry seasons) and where further reductions are threatened because of potential government action.

[1] Department of Land & Water Conservation does not agree with this statement.
[2] Department of Land & Water Conservation believes this option has very limited potential.

TABLE 9(a): **DEPTH TO WATERTABLE FOR THE MIA's & DISTRICTS**

YEAR	Percentage of Contoured Area With Water Tables at Depths Indicated		Contoured Area ('000xha)	Estimation of area (ha) with water tables at depths indicated based on new contoured area	
	0-2m	2-4m		0-2m	2-4m
1991	64.7	30.8	159.7	81100	38600
1993	69.1	26.3	159.7	86600	33000
1994	58.1	34.7	159.7	72800	43500
1995	70.3	20.0	159.7	88100	25100
1996	65.0	28.3	159.7	81000	35800
1997	55.9	36.0	159.7	69900	45000
1997	55.1	37.8	125.1	68900	47300
1998	52.2	42.2	125.3	65400	52900

Note: *In 1998 the piezometric data in the MIA was reviewed. It was found that the density of piezometers in some locations (particularly in the West of the region) was insufficient to allow for reasonable extrapolation of groundwater contours. In such locations contour mapping has been discontinued. In effect the area contoured for shallow groundwater levels haschanged from 159.600ha to 125,300ha. Comparative data was prepared for 1997 and show that the percentage indicated at the two depths is virtually identical.*

TABLE 9(b)**: DEPTH TO WATERTABLE FOR COLEAMBALLY**

Year	Area (ha) Depth 0-2m	Area (ha) Depth 0-4m
1986	7,600	20,600
1987	9,400	22,800
1990	30,100	44,500
1992	19,100	53,200
1994	18,100	57,000
1996	44,000	35,900
1997	22,200	49,500
1998	19,100	55,100

TABLE 9(c): **Depth to Watertable for the Murray Irrigation Limited Area of Operations July/August 1992 to 1999**

Year	Area (ha)	
	Depth 0-2 m	Depth 2-4 m
1992	95,995	247,189
1993	120,941	265,319
1994	112,878	293,091
1995	110,080	293,200
1996	87,837	320,838
1997	75,847	331,940
1998	55,152	338,884
1999		

TABLE 9(d): **Depth to Watertable for Berriquin and Denimein Irrigation Districts July/August 1990 to 1999**

Year	Area (ha)	
	Depth 0-2 m	Depth 2-4 m
1990	91,300	73,800
1991	80,810	98,540
1992	65,218	115,996
1993	86,135	104,009
1994	76,588	122,491
1995	78,670	132,950
1996	65,875	141,041
1997	60,440	149,189
1998	44,124	157,664
1999		

TABLE 9(e): **Depth to Watertable for Deniboota Irrigation District July/August 1990 to 1999**

Year	Area (ha)	
	Depth 0-2 m	Depth 2-4 m
1990	5,200	55,500
1991	4,600	58,000
1992	4,337	60,593
1993	7,033	68,790
1994	9,890	69,200
1995	6,800	67,400
1996	3,278	73,299
1997	3,397	75,145
1998	1,868	77,348
1999		

TABLE 9(f): **Depth to Watertable for Wakool Irrigation District July/August 1992 to 1999**

Year	Area (ha)	
	Depth 0-2 m	Depth 2-4 m
1992	26,440	70,600
1993	27,773	92,520
1994	26,400	101,400
1995	24,610	92,850
1996	18,684	106,498
1997	12,010	107,606
1998	9,160	103,872
1999		

15. ENVIRONMENTAL ISSUES - SALT

Irrigation activity is a net importer of salt. Even through the water supply is of high quality, large quantities are used, and as drainage flows of water (and salt) back into the rivers are substantially avoided, salt is transported into the soil profile and into groundwater.

Net imports of salt in 1997/98 are as follows: -

MIA's and Districts	100,000t
Coleambally	49,000t
Murray Valley	32,000t

However provided this salt can be leached out into the Watertable then there may not be a deleterious effect on production, unless watertables are so close to the surface that waterlogging is caused.

The recently published Salinity Audit indicates that mainly because of clearing in the catchments of the river valleys that salt is rapidly being mobilised in the catchments. This will result in increases in the salinity levels of irrigation water supply.

For the Murrumbidgee it is estimated that average river salinity at Wagga Wagga will rise from the 1998 level of 140EC to 190EC in 2050. By extrapolation this suggests that if current irrigation operations regarding drainage water and salinity returns to the river are maintained the salt retained in the MIA's and Districts and Coleambally will rise from the 1998 level of 149,000t to about 200,000t in 2050.

In the Murray Districts salinity levels in the water supply are not expected to increase significantly as inflows above Albury are very fresh and supplemented with good quality water through the Snowy Mountains Scheme.

16. ENVIRONMENTAL ISSUES – PESTICIDE RESIDUES IN DRAINAGE WATER

It is a requirement of the Pollution Control Licenses held by the irrigation corporations that the level of certain agricultural chemicals is monitored. For each pesticide instances of levels above environmental guidelines, notification and action levels are recorded. For notification and action level occurrences appropriate actions are required to be taken.

Detections are summarised in Table 10.

Generally the level of recording detections is regarded as low and appears to be declining. This is attributed to active education programs conducted by all the corporations and improved farm layout and on-farm practices.

TABLE 10: **NUMBER OF PESTICIDE DETECTIONS IN DRAINAGE WATER**

	Above Environmental Guidelines		Above Notification Level		Above Action Level		Total - Above Environmental Guidelines	
	97/98	98/99	97/98	98/99	97/98	98/99	97/98	98/99
Murrumbidgee	32	14	12	11	3	2	47	27
Coleambally	na	7	na	1	na	2	na	10
Murray	1	na	0	na	0	na	1	na

na = *not available*

17. ENVIRONMENTAL ISSUES – DETECTION OF THE RICE HERBICIDE CHEMICAL MOLINATE

Molinate is used extensively in the rice industry for weed control. As a requirement of the Pollution Control Licenses the irrigation corporations monitor the level of molinate at key points in the irrigation supply and drainage systems during the period October to December each year.

Summary data are shown in Tables 11(a), 11(b) and 11(c).

The data suggests an improving situation with a marked decline in recordings above notification and action levels.

TABLE 11(a): SUMMARY OF MOLINATE DETECTIONS 1997 AND 1998 - MIA's AND DISTRICTS

	1997 (%)	1998 (%)
Below Environmental Level	68	76
Above Environmental Level	29	18
Above Notification Level	4	4
Above Action Level	8	2

TABLE 11(b): **SUMMARY OF MOLINATE DETECTIONS 1995 TO 1998 - COLEAMBALLY**

	1995 (%)	1996 (%)	1997 (%)	1998 (%)
Below Environmental Level	31	47	48	63
Above Environmental Level	17	27	30	29
Above Notification Level	16	12	13	5
Above Action Level	36	14	9	4

TABLE 11(c): **SUMMARY OF MOLINATE DETECTIONS 1995 TO 1998 - COLEAMBALLY**

	1995	1996	1997
Below Environmental Level	na	na	na
Above Environmental Level	52	43	25
Above Notification Level	29	4	0
Above Action Level	14	1	0

na = *not available*

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Rice CRC .... of growing importance

About the Rice CRC

The Rice CRC is strengthening the rice industry's research and development (R&D) effort through its focus on sustainability.

Its mission is to increase the environmental, economic and social sustainability of the Australian Rice Industry and enhance its international competitiveness through both strategic and tactical research and the implementation of practical, cost-effective programs.

The Centre uses the intellectual resources of some of Australia's peak R&D organisations to target five main program areas:

1. Sustainability of Natural Resources in Rice-Based Cropping Systems
2. Sustainable Production Systems
3. Genetic Improvement for Sustainable Production
4. Product and Process Development
5. Education, Skills Development and Techology Transfer

Rice CRC core participants are Charles Sturt University, NSW Agriculture, CSIRO, Department of Land and Water Conservation, University of Sydney, Ricegrowers' Co-operative Ltd and the Rural Industries Research and Development Corporation.

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