Lachlan Catchment Irrigation Profile

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The Water Use Efficiency Advisory Unit is a NSW Government joint initiative between NSW Agriculture and the Department of Sustainable Natural Resources.

NSW Agriculture (2003)

ISBN 0 7347 1416 5 (individual)

ISBN 0 7347 1372 X (series)

This Irrigation Profile, *Lachlan Catchment Irrigation Profile*, is one of a series for NSW catchments and regions. It was written and compiled by Meredith Hope, NSW Agriculture, for the Water Use Efficiency Advisory Unit, 37 Carrington Street, Dubbo, NSW, 2830.

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Acknowledgments

Thanks to the NSW Water Management Fund for providing initial financial support to undertake this work.

Thanks to the following individuals and groups:

- Water Analysis and Audit Branch, Sustainable Water Management, Department of Land and Water Conservation (DLWC), Parramatta, now Water Management Systems, Natural Resources Products Division, Bridge Street, Sydney
- Licence Administration Branch, DLWC, Parramatta, now Water Management Systems, Bridge Street, Sydney
- NSW Agriculture staff, especially Greg Markwick, Eddie Parr, Mike Robbins, Ian Smith and Udai Pradhan
- Lachlan Valley Water, Forbes, NSW

for their assistance in preparing this document.

1. EXECUTIVE SUMMARY

The *Lachlan Catchment Irrigation Profile* was developed from a study to obtain catchment and industry-based assessments of water use efficiency (WUE)[1] and irrigation efficiency (IE)[2].

Readily accessible irrigation data were collected from State and Commonwealth sources, from published research and industry reports and from unpublished reports. These data were assigned a reliability rating using a system developed by the National Land and Water Resources Audit (1999).

The report summarises, where possible by water source and by catchment, what is known about:

- the number of irrigators
- the number of licences
- the entitled volume or area authorised for irrigation
- the area irrigated and water used in total and by crop type
- irrigation methods
- yields of irrigated crops
- the value of irrigation to agriculture

in the Lachlan catchment.

This Profile does not attempt to calculate or analyse catchment or industry based estimates of WUE or IE. This will be carried out in a subsequent report.

Users of this document are advised to proceed with caution. The data presented in this report should be treated carefully and with respect for the various collection, storage and retrieval processes that can impact on information reliability.

[1] WUE refers to the volume of crop produced (harvested dry matter) per unit of water delivered to the crop. This is usually expressed as tonnes per megalitre (t/ML) (Alexander & Foley 1998).

[2] IE is a measure, expressed as a percentage, of the volume of water used or delivered by a system relative to the total volume of water entering the system (Alexander & Foley 1998).

1.1 An overview of the Lachlan catchment

The Lachlan catchment is in central NSW west of the Great Dividing Range. It has an area of 84 700 square kilometres, representing 8% of the total land in the Murray-Darling Basin. The landscape ranges from undulating hilly country in the east to flat riverine plains in the west.

Annual rainfall in the catchment decreases from around 780 mm in the east to 370 mm in the west while evaporation increases from 1351 mm in the east to 1825 mm in the west. The catchment is affected by two weather systems: to the south, winter rainfall dominates, whereas to the north, summer rainfall is dominant.

The Lachlan catchment has a diverse range of irrigated crops, from pasture, cereals and oilseeds grown on the alluvial soils of the riverine plain to vegetables, wine grapes and stone fruit grown on the riverine plain and the tableland region. Pasture (summer and winter) and lucerne are the predominant irrigated crops, followed by cereals. Smaller irrigated areas of cherries are grown around Young and wine grapes are grown around Cowra. Cotton is now grown around the Hillston area.

Of the total value of agriculture in the catchment ($981 million), around 17% ($165 million) each year can be attributed to irrigation. The total value of irrigation has increased from $92 million to $165 million between 1991–92 and 1996–97. Of this total irrigated value, around 30% can be attributed to cereal crops and a further 20% to other crops such as oilseeds and legumes.

The sum of the value of irrigated pasture and grasses, meat and livestock products was $36 million, representing 22% of the total irrigated value in 1996–97. Cotton was still a fledgling industry in 1996–97, producing $0.8 million. This value is likely to have increased markedly since then, given that the volume of water used on cotton has increased considerably.

Of the 1 150 000 ha of land irrigated in NSW, approximately 6% is in the Lachlan catchment. Pasture and lucerne have the largest combined irrigated area of all crops in the catchment and represent around 50% of the total area irrigated. By comparison, cereals represented between 30 and 40% of the total area irrigated. When compared to pasture, cereal crops received a higher income for less area.

The total volume of water used by irrigated agriculture is not known with accuracy due to gaps in information for some sources of water. Best estimates suggest that somewhere between 444 400 ML and 477 000 ML were extracted by irrigated agriculture in 1996–97 (Table 1). Generally, the greatest proportion is taken from the regulated river system. Extraction from the remaining sources appears to be relatively minor.

Figure 1. The Lachlan catchment

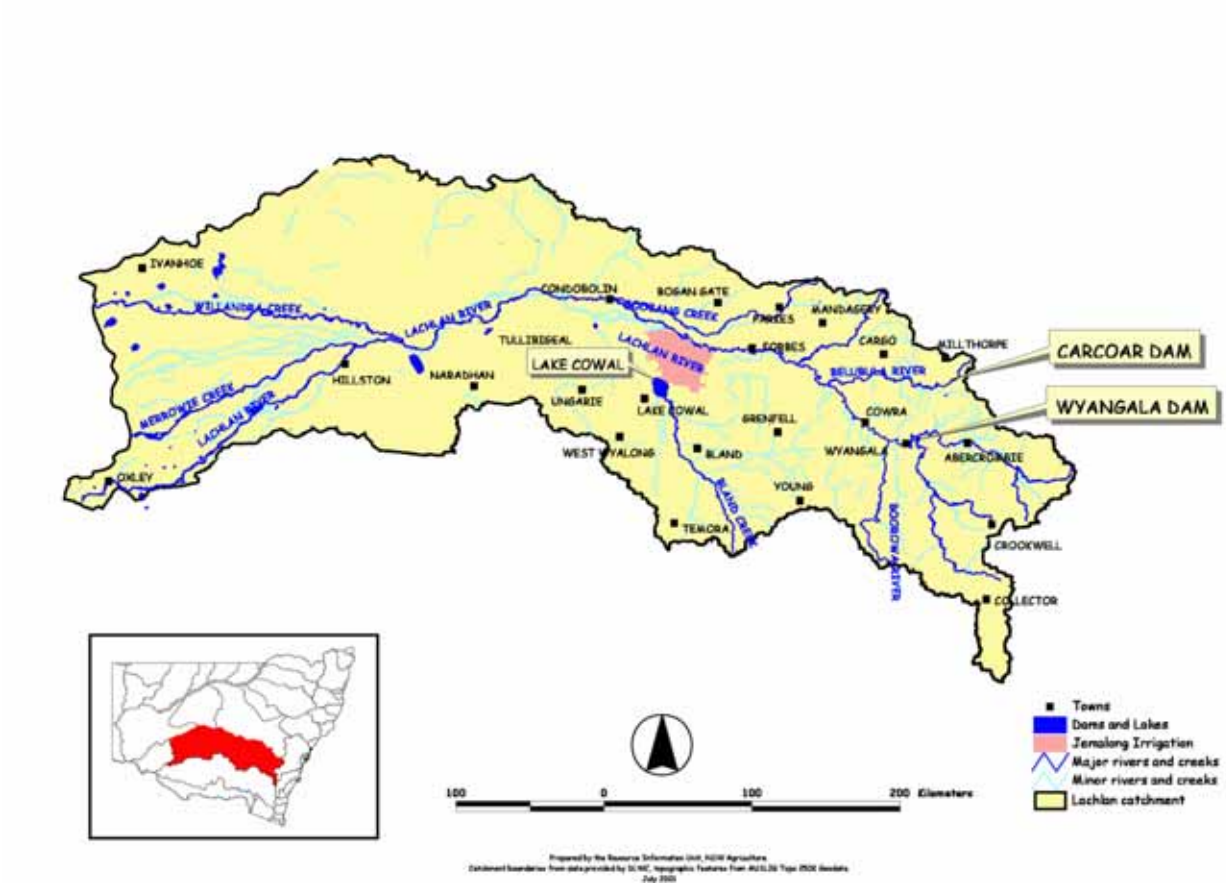


Table 1. Irrigation data for 1996–97 season in the Lachlan catchment

Source of water	Total irrigated area (ha)	Total water used by irrigated agriculture (ML)	Number irrigation licences	Number enterprises irrigating	Value of irrigation ($million)
NSW total	*1 150 000*	*7 700 000*	*24 000*	*7 846*	*2 496*
All sources of water	*est. 81 836 (around 50% is pasture)*	*est. 444 400–477 000*[a]	1 616	515	165 (30% is cereals)
Regulated	95 145	424 400 or 457 000	843	nd *423 (1993–94)*	nd
Unregulated	2 533	nd *3 800 (1989–90 to 1991–92)*	317	nd *438 (1993–94)*	nd
Groundwater	nd *4 223 (1993–94)*	nd *16 200 (1980)*	456	nd *81*[b] *(1993–94)*	nd
Farm dams	nd *4 496 (1993–94)*	nd	nd	nd *96 (1993–94)*	nd
Reticulated	nd *31 (1993–94)*	nd	na	nd *4 (1993–94)*	nd

nd= no data, na = not applicable.

a. When summing extraction volumes from different sources, the maximum extraction by irrigation (3 801) from unregulated rivers was used. Data from farm dams and town water supply were non-existent. However, extraction from these sources is likely to be small and the impact on these total water use figure minimal.

b. The number of active groundwater licences (those that have recorded using water from groundwater supplies) is not known.

Of the estimated 24 000 licences (regulated, unregulated and groundwater) in NSW, 7% exist in the Lachlan catchment. Of the total number of irrigation enterprises in NSW (those with an estimated value of agricultural operations of $5000 or greater), 7% were in the Lachlan catchment. Most of these enterprises use water from either the regulated or unregulated river supply. Far fewer enterprises irrigate crops using groundwater, town water supplies or farm dams (Table 1).

1.2 Irrigation data issues

A number of issues were raised in the *Lachlan Catchment Irrigation Profile*. Generally, these issues relate to the scarcity of irrigation data, the scales at which irrigation data have been collected and disseminated and the reliability of available irrigation data.

1.2.1 Scarcity of irrigation data

Data have been collected for different purposes in the past to those now needed. For example, water management committees (WMC) are developing water-sharing agreements for catchments across the State and require information on how and where water is being used. Information on crop areas and water use, yields of irrigated crops, irrigation methods and the value of irrigation are needed to assist in the development of water sharing plans. This Profile has shown data from most sources (except the regulated system) to be either scant or never collected. Better data need to be collected to inform the water sharing debate.

1.2.2 Scales at which data have been collected

Point-scale data collected by ABS and ABARE are confidential and have been reported at SLA, catchment, groups of catchments or Agro-Ecological Region scales (AER[3]). These scales limit the data usefulness to natural resource managers who are often working at much finer levels (subcatchment or river reach).

1.2.3 Reliability of irrigation data

Reliability of data varied according to water source. For example, data from regulated supplies were more reliable than data from unregulated and groundwater supplies.

There were mismatches in information at different scales. For example, the DLWC estimated the area irrigated from regulated supplies to be about 20,000 ha greater than the ABS estimate for the area irrigated from all sources. It would be reasonable to expect the reverse to be true.

State agencies do not consistently report reliability of irrigation data. Such omissions make it easier for data users to inappropriately manipulate or analyse irrigation data and to draw spurious conclusions.

[3] AER are based on climatic regions which often span catchments and cannot be used to build catchment snapshots of irrigation.

1.2.4 Conclusion

A more comprehensive and consistent approach to the collection of irrigation statistics is needed. This would help to ensure that data are comparable across different water sources and industries. The following are needed to improve the situation:

- Recognition of the need to collect irrigation data on crop area and water used, irrigation methods and value of irrigation. Without these data, the ability to calculate WUE and IE will be limited.
- Data need to be collected at scales large enough to protect point-scale confidentiality but small enough to allow users to aggregate information to useful scales
- Protocols for provision of data to users are needed. This would help users make better decisions about the use of data and to manipulate data appropriately.
- Two-way flow of information between agencies and irrigators needs to be fostered. Typically, data have been obtained from irrigators by agencies. These data need to flow back to irrigators in forms that might assist them make better water management decisions.

Finally, such a comprehensive approach to improving the collection, management and distribution of irrigation data can only be developed with the full involvement of the many irrigators, agencies and community groups who require these data.

2. INTRODUCTION

During 1998, a desktop study was undertaken to develop a comprehensive database of irrigation in NSW in order to obtain catchment and industry based assessments of on-farm WUE and IE. From this study, Irrigation Profiles, or situation statements of irrigation, were developed for each of the major catchments in NSW. This is one such Profile. It focuses on the Lachlan catchment (see Figure 2) and attempts to detail what is known about the number of irrigators, the area irrigated and water used in total and by crop, irrigated production, irrigation methods and the value of irrigated agriculture.

This Profile does not attempt to calculate WUE or IE based on these data. This analysis will be carried out in a subsequent report.

2.1 Background

Irrigation statistics have been collected in NSW over the last 50 years.

1980 The Water Resources Commission (WRC 1980) undertook an assessment of irrigation in NSW.

1986 The WRC (1986) undertook a study to assess WUE in NSW. Data on WUE were reported catchment by catchment. The study highlighted a lack of data on crop areas irrigated, water used, yields of irrigated crops and financial returns.

1980–89 A report was compiled on crop areas irrigated, yields of irrigated crops and the values of individual irrigated commodities between 1980 and 1989 in NSW (DWC 1990).

1988–92 Sloane (1993) provided an overview of the number of farms and area irrigated for four broad agricultural regions in NSW between 1988 and 1992.

1986–2002 The Australian Bureau of Statistics (ABS) has collected information on irrigation for various years since 1986 (ABS 1998).

1950s–2002 The NSW Department of Land and Water Conservation (DLWC) collected information over the last 50 years on the area irrigated and water used by sections of the irrigation industry across NSW.

1996–97 The Australian Bureau of Agricultural Resource Economics (ABARE 2000) completed a survey of broadarea[4] and dairy farms in each of the major catchments in NSW in 1996–97

[4] Broadarea refers to all crops excluding horticultural and vegetable crops.

INTRODUCTION

Despite the volume of statistics collected in NSW, a basic description of the irrigation industry remains elusive. A review (Crabb 1997a & 1997b) commissioned by the Murray-Darling Basin Commission (MDBC) highlighted a lack of data describing:

1. the number of irrigators
2. the area of land irrigated
3. the location of irrigated land
4. the volume of water used

Four additional points could be added to the list: the crop type, the irrigated yields that are being obtained, the methods that are being used to irrigate crops and the value of irrigated agriculture.

The importance of reliable historical and current information about the irrigation industry in NSW is increasing. The Council of Australian Governments (COAG), comprising all States, territories and the Commonwealth, introduced reforms to improve the way water is managed in Australia. These reforms include processes to enable better sharing between users and the environment, trading between users, better defining a water right to users and recovering the real cost of storing and supplying water to users. A number of activities are and will continue to be heavily dependent on historical information and on the future collection of reliable irrigation data.

- With the introduction of the new *Water Management Act 2000*, NSW community and agency groups have been developing water sharing plans. These plans require accurate and reliable irrigation data to underpin their development and implementation. Water sharing plans are operational for 10 years with a review in the fifth year.

- In all Australian States, programs have been initiated to improve WUE and IE in irrigated agriculture. In NSW, WUE officers have been appointed across the State to help calculate farm WUE and IE and help improve farm water management. As part of the NSW Government's Structural Adjustment Program, an Irrigated Agriculture Water Use Efficiency Incentive Scheme operates to assist irrigators adjust to the NSW Water Reforms. The scheme is jointly managed by NSW Agriculture and the Rural Assistance Authority. In order to measure change as a result of this scheme, historical and current irrigation data are needed to describe the base-line situation and the situation after implementation.

In summary, there is a pressing need to obtain more accurate and reliable irrigation data to help strategically focus efforts to improve WUE and IE, provide communities with information on irrigation to aid decision making about sharing water in NSW, and help agencies and communities measure change as a result of water reform.

3. METHODS

3.1 Summary of data collection

During 1998, a desktop study was undertaken to review readily accessible data about irrigation from State sources including the DLWC and from Commonwealth sources including the ABARE and the ABS. Electronic data collected include:

1. **The ABS Irrigation Statistics Catalogue, AgStats** (ABS 1998). The ABS has collected information by Statistical Local Area (SLA) and in most instances these units can be aggregated into the Lachlan catchment. For a definition of an SLA see Appendix 14.1. For the grouping of SLAs used in the Lachlan catchment, see Figure 2. Only the most recent years for which the appropriate data are available (1993–94, 1995–96 and 1996–97) with the same Estimated Value of Agricultural Operations (EVAO)[5] and the same collection method have been compared.

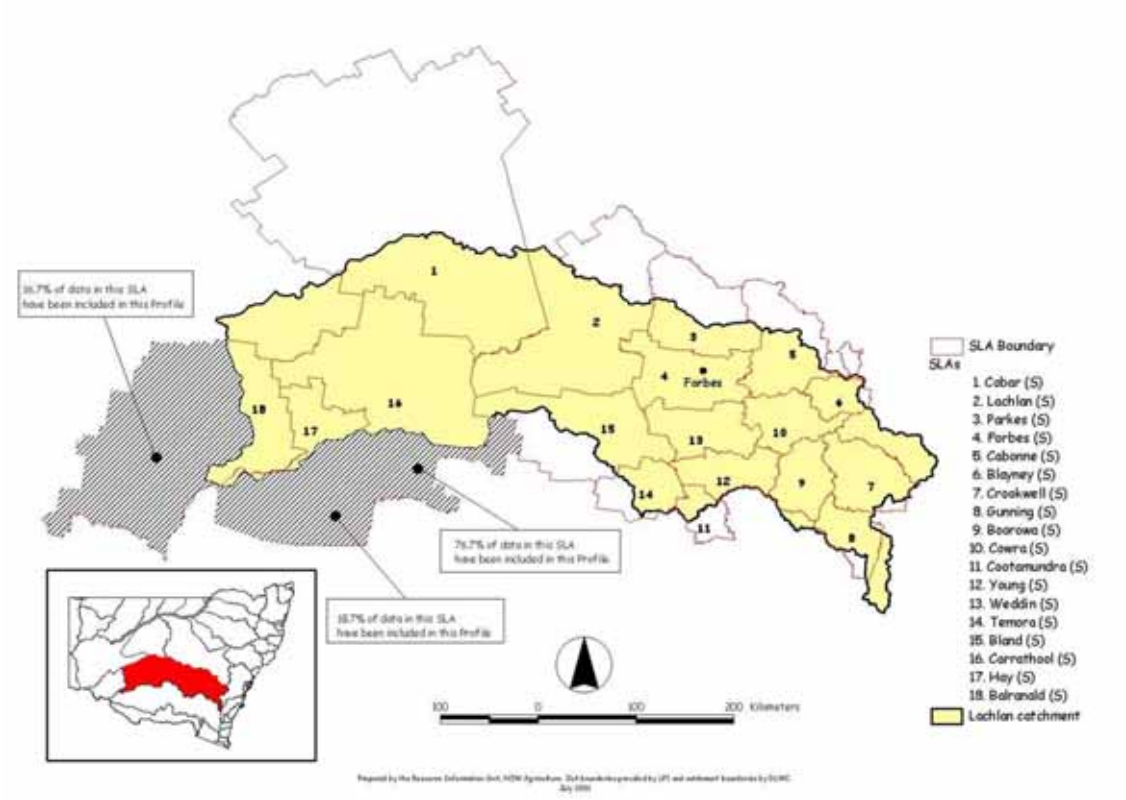
Table 2. EVAOs and collection units used by the ABS to collect data about irrigation in NSW

Year	EVAO ($)	Collection Unit
1986–87	20 000	SLA[a]
1989–90	20 000	SLA
1990–91	20 000	SLA
1991–92	22 500	SLA
1992–93	22 500	SLA
1993–94	5 000	SLA
1994–95	5 000	SLA
1995–96	5 000	SLA
1996–97	5 000	SLA
1997–98	22 500	AER[b]
1998–99	22 500	AER
1999–00	22 500	AER
2000–01	5 000	SLA

a. SLA = Statistical Local Area. b. AER = Agro-Ecological Region

[5] The population to be surveyed is determined from the Estimated Value of Agricultural Operations or EVAO. The value of the area of crops sown and the livestock numbers on holdings at a point in time as well as the crops produced and the livestock turnoff during the year are taken into account. The resultant aggregation of these commodity values is termed the EVAO.

Figure 2 Relationship between the Lachlan catchment and ABS SLAs



Between 1997–98 and 1999–2000, the ABS collected information by Agro-Ecological Regions (AER). These span across catchments and cannot be used to build catchment snapshots of irrigation. (Data for the 2000–01 year is still to be released.)

Catchment totals may be over-estimated when SLAs cross into other catchments. For example, the Carrathool SLA spanned important areas of large-scale irrigation in both the Lachlan and Murrumbidgee catchments.

Inclusion of the whole SLA in this Profile may lead to significant over-estimation of area irrigated and number of enterprises irrigating.

A licence-based concordance was used to proportion the data in all SLAs in the Lachlan catchment to help overcome this problem of overestimation (Table 3).

Table 3. Proportion of total number of surface licences in each SLA that falls into the Lachlan and surrounding catchments

SLA	Catchment						
	Lachlan	Murrum-bidgee	Murray	Macquarie	Barwon-Darling	Hawk'y-Nepean	100% of data used
Balranald	16.7	42.8	40.6				✖
Bland	75	25					✓
Blayney Pt A	82.8			17.2			✓
Blayney Pt B	91.5			8.5			✓
Boorowa	100						✓
Cabonne Pt C	79.1			20.9			✓
Carrathool	76.7	23.3					✖
Cobar	81.6				18.7		✓
Cootamundra	40	60					✓
Cowra	100						✓
Crookwell	82.1					17.9	✓
Forbes	100						✓
Gunning	60.4	38.5				1.1	✓
Hay	18.7	81.3					✖
Lachlan	97			3			✓
Parkes	73.6			26.4			✓
Temora	87.9			12.1			✓
Weddin	100						✓
Young	100						✓

In Carrathool SLA, 76.7% of surface irrigation licences were inside the Lachlan catchment, with the remainder in the Murrumbidgee catchment (Table 3). Consequently, only 76.7% of the data from this SLA were included in this Profile. The same principle was applied to Balranald and Hay SLAs. For other SLAs such as Bland, Blayney, Cabonne, Cobar, Crookwell, Gunning, Lachlan, Parkes and Temora, 100% of the data were included even though only a proportion of the licences were in the Lachlan catchment. This was because the amount of irrigation in these SLAs is relatively small and the overall impact from proportioning the SLA irrigation data on the total figure would be minimal. Central Darling SLA does not appear in this Profile or in Figure 2 and Table 3. The number of irrigation licences falling inside the Lachlan catchment was less than 8% and the irrigated area was relatively small. It was thought that excluding the Central Darling SLA data completely could be justified by the very small impact it would have on the final figures.

2. **The 1996–97 ABARE Irrigated Farm Survey results obtained from the ABARE Survey of Primary Industry, Resources and Energy (ASPIRE) database** (ABARE 2000). The combined Greater Macquarie catchment (including the Castlereagh, Macquarie and Bogan catchments) and the Lachlan catchment is

the reporting unit for the 1996–97 survey of irrigators by ABARE (2000). These data cannot be disaggregated into smaller units such as SLAs or catchments.

3. **A DLWC database of crop area and water use, designed for use by NSW Agriculture** (DLWC 1998a). The DLWC has collected information on water use and area by crop type and by licence and these data can be aggregated to any small scale (stream reach, subcatchment) or any large scale (catchment).

4. **Various spreadsheets** provided by the Water Analysis and Audit Branch, Sustainable Water Management, DLWC, Parramatta.

Data were also obtained from relevant research and industry reports. This Profile was further developed in collaboration with NSW Agriculture staff in regional offices. As staff uncovered regional data, such as unpublished reports, this information was incorporated into the profiles. This Profile was prepared in the period before the full implementation of the *Water Management Act* 2000 but with knowledge of its provisions.

Rating data reliability

The reliability of these irrigation data has been described using a rating system developed by the National Land and Water Resources Audit (1999). The four classes are:

1. **Class A** – data based on reliable recorded and surveyed information. Little or no extrapolation or interpolation required;

2. **Class B** – data based on approximate analysis and limited surveys. Some measured data and some interpolation/extrapolation required to derive the data-set;

3. **Class C** – little measured data. Data based on reconnaissance survey; and

4. **Class D** – data derived without investigation. Figures estimated from other data in nearby catchments or extrapolated/interpolated from any available data.

In this Profile, the reliability rating class has been indicated with the symbols:

- Class A: ①
- Class B: ②
- Class C: ③
- Class D: ④

So, for example, 'the number of irrigated enterprises in the Lachlan catchment was 515 (ABS 1998) ②'.

3.2 Structure of the irrigation profile

The availability and reliability of data in the Lachlan catchment have been summarised below.

Regulated rivers[6] are those rivers that have been declared by the Minister, by order published in the *Gazette*, to be a regulated river (NSW *Water Management Act 2000)*. Regulated rivers have their flows controlled by major government-owned rural dams. These capture water that is then released to users downstream when needed (DLWC 1999c).

Unregulated rivers[6] are all other rivers that are not regulated rivers (NSW *Water Management Act 2000)*. Many of these rivers may still have dams or weirs built on them by urban water suppliers to control water flows (DLWC 1999c).

Groundwater is water that can be accessed from an aquifer. An aquifer is a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water (NSW *Water Management Act 2000)*.

Farm dam water is water from dams containing water that is permitted to be captured under a Harvestable Right.

Reticulated (town water) supplies are those that have been reticulated for a town or city's drinking water.

The presentation of information by water source was necessary as data availability and reliability varied markedly depending on the water source to which it was related.

This report summarises, where available, by water source, SLA, subcatchment and catchment:

1. number of licences with the purpose of irrigation
2. number of enterprises using irrigation
3. entitled volume or area authorised for irrigation
4. area irrigated and water used in total and by crop type
5. method of irrigation
6. yield of irrigated crops
7. value of irrigated production.

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[6] **Rivers:** A river includes:

(a) any water course, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved;

(b) any tributary, branch or other watercourse into or from which a watercourse referred to in paragraph (a) flows; and,

(c) anything declared by the regulations to be a river;

but does not include anything declared by the regulations not to be a river.

4. CATCHMENT DESCRIPTION

4.1 Physical description of the Lachlan catchment

The Lachlan catchment is located in central NSW and covers approximately 84 700 km^2 (Figure 1).

The Lachlan River is the main water source in the catchment and is fed from its tributaries, the Belubula, Abercrombie, Crookwell, and Boorowa rivers and Mandagery Creek. The Lachlan River flows northwest from Cowra to Forbes, then generally west to Lake Cargelligo and then divides into a large number of effluent streams. The river then ends in the Great Cumbung Swamp and only floods to the Murrumbidgee River after exceptionally wet climatic periods.

The catchment can be broken into three zones: the upper, mid and lower catchment.

- **The upper catchment** includes the western slopes of the Great Dividing Range, which are characterised by elevated, undulating country. The Abercrombie River and the unregulated portion of the Lachlan River drain water from the western slopes of the Great Dividing Range. This water is then stored in Wyangala Dam for release downstream to irrigation farms, towns, industrial, stock and domestic users. Water is also captured by the unregulated section of the Belubula River and stored in Carcoar Dam. Townships in the upper catchment include Blayney, Gunning and Boorowa.
- **The mid-catchment** includes the section of river from Wyangala Dam to Lake Brewster. This area is characterised by undulating landscape and fertile alluvial floodplains adjacent to watercourses. Towns in this area include Parkes, Forbes, Cowra, Condobolin, Grenfell, Young, West Wyalong and Lake Cargelligo. Jemalong Irrigation (JI) – formerly known as Jemalong and Wyldes Plains Irrigation Districts – is also located in this section of the Lachlan catchment.
- **The lower catchment** includes the section west of Lake Brewster to the Lachlan River confluence with the Murrumbidgee River. The Lachlan River flows across the broad fertile alluvial floodplain, discharges into the Great Cumbung Swamp and then drains into the Murrumbidgee River. Towns in this section include Hillston, Booligal, Oxley and Ivanhoe.

To give an indication of how much water flows through the Lachlan catchment, figures on inflow, levels of extraction and outflow for the 1999–2000 year have been provided. Storage inflows into Wyangala and Carcoar Dams were 530 000 ML and approximately 447 000 ML of water were released. The amount of water entering the river system after the dams from gauged tributaries was 216 000 ML and the amount of water extracted by all users (industrial, irrigation, stock and domestic and town water supply) in 1999–2000 was 285 000 ML. The volume leaving the system (draining into the Great Cumbung Swamp) was 86 000 ML, which left 292 000 ML of water that could not be accounted for. This volume is likely to be the result of evaporation, seepage, floodplain flows, ungauged effluents or inflows from ungauged tributaries (DLWC 2000d).

4.2 Climate

The Lachlan catchment has a semi-arid climate with annual rainfall that decreases in a westerly direction. In the higher eastern sections of the catchment, the long-term mean annual rainfall is 767 mm (Blayney) while, in the far western reaches, Hillston receives 367 mm (Table 4).

Table 4 Climate in the Lachlan catchment

	Blayney	Cowra	Forbes	Condobolin	Hillston
Elevation (m)	863	318	240	199	122
Mean daily max temp (deg C)	18.3	21.9	23.8	24	24.2
Highest max temp (deg C)	37.5	42	43	44.9	46
Mean daily min temp (deg C)	4.4	9.9	10	11	10.9
Lowest min temp (deg C)	-10.6	-4.2	-5.6	-5	-4.4
Mean daily evaporation (mm)	nd	3.7	nd	4.2	5
Long-term annual evaporation	nd	1351		1533	1825
Long-term annual evapotranspiration[7] (mm)	1 172	1 331	1 437	nd	1 337
Mean rainfall (mm)	767	643.8	526	458	367.2
Evaporative deficit (mm)	405	687	911	nd	970

Source: Bureau of Meteorology (2000). Nd = No data

The catchment is located between two weather systems: the winter-dominated southern pattern, and the summer-dominated northern pattern. The result is an even monthly average rainfall across most of the catchment, with the exception of the most easterly parts around Blayney, where winter rainfall dominates (Appendix 14.2).

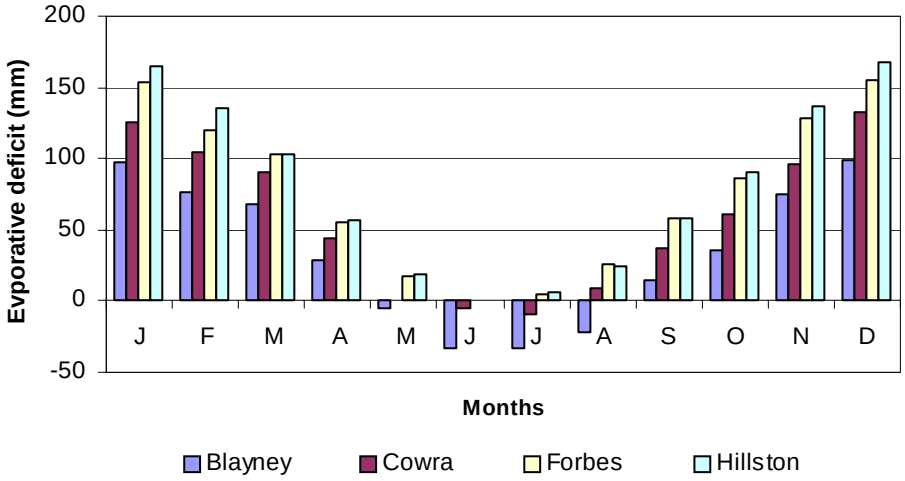
Rainfall is highly variable and this variability increases from east to west. Summer rainfall tends to be more variable than winter rainfall (NSW Agriculture & Fisheries Division of Plant Industries 1990).

There is an increase in mean daily maximum temperature and evaporation in a westerly direction, which is again associated with decreasing elevation (Table 4). The catchment has mean daily maximum temperatures of between 18 and 24°C. Extreme temperatures of 46°C occur in the westerly areas of the catchment around Hillston. Temperatures as low as –10.6°C have occurred in Blayney (Table 4).

[7] Reference evapotranspiration is the amount of evaporation and transpiration of a grass reference crop (Allen *et al.* 1998).

The evaporative deficit[8] gives some indication of when irrigation water is needed by crops. The requirement for irrigation water is greatest in the lower part of the catchment (Hillston and Forbes) (Table 4). Irrigation water is generally needed in the months between August and May across the Lachlan catchment (Figure 3).

Figure 3 Evaporative deficit at Blayney, Cowra, Forbes and Hillston

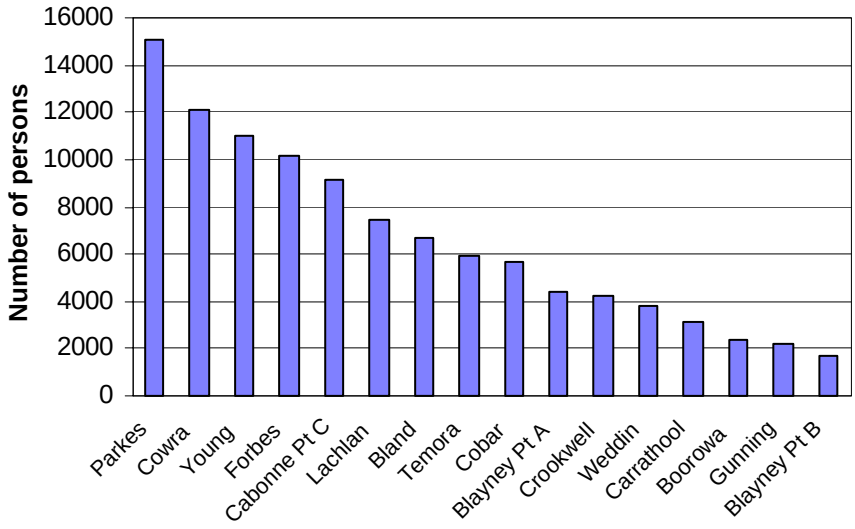


[8] Evaporative deficit = reference evapotranspiration minus rainfall. Reference evapotranspiration was determined using the FAO 56 methodology (Allen et al. 1998). Climatic data were obtained from the (Bureau of Meteorology 2000).

4.3 Population

The total population in the Lachlan catchment is estimated to be 105 114. The SLA with the largest population is Parkes (15 000 people), followed by the SLAs of Cowra, Young and Forbes, each with over 10 000 people (Figure 4).

Figure 4 Population in SLAs of the Lachlan catchment in 1996



Source: ABS (1997) ①. See Appendix 14.3 for SLA naming conventions

5. IRRIGATION FROM ALL SOURCES

5.1 Description of irrigation

Historically, pastoralists extracted water from the river system to irrigate fodder crops in order to produce reliable sources of feed. However, unreliable river flows restricted further irrigation development.

In 1935, irrigation developed in the mid to lower areas of the Lachlan catchment following the construction of Wyangala Dam. This water supply was augmented in 1970 with the construction of Carcoar Dam. People were encouraged to establish new irrigation enterprises and to utilise this more reliable water supply. Less irrigation development occurred along the unregulated rivers where flows are variable and volumes small.

Today, irrigation farms can be found either along the fertile riverine plains and slopes in close proximity to the Lachlan River or in the Jemalong and Wyldes Plains Irrigation Districts (now Jemalong Irrigation [JI]). The following section describes irrigation along the Lachlan River in four sections from east to west.

1. **Belubula River (from Carcoar Dam to its confluence with the Lachlan River).** Lucerne is grown along the small alluvial flats of the Belubula River. Oats and pasture are also irrigated here but in smaller quantities (Whiteley et al. 1996).

2. **Upper Lachlan (Wyangala Dam to Lake Cargelligo).** Large areas of lucerne and pasture (summer and winter) are irrigated. Smaller areas of cereals (winter and summer) are also irrigated, especially around Condobolin. Lucerne is confined to the fertile alluvial soils whereas winter cereals and pasture are irrigated on the poorer red soils. The Upper Lachlan catchment supports important fruit, wine and vegetable industries. Asparagus, corn, tomatoes, beetroot and wine grapes are irrigated around Cowra (Whiteley et al. 1996). Cherries and plums are irrigated around Young, which is also known as the 'premier' cherry area (NSW Agriculture & Fisheries Division of Plant Industries 1990). These industries depend on water from unregulated rivers. Storm damage and inconsistent water supply have meant that there has been no guarantee of consistent produce supply. Plots of cherries, nectarines and peaches have been trialled at Canowindra and there is also a small irrigated wine (NSW Agriculture & Fisheries Division of Plant Industries 1990), stone fruit and apple industry around Forbes (I Smith, pers. comm.).

2. **Lower Lachlan (Lake Cargelligo to Oxley).** Upstream of Hillston, wheat, canola, pasture and maize are irrigated on the poor red soils. Citrus has also been established in the Hillston area as have cotton, wine grapes (Whiteley et al. 1996), potatoes and vegetables (I Smith, pers. comm.). Cotton has increased significantly in the last two years around the Hillston area.

3. **Jemalong Irrigation.** This irrigation district supports lucerne, pasture (summer and winter), oilseeds, summer grain legumes and cereals (summer and winter)

(Whiteley et al. 1996). A Geographic Information System (GIS) has been developed for this area. This tool can provide layers of spatial information ranging from soil type, boundary layers to wetlands and floodways (McGrath 1997) and is the base layer of information for the Land and Water Management Plan.

Irrigation farms increase in size from the top of the catchment to the bottom. In 1992, farms between Wyangala Dam and Gooloogong averaged 240 ha, while average farm sizes between Condobolin and Oxley were 1560 ha (Rose et al. 1992). The area irrigated on broadarea[9] and dairy farms in the amalgamation of the Lachlan catchment and Greater Macquarie catchment was estimated to be 201 ha, which is only slightly larger than the NSW average of 189 ha in 1996–97 (ABARE 2000).

The soil and climate of the Lachlan catchment can support a diverse range of annual and perennial broadarea and horticultural crops. A number of grain crops and small seed crops were identified by Benson and Associates (1997) as having potential in the Lachlan Valley, including adzuki beans, faba beans, jojoba, maize, mung beans, mustard, sesame seed, seed production and soybeans. Rice is currently being grown in the mid-catchment.

Benson and Associates (1997) suggested the deciduous stone fruit industry (cherries and apricots) should be further developed, especially where new varieties or climatic considerations give the catchment a marketing edge. Olives are well suited climatically to the Lachlan catchment.

According to NSW Agriculture and Fisheries Division of Plant Industries (1990), the area is ideally suited to production of a wide range of vegetables. Either the farming of vegetables such as sweet corn, asparagus, broccoli and lettuce for the export market and glasshouse quality tomatoes, capsicums and potatoes could be introduced or existing enterprises expanded.

The irrigation industry is limited by competitive pressure in the marketplace, lack of organisational planning, expertise and associated infrastructure investment and recognition that some landowners lacked the incentive or motivation to adopt new technologies or cropping practices, according to Benson and Associates (1997).

The agricultural consultants McGowan International (1996) suggest that the high security of supply and the lack of highly profitable crops, combined with an old irrigation system, give rise to large operational losses.

In the Young area, cherry production is limited by lack of water (NSW Agriculture & Fisheries Division of Plant Industries 1990). Construction of farm dams and the refinement of irrigation management are needed to increase the security of investment in the district.

As with many of the irrigation areas and districts in NSW, Jemalong Irrigation is affected by shallow watertables and associated salinisation (Anderson & Gates 1994).

[9] Broadare farms are all farms that grow crops such as cereals, oilseeds, cotton and pasture. Fruit and vegetable crops are not included in this definition.

A Land and Water Management Plan has been developed to help control this degradation.

Of added concern is the predicted increase in river salinity in the catchment. The average river salinity of the Lachlan River is expected to increase from 530 Electrical Conductivity (EC) units in 1998 to 1460 EC units in 2100 (MDBMC 1999). This will have consequences for irrigation in terms of increased foliar burning from applied river water and increased soil salinisation. As salinised river water is applied to soil, water will either evaporate or enter the soil and be used by the crop. With inadequate leaching, salt will accumulate in the soil[10].

The available irrigation data for the catchment is summarised in Table 5. This matrix demonstrates a considerable lack of data across all categories, especially relating to total water use, crop water use and irrigated yields.

[10] The impact of different soil salinity and water salinity on the yield of irrigated crops is detailed in the Food and Agricultural Organisation (FAO) publication number 24 (Doorenbos and Pruitt 1977).

Table 5. Summary of irrigation data in the Lachlan catchment

Year July to June	Number enterprises irrigating [a]	Total irrigated area (ha) [a]	Area of pasture irrigated (ha)	Total water used by irrigated agriculture (ML)	Total water used on cereals (ML)	Yield of pasture (t/ha) [c]	Value of irrigation ($ m) [d]	Value of pasture ($ m) [d]
1988–89	-	-	-	-	-	-	-	-
1989–90	-	-	-	-	-	-	-	-
1990–91	-	-	-	-	-	-	-	-
1991–92	-	-	-	-	-	-	92	34
1992–93	-	91 423 [e]	-	-	-	-	106	36
1993–94	678	112 041 [a]	67 904 [a]	-	-	-	120	39
1994–95	-	-	-	-	-	-	103	43
1995–96	426	66 012 [a]	-	-	-	-	150	44
1996–97	515	81 836 [a] 78 122 [e]	40 388 [a] 37 394 [e]	*est. 444 400 –477 000* [b]	-	3	165	36
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to section	5.3	5.4	5.4	5.4	5.4	5.6	5.7	5.7

[a] *ABS 1998 ② Estimated Value of Agricultural Operations (EVAO) – $5,000*[11]

[b] *regulated use data taken from DLWC (2001a) ① and DLWC (2001b) ①, unregulated use data taken from DLWC 1998a④ and groundwater use data taken from WRC (1980) ③*

[c] *Paul Lukins*[b] *pers. comm. ④.*

[d] *Donovan 2000 ③. Pasture values are the aggregation of the pasture and grasses, livestock slaughtering and livestock product values.*

[e] *National Land and Water Resources Audit 2002 ②*

[11] Only years where the ABS used an EVAO of $5,000 have been compared. See page 9 for definition of EVAO.

5.2 Number of licences (all sources)

There were 1616 licences with the purpose of irrigation in 1999 in the Lachlan catchment. This figure was determined by summing the following data:

- 843 irrigation licences for extraction of water from regulated surface supplies (DLWC 1999b)①
- 317 irrigation licences for extraction of water from unregulated rivers (DLWC 1999b)①
- 456 irrigation licences for extraction of water from groundwater aquifers (G Lennox, pers. comm. – from the DLWC's Licence Administration System ①)

This estimated figure may be lower if one discounts the 178 conjunctive irrigation licences.

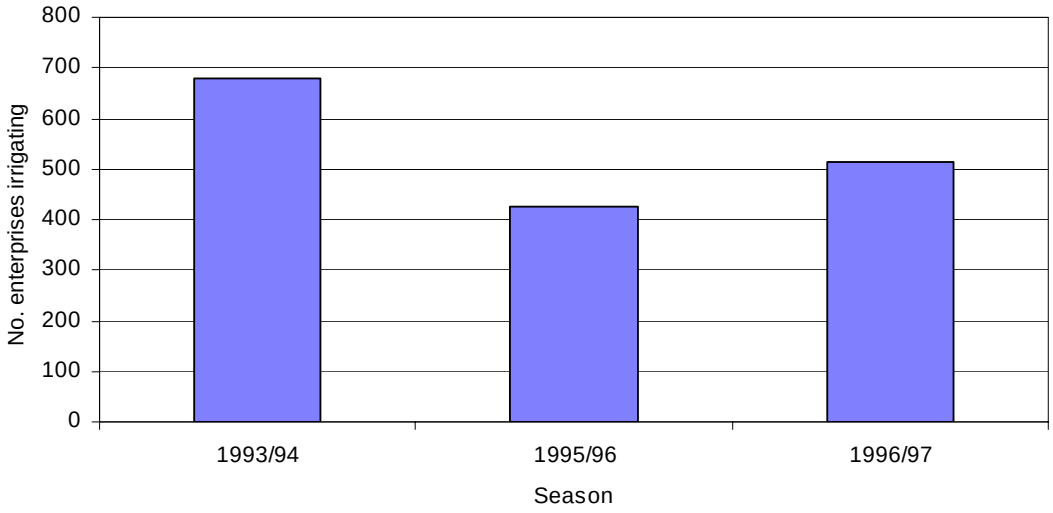
Licences extracting water from the regulated system are volumetric-based and exist mostly downstream of Wyangala Dam and downstream of Carcoar Dam on the Belubula River. Licences on unregulated streams exist upstream of the dams (along the Abercrombie, Lachlan and Belubula rivers) or along the unregulated tributaries of the Lachlan River (Boorowa River). These were converted from area-based to volume-based in 2000 (DLWC 2000c). Most of the groundwater licences exist in the upper Lachlan catchment and are volume-based.

5.3 Number of enterprises irrigating (all sources)

There were 515 enterprises irrigating crops in the Lachlan catchment in 1996–97 and 28% of these were in the SLA of Forbes (Appendix 14.4) ② while a further 14% were in the SLA of Lachlan.

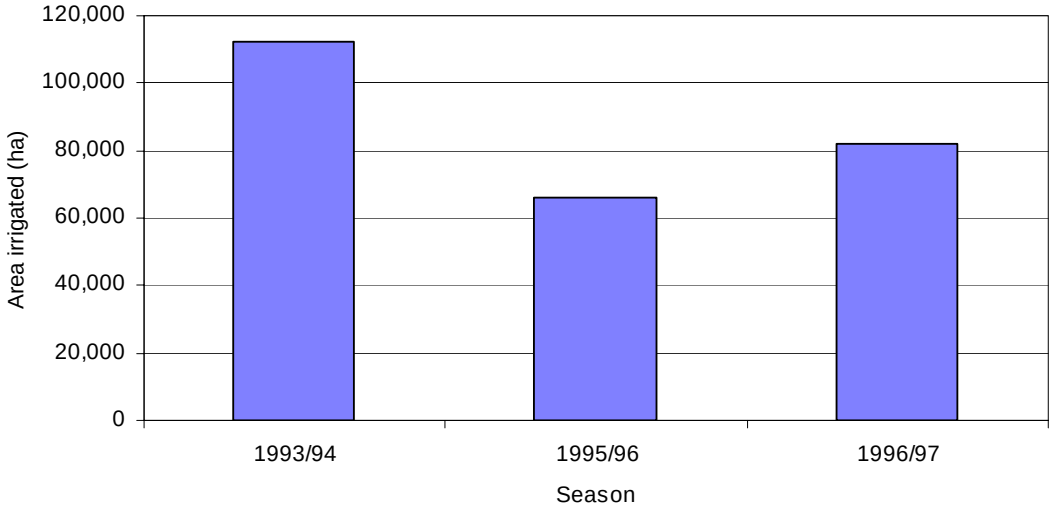
According to ABS figures, the total number of enterprises fell between 1993–94 and 1996–97 (Figure 5). More specifically, large drops (greater than 50% of the 1993–94 figure) occurred in the SLAs of Bland, Parkes, Blayney Pt A, Gunning and Temora (ABS 1998)② (Appendix 14.4)②. This trend was reported to a greater or lesser extent in most SLAs across the State and should be treated with caution. The allocation from the dams was similar for 1993–94 and 1996–97 (Appendix 14.5) and one would therefore expect the number of enterprises not to have changed greatly.

Figure 5 Number of enterprises irrigating in the Lachlan catchment (all sources)



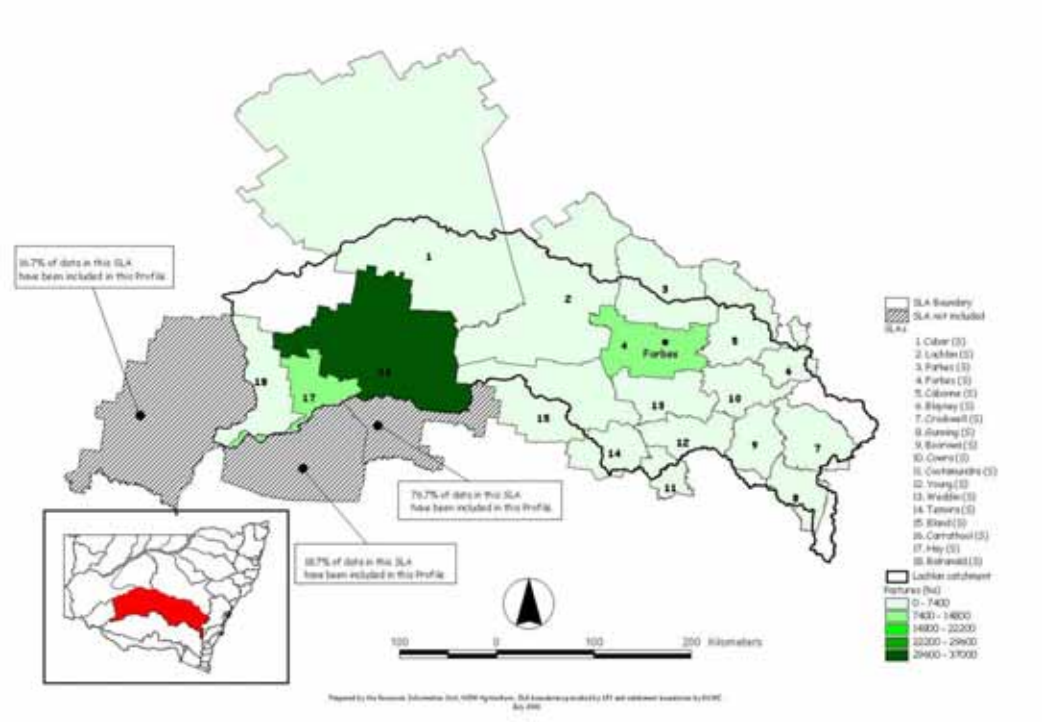
Source: ABS 1998 ②

Figure 6 Area irrigated in the Lachlan catchment (all sources)



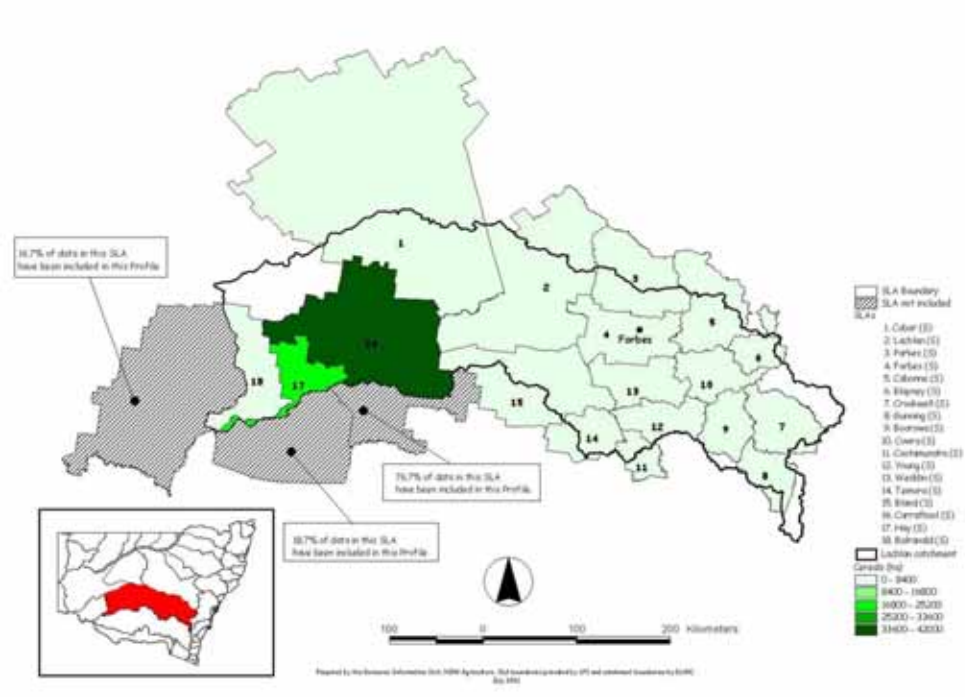
Source: ABS 1998 ②

Figure 7. Area, irrigated pasture in the Lachlan catchment (1996–97)



Source: ABS 1998 ②

Figure 8 Area, irrigated cereals in the Lachlan catchment, 1996–97



Source: ABS 1998 ②

5.4 Area irrigated and water used (all sources)

Area irrigated – The area irrigated from all sources of water decreased over the period between 1993–94 and 1996–97 from 112 041 ha to 81 836 ha (ABS 1998)② (Figure 6). Again, this drop in area is questionable for the reasons noted in Section 5.3. Where references could be compared, figures were generally close (see 1996–97 figures in Table 5).

Pasture is the dominant irrigated crop in the Lachlan catchment and is grown right along the river (Figure 7). Pasture is irrigated mostly in the SLAs of Carrathool, Forbes and Lachlan (Appendix 14.6) and, according to ABS figures, decreased in area between 1993–94 and 1996–97 from 67 904 ha to 40 388 ha (ABS 1998)②. Where references could be compared (see 1996–97 in Table 5), figures were generally close.

Irrigated cereals (Figure 8) were the next largest irrigated crop category in the catchment. Between 1993–94 and 1996–97, cereal irrigated areas dropped from 31 814 ha to 29 894 ha (Appendix 14.6), representing a much smaller decline than pasture. The cereal area irrigated actually increased in some SLAs: see, for example, Carrathool, Lachlan and Hay (Appendix 14.6).

Water use – It was not possible to determine accurately the total volume of water used by irrigated agriculture in the catchment. The volume used by irrigation in 1996–97 was either 444 400 ML or 477 000 ML and was estimated by summing the following information:

- 424 400 ML (DLWC 2001a)① or 457 000 ML (DLWC 2001b) ① used from the regulated system in 1996–97 (data available since early 1980s),
- 3800 ML (DLWC 1998a)④ from the unregulated system from 1989–90 to 1991–92, and
- 16 200 ML (WRC 1980)③ from groundwater systems (data only available for 1980).

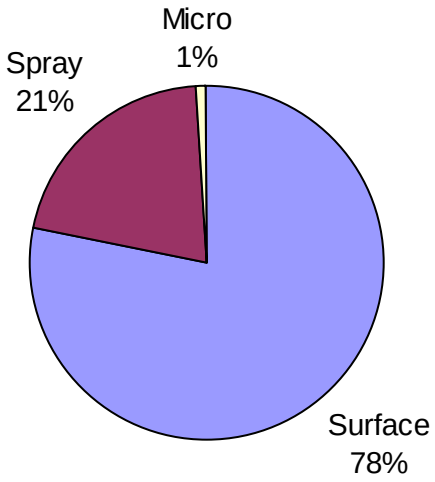
Volumes extracted from farm dams and reticulated water supplies are not known but likely to be very small.

Depending on climate, this total volume extracted by irrigation could vary considerably. For example, volumes used by irrigation from the regulated system have ranged from 232 000 ML to 456 000 ML over the last decade.

5.5 Irrigation methods (all sources)

The most recent ABARE survey (1998) shows that approximately 91% of irrigated crops in NSW are watered using surface methods. This proportion is only slightly greater in the Central West area, which is the amalgamation of the Lachlan and Greater Macquarie catchments (Appendix 14.9) ③. Other information shows that the percentage of surface irrigation could be much less than this. For example, data from the Lachlan regulated system suggest that surface methods comprise only 78% (Figure 9) (see Section 6.6).

Figure 9. Irrigation methods used by enterprises dependent on the regulated water supply of the Lachlan catchment



Source: DWR 1996②

5.6 Irrigation yields (all sources)

Information on irrigated yields based on water from all sources is scant, and most data were obtained through unpublished estimates from NSW Agriculture staff (Appendix 14.8) ④, or from the 1996–97 ABARE survey. Yields for these crops are summarised in Table 6.

Figures for annual pasture appear to be very low when compared with data from other catchments. Lachlan catchment estimates suggest average yields of 3 t/ha with minimum and maximum yields of 2 t/ha to 4 t/ha respectively. Figures in the neighbouring Murrumbidgee and Murray catchments were estimated to have average yields of between 8 t/ha and 10 t/ha and minimum and maximum yields of 3 t/ha to 12 t/ha respectively (J Lacy, pers. comm., and P Beale, pers. comm.).

ABARE yields for irrigated lucerne (3.8 t/ha on average) also appear to be low. In the Hunter region, average lucerne yields were 11 t/ha and ranged between 5 t/ha and 20 t/ha (C Rose 1999, pers. comm.).

Table 6. Yields from irrigated crops in the Lachlan catchment

Crop	Average (t/ha)	Minium (t/ha)	Maximum (t/ha)	References and reliability rating
Cereals				
Barley	2.3			ABARE 2000 [a] ③
Grain sorghum	4			ABARE 2000 [a] ③
	6	4	8	pers. comm. Paul Lukins[b] ④
Oats	0.9			ABARE 2000 [a] ③
	3	2	4.5	pers. comm. Paul Lukins[b] ④
Wheat	3			ABARE 2000 [a] ③
	3.6	2.4	5.5	pers. comm. Paul Lukins[b] ④
Maize	8	6	15	pers. comm. Paul Lukins[b] ④
Millet	1.5	1	2.5	pers. comm. Paul Lukins[b] ④
Oilseeds	1.8			ABARE 2000 [a] ③
Canola	1.6	1.3	2.7	pers. comm. Paul Lukins[b] ④
Soybeans	1.9	1.2	2.9	pers. comm. Paul Lukins[b] ④
Sunflowers	1.8	1.4	2.8	pers. comm. Paul Lukins[b] ④
Grain legume	1.7			ABARE (2000) [a] ③
Pasture				
Annual	3	2	4	pers. comm. Paul Lukins[b] ④
lucerne [b]	3.8			ABARE (2000) [a] ③
	7	4	12	pers. comm. Paul Lukins[b] ④
Hay and silage production	7.8			ABARE (2000) [a] ③
Vegetables	3.6	2.4	5.5	pers. comm. Paul Lukin[b]④

*a. Values are for the Central West area, which is the amalgamation of the Lachlan and Greater Macquarie catchments. Yield of a **crop** was calculated by dividing tonnes produced (t) by area (ha) and the RSEs (%)[12] for these values were: **barley** - 24, 26, **grain sorghum** 53, 53, **Oats** t 20, 20, **wheat** 12, 11, **Oilseeds** t 29, ha 30, **Grain legumes** 62, 59, **lucerne** 21, 22, **Hay & Silage** 18, ha 33. [b] Data taken from Hope (1999).*

[12] The Relative Standard Error or RSE is the standard error divided by the actual data value. The result is dimensionless. The RSE shows how big the standard error is as a proportion of the actual data value.

5.7 Value of irrigated production (all sources)

Irrigated agriculture produces around 15% of the total value of production in the Lachlan catchment. Of the $981 million② produced in 1996–97 from all types of agriculture, $165 million (17%) could be attributed to irrigation alone (Donovan 2000)③. Irrigation values as a percentage of total agricultural values (irrigation plus dryland agriculture) have ranged from 15% to 17% of the total value over most of the last decade (Figure 10). The total value of irrigation has increased from $92 million to $165 million between 1991–92 and 1996–97.

These irrigation values from Donovan should be treated with some caution as they are derived synthetically (Donovan 2000) ③. The individual irrigated commodity values for Australia were determined by estimating the percentage of the total commodity value that could be attributed to irrigation. The irrigated percentage was determined from numerous agency reports and wide consultation with industry bodies (DWC 1990). These individual commodity percentages were then applied to the total NSW commodity value data from the ABS for each SLA over the period between 1991 and 1997 (Donovan 2000) (②[13]). It should be noted that there are no data since 1996–97 from Donovan. The reason for this is that the ABS ceased collecting information by SLAs and, as a result, methodologies that relied on SLA data such as those of Donovan could no longer be used.

These estimated irrigated commodity values were then summed to provide synthetically generated estimates of the total value of irrigated agriculture for each catchment. The reliability of the estimated percentage value for individual commodities may vary from crop to crop. For example, grape values are more likely to be reliable than wheat values. This is because grapes are usually irrigated with high-security water that helps to ensure yields and areas remain reasonably static. Cereal areas and yields can, by comparison, vary markedly with climate and water availability. The overall reliability rating for these data is ③ [14].

Cereals (maize, wheat, oats, barley) are the most valuable irrigated crop in the catchment. Of the total value of irrigated agriculture ($165 million), nearly 30% ($48 million) was generated from irrigating cereals ③ (Appendix 14.10). Cereal values have been fluctuating each season and have ranged from $12 million to $47 million over the period between 1991–92 and 1996–97 (Donovan 2000)③.

The total value of products dependent on irrigated pasture was estimated to be $36 million (1996–97). This figure was determined by summing the following information:

- pasture and grasses – $9 million
- livestock products – $16 million
- meat – $11 million

[13] These data have not been manipulated by Donovan and receive a reliability rating of ②.

[14] These data have been manipulated by Donovan and receive a lower reliability rating accordingly.

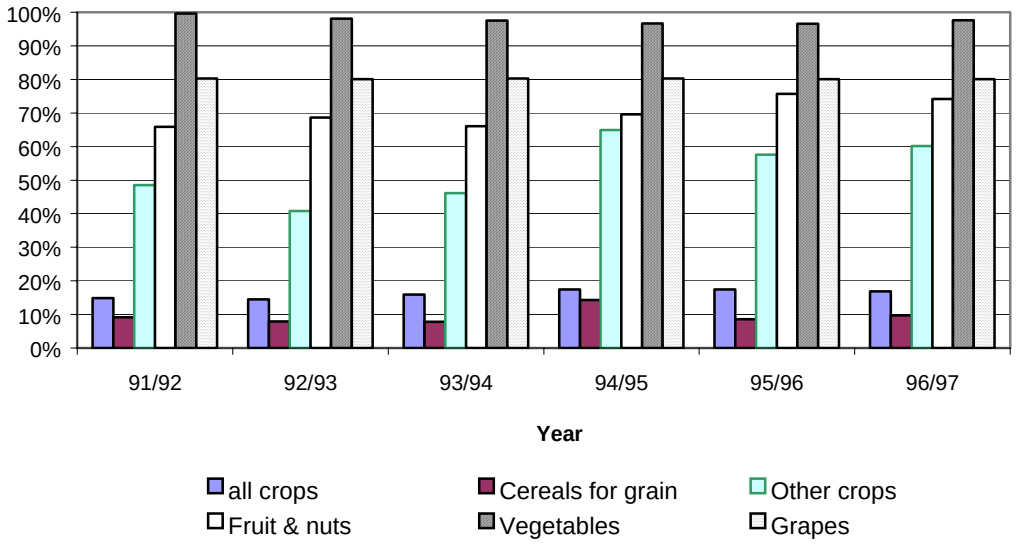
The figure may be overestimated slightly if one considers that dairy cows and cattle for meat may be fed on fodder crops such as oats, sorghum and wheat as well as pasture. Putting this aside, irrigation from pasture and grasses generates significant income in the catchment. A summary of figures is shown in Table 5.

Other crops (field peas, chickpeas, lupins, nursery production, canola, soybean, sunflowers and cotton) were the next most valuable irrigated category in the Lachlan catchment totalling $33 million (Figure 11). Cotton produced $0.8 million, and has probably risen in value since 1996–97, given that the volume of water used on cotton has increased considerably. The 'other crops' category were closely followed by irrigated fruit and nuts (excluding grapes)($23 million) and vegetables ($21 million) (Figure 11). Fruit and nuts (excluding grapes) decreased in value between 1994–95 and 1995–96 and then recovered in 1996–97 (Appendix 14.10) ③. Values were adversely affected in 1994–95 by drought and water shortages (IBIS 2000b). Despite apparently favourable seasonal conditions across NSW in 1995–96, values remained low (Appendix 14.10). In comparison, vegetable values increased every year between 1991–92 and 1995–96, stabilising in 1996–97 (Appendix 14.10). This increase in value occurred despite drought conditions in 1994–95 (IBIS 2000a).

After vegetables, grapes were the next most valuable crop, followed by crops for hay (Figure 11).

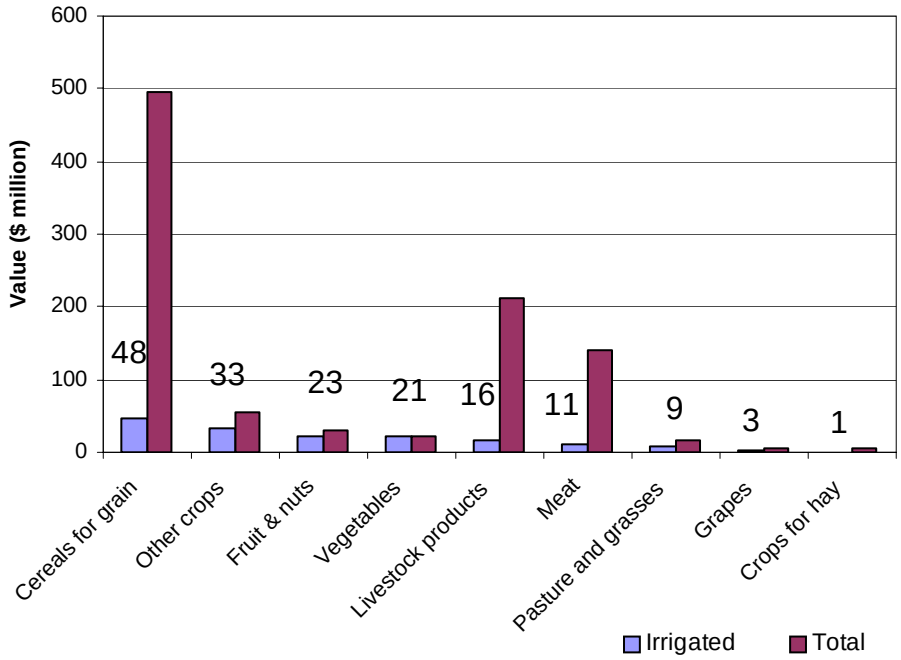
Individual commodity data (for example, broccoli or wheat) are available by category from Donovan (2000)③. For example, included in the total value of pasture and grasses ($9 million) was lucerne with a value of $6 million. See Donovan (2000) for further information.

Figure 10.Total value (%) of agriculture that can be attributed to irrigation in the Lachlan catchment



Source: Donovan (2000) ③. 'Other crops' includes cotton, oilseeds, legumes, nurseries.

Figure 11. Value of commodities produced from irrigated agriculture compared with that from all agricultural practices



Source: (Donovan 2000) ③ 'Other crops' includes cotton, oilseeds, legumes and nurseries. Irrigated values are labelled.

6. IRRIGATION FROM REGULATED RIVERS

6.1 About the regulated water supply

Most irrigation in the Lachlan catchment is dependent on water from regulated supplies. Irrigation occurs right along the regulated section of the Lachlan and Belubula rivers and also in the off-river irrigation district (Jemalong Irrigation).

The Lachlan River is controlled by the Carcoar and Wyangala dams, which have a combined storage capacity of 1 256 000 ML.

- Wyangala Dam, on the Lachlan River, was completed in 1935 and then enlarged in 1960. The dam has a storage capacity of 1 220 000 ML.
- Carcoar Dam, located on Belubula River (a tributary of the Lachlan catchment), has been in operation since 1970 and has a storage capacity of 36 000 ML.

The Lachlan River is also re-regulated by Lake Cargelligo (36 000 ML) and Lake Brewster (153 000 ML) (DLWC 1998c). These natural lakes, which lie between Condobolin and Hillston, were modified between 1902 and 1954 respectively. Inlet, outlet and regulation structures and levees (EPA 1997) help to re-regulate the river.

Lake Cargelligo is the barrier to trade of permanent licences upstream and downstream. As such, licences below Lake Cargelligo cannot be traded upstream of Lake Cargelligo, and vice versa.

In addition to these re-regulating structures, there are numerous weirs including Jemalong, Willandra, Gonowlia and Torriganny (DLWC 1998c).

As a result of regulation, there has been a change in total flow at some points along the river. Prior to regulation, flows at Oxley (at the end of the controlled system) were 234 000 ML /y. Following the construction of the dams, flows are now 120 000 ML/y (EPA 1997). Average annual flows at Forbes have changed little as a result of regulation. The average annual flow at Forbes is 1 108 000 ML/y – under natural conditions, the flow was 1 057 000 ML/y.

Regulation has also changed the seasonal pattern of water flows. Prior to construction of the dams, natural stream flows were usually highest from late winter, early spring and lowest in late summer. Since regulation, stream flows are highest in summer and lowest in winter and spring. The dams operate by capturing water between April and August and then releasing this stored water during the irrigation season (September to March).

In response to declining river health and the erosion of security of supply for existing irrigators, the Murray-Darling Basin Ministerial Council (MDBMC) introduced a cap on the diversion of water from the Basin's river systems. The Murray-Darling Basin Initiative aims to promote and coordinate effective planning and management for the

equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin.

The long-term cap average for the Lachlan catchment is estimated to be 339 000 ML and over the period between 1997 and 2000, total diversions have not exceeded this volume (D Barma, pers. comm., from the Licence Administration System).

The figures provided Table 7 summarises the data presented in this section.

Table 7. Summary of irrigation data (regulated system)

Year[15]	No. enterprises irrigating	Total area irrigated (ha)	Pasture area irrigated (ha)	Total water use by irrigated ag. (ML)	Total volume of water used on pasture (ML) ②	Yield of pasture (t/ha)[e]	Value of irrigation ($m)	Value of pasture ($m)
1988–89	-	82 585[c]	-	-	-	-	-	-
1989–90	-	52 238[a] 88 571[c]	23 435[a]	222 328[a]	95 167[a]	-	-	-
1990–91	-	59 051[a] 80 929[c]	30 861[a]	232 850[a] 317 400[d]	109 289[a]	-	-	-
1991–92	-	65 100[a] 76 974[b] 77 250[c]	32 227[a] 32 995[b]	288 921[a] 329 812[b] 357 700[d]	132 203[a] 101 908[b]	-	-	-
1992–93	-	85 221[b] 86 432[c]	35 221[b]	361 564[b] 263 100[d]	108 456[b]	-	-	-
1993–94	423[f]	80 782[b] 80 822[c] 89 410[f]	33 600[b]	349 960[b] 273 800[d]	103 532[b]	-	-	-
1994–95	-	88 338[b] 88 211[c]	32 579[b]	418 578[b] 425 100[d]	111 001[b]	-	-	-
1995–96	-	83 718[b] 83 938[c]	23 089[b]	383 470[b] 374 000[d]	73 830[b]	-	-	-
1996–97	-	99 788[b] 95 145[c]	27 109[b]	456 884[b] 424 400[d]	85 373[b]	7.8	-	-
1997–98	-	94 335[b] 94 335[c]	28 619[b]	434 769[b] 405 500[d]	85 894[b]	-	-	-
1998–99	-	72 174[b] 72 174[c]	17 829[b]	394 900[b]	55 663[b]	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to section	6.4	6.5	6.5	6.5	6.5	6.7	6.8	6.8

[a] *DLWC 1998a ② (Appendix 14.11) – total area irrigated ②, total water used ①.*

[15] It should be noted that data for the Lachlan catchment are based on a July to June water year.

[b] *DLWC 2001b. A reliability rating of ② is given to total area irrigated, irrigated area and water used on pasture (summer and winter); For the total water used a reliability rating of ① is given[16] (see Appendix 14.12 for further details)*

[c] *Figure adopted from range of data including DLWC 1998b; DWR 1995; DLWC 1999a; DWR 1994, DLWC 1994 Circa and DWR 1989 ② (see Appendix 14.13)*

[d] *DLWC 2001a①*

[e] *ABARE 2000③. Hay and silage production.*

[f] *ABS 1998②*

Of note is the lack of information on the number of enterprises, irrigated yields and value of irrigation. In addition, there are multiple figures for some years, making it difficult for a person unfamiliar with the vagaries of each data-set to choose the most reliable.

6.2 Volumetric entitlement (regulated)

Total licensed entitlement for all extractive purposes (irrigation, stock and domestic, towns and industry) was 665 000 ML/y (DLWC 1999b) while the volumetric entitlement for irrigation was 611 700 ML/y (DLWC 1999b).

The volumetric entitlement has been provided for several sections of the Lachlan catchment (NSW Agriculture 1996) (Table 8)①. It should be noted that these figures show a higher total allocation to irrigation (619 500 ML) for 1993–94 than for 1998–99. Nearly 90% of the total volume is allocated to irrigators outside Jemalong Irrigation and around one-third has been allocated to the zone between Lake Cargelligo and Oxley.

[16] total area irrigated, pasture and lucerne area and water use receive a reliability rating of ② as these data were estimated by meter inspectors. Total water use receives a reliability rating of ① as these data were taken from metered information.

Table 8. Volumetric entitlement for irrigation for five zones in the Lachlan Catchment

Zone	Volumetric entitlement for irrigation (ML)	Irrigation entitlement as a percentage (%) of total entitlement
Wyangala Dam to Payten's Bridge	81 600	13
Payten's Bridge to Island Creek Off-take	106 900	17
Island Creek off-take to Lake Cargelligo	144 700	23
Lake Cargelligo to Oxley	206 300	33
JI	80 100	13
Total	**619 500**	

Source: NSW Agriculture (1996) ①

The volume supplied to irrigators includes general, high-flow and high-security irrigation licences. General security and high-flow licences are used to water annual crops such as lucerne and pasture while high-security licences are used to supply water to perennial crops such as citrus, grapes and stone fruit (NSW Agriculture & Fisheries Division of Plant Industries 1990). General security and high-flow licences receive water when and if it becomes available, whereas high-security licences receive the allocated water for permanent plantings every year. Due to variability in rainfall, the availability of water changes from year to year (Appendix 14.5). For example, for a general security licence holder, when the allocation is 80%, a grower will receive 80% of their entitlement.

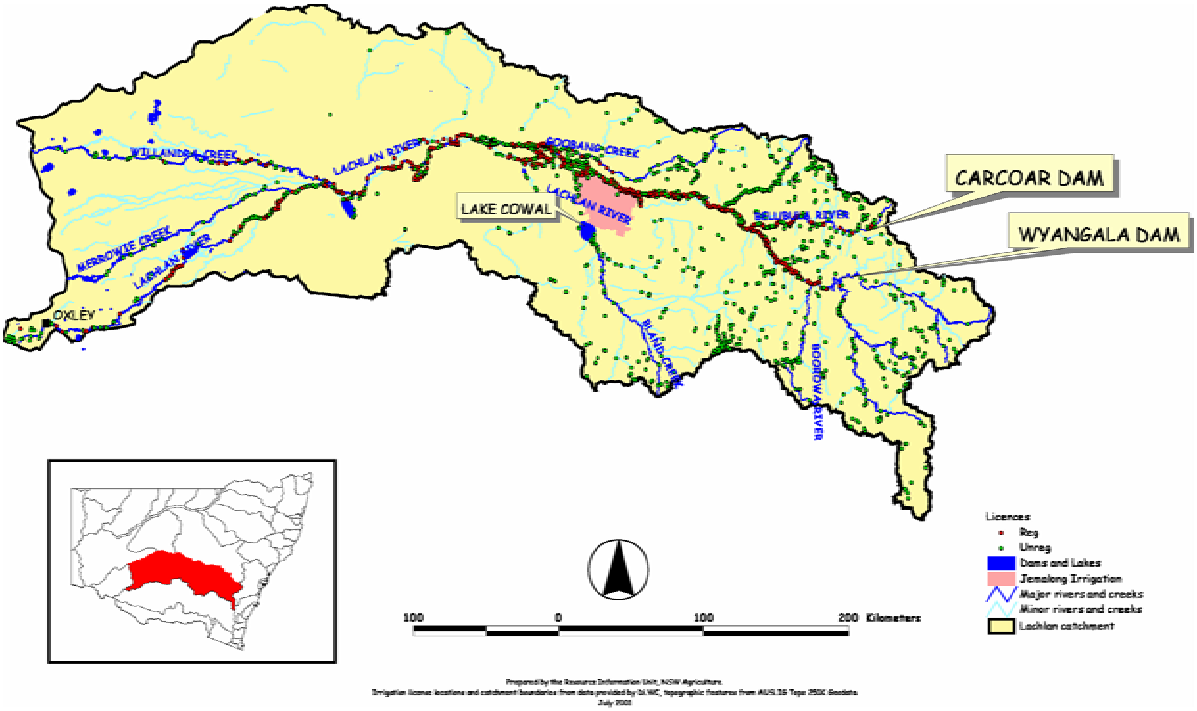
In 1999–2000, 8700 ML of off-allocation diversions for that season were used. The maximum off-allocation cap for the Lachlan catchment was 30 000 ML.

6.3 Number of volumetric licences (regulated)

There are 985 licences for all purposes in the Lachlan catchment and most of these (843) have a purpose of irrigation (DLWC 1999b)① (Figure 12). Around 70% of licences with a purpose of irrigation had a water use record (DLWC 1998a)[17], that is, had used water in any one year and then registered this use with DLWC.

[17] Not all licence details have been entered into the licence administration database. This data cannot be used to determine the number of sleepers and dozers each year and work is being carried out to rectify this problem.

Figure 12. Location of irrigation licences on regulated and unregulated rivers in the Lachlan catchment ①



6.4 Number of enterprises irrigating (regulated)

In 1993–94, the ABS conducted a survey to show how many irrigation enterprises were using water from different supplies. An estimate of 423 (ABS 1998)④ was determined by summing data from two ABS questions:

- channel/piped water from surface supplies in State irrigation schemes
- enterprises using water from rivers controlled by water boards or by resource commission dams

Note that the ABS questionnaire does not clearly differentiate between regulated and unregulated watercourses (Appendix 14.14). A respondent may mistakenly believe that a stream controlled by a water board is regulated. As noted in Section 3.2, a regulated watercourse is one that is controlled by a major government-owned rural dam only. The figures on irrigation from regulated watercourses from ABS may therefore be overestimated (see Table 7). See Appendix 14.15 for an indication of where these enterprises are irrigating.

The number of enterprises irrigating could also be determined from DLWC licence databases. However, this approach has many difficulties and was not attempted. Often one licence may be held by many irrigators, as for Surface Authorities for Joint Water

Supplies[18] (SA) or, alternatively, many single licences[19] (SL) may be held by one irrigator. In order to determine, for example, the area irrigated or volume use by an irrigator, the user must:

- amalgamate licences held by one owner using available contact details. This approach flounders where family members in an irrigation enterprise each own a licence or where licences are listed under different contact addresses.
- approach managers of SA licences to access private information about irrigators operating within a scheme. Access will be dependent on the development of trust and good relations between the user and provider and on the extent to which these data have been collected and recorded.

6.5 Area irrigated and water used (regulated)

Area irrigated – An average of 85 000 ha of land was irrigated annually in the Lachlan catchment from regulated supplies between 1988–89 and 1998–99. Areas ranged from a low of 72 000 ha (1998–99) to a high of nearly 100 000 ha (1996–97) (Table 7).

Where comparisons between references could be made, data were generally close, with the exception of information from the late 1980s and early 1990s (Table 7). Reasons for these differences are not known.

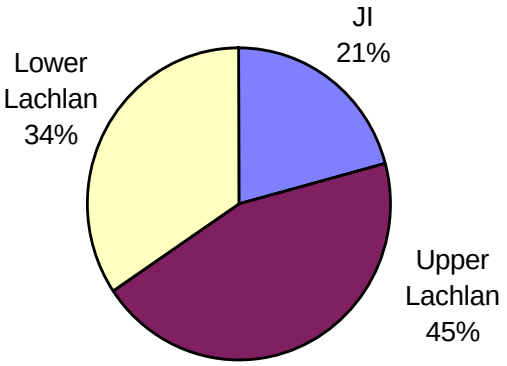
The total area figures in Appendix 14.13 and shown in Table 7 were the adopted numbers taken from a series of five data-sets collected by DLWC on the area irrigated in the catchment. Confusion can arise where there is more than one data-set for a single variable sourced from within the same agency.

Around 79% of the area irrigated in the catchment can be attributed to growers irrigating land outside JI (Figure 13). The remaining 21% occurs inside.

[18] A Surface Authority for a Joint Water Supply (SA) is one licence which supplies a group of farmers. These schemes are private and have no board of management.

[19] A Single Licence supplies water to one property.

Figure 13. Area irrigated in each zone in the Lachlan catchment as a proportion of the total area irrigated (1998–99)



Source: DLWC (2001b)

In 1989–90, pasture (summer and winter) had one of the largest irrigated area representing either 26% or 44% of the total area irrigated, depending on which reference for total area was used (Table 7). By 1998–99, this percentage had dropped to 25% of the total area irrigated (Table 7) (Appendix 14.12).

Cereals (summer and winter) represented around 26% of the total area irrigated from regulated supplies in the catchment in 1998–99. Following cereals, oilseeds and then orchard crops and vegetables were the next largest crops irrigated (Appendix 14.12).

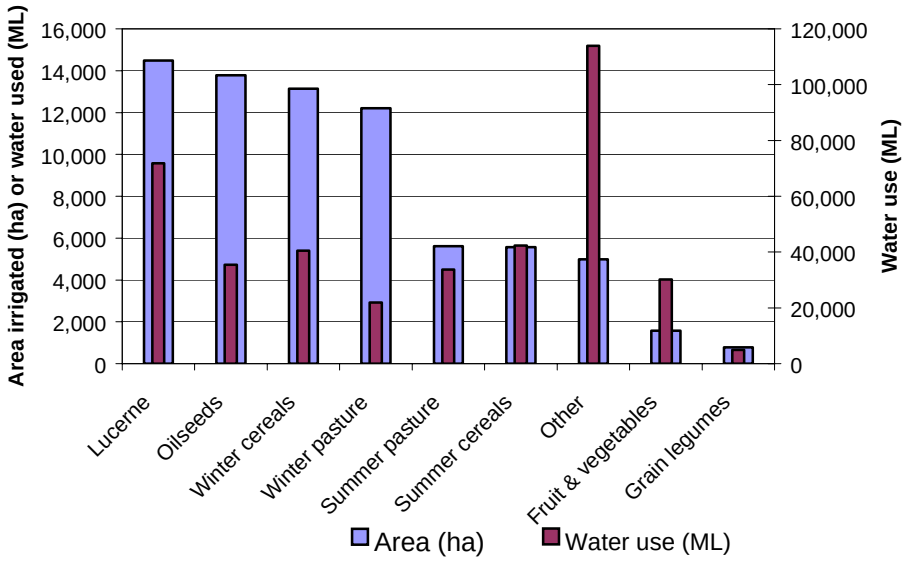
Water use The average yearly extraction by irrigation between 1991–92 and 1997–98 was estimated to be either:

- 390 719 ML (DLWC 2001b)①, or
- 360 500 ML (DLWC 2001a) ①.

(See Table 7 for further details.) Reasons for this difference are not known. Depending on which average total volume is used, this represents either 64% or 59% of the entitlement to irrigation in the Lachlan catchment. Irrigators along the river use approximately 80%, while 20% of the water is used in JI.

Summer and winter pasture consumed around 100 000 ML of the total volume extracted by irrigators in the early 1990s (Table 7). By 1998–99, the volume had dropped significantly to around 56 000 ML (Table 7). A significant proportion of the water extracted from regulated supplies is now used on cotton. In 1991–92, 6972 ML were used, while in 1998–99, 97 316 ML were used (Appendix 14.12). By 1998–99, cotton accounted for most of the volume of water shown under the 'other crop' category inFigure 14. The remaining water was used on crops such as oilseeds, cereals, orchards and vegetables.

Figure 14. Crop area irrigated (ha) and crop water use (ML) in the Lachlan catchment (regulated), 1998–99



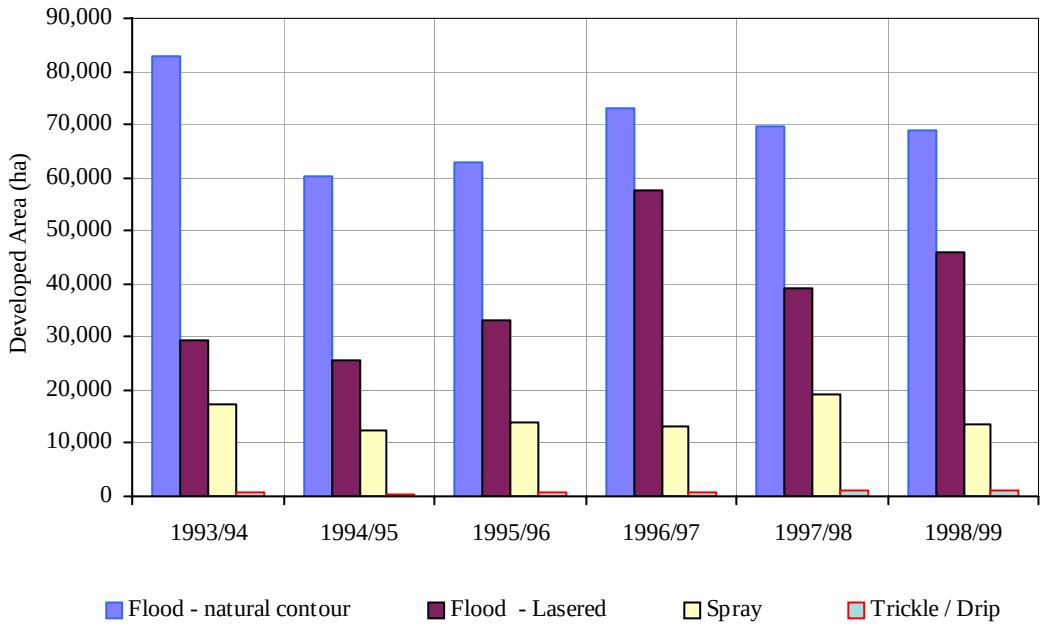
Source: DLWC (2001b)

6.6 Irrigation methods (regulated)

The Lachlan catchment has the most comprehensive data-set on irrigation method for regulated supplies in the State. Generally, surface irrigation predominates in the catchment (Figure 15). The data in Figure 15 show a decrease in the lasered area. Laser levelling grades a paddock to a specific slope: given that this practice is a significant expense to the farmer, and returning land to its natural contour would be ridiculous and probably impossible, the decrease is most likely due to a survey methodology problem. The data show that, in 1994–95:

- Surface irrigation was the dominant method of irrigation along the Lachlan River between Wyangala Dam and Lake Cargelligo (Figure 16).
- Spray irrigation was the dominant method of irrigation along the Belubula River (Figure 16).
- Very little micro-irrigation occurred in the Lachlan catchment (Figure 16). Micro-irrigation was practised between Lake Wyangala and Lake Cargelligo, where most of the cherries and wine grapes are grown. Other sources suggest that micro/drip irrigation occurs right along the Lachlan and Belubula rivers (M Robbins, pers. comm.). The use of these micro-irrigation systems has increased since 1994–95 when the data in Figure 16 were collected (G Markwick, pers. comm.).

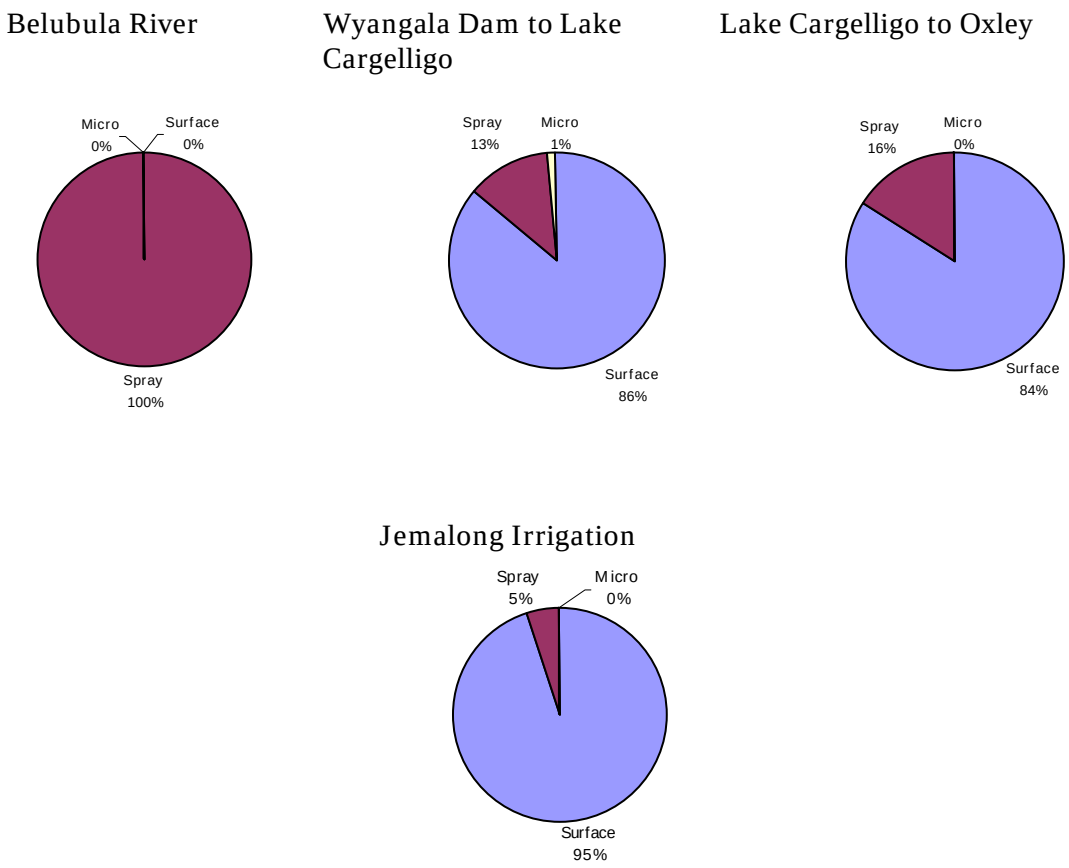
Figure 15. Irrigation methods used in the Lachlan catchment



*Source: DLWC (2001b)*②

For details on irrigation methods for crops in the Lachlan catchment, see Appendix 14.16. The crops with the largest irrigated area (pasture and lucerne) were predominantly irrigated by surface methods (DLWC 2001b)②.

Figure 16. Irrigation methods by river section in the Lachlan catchment in 1994–95



Source: DWR 1996 in Whiteley et al., 1996

6.7 Irrigated yields (regulated)

There are no data specifically collected on the yields of crops irrigated from regulated supplies only. However, as irrigation in the catchment is mostly reliant on water from regulated supplies, the data provided in Section 5.6 can be used.

6.8 Value of irrigated production (regulated)

There are no data showing the total value of crops irrigated from regulated supplies only.

7. IRRIGATION FROM UNREGULATED RIVERS

7.1 About the unregulated water supply

Unregulated water supplies are an important source of water for the irrigation industry, especially in the upland region around Young where cherries and plums are grown.

There are numerous unregulated subcatchments in the hills of the upper Lachlan catchment and small tributaries feeding into the Lachlan River itself (see Appendix 14.17 for a list of these subcatchments). Water flow in these streams is highly variable: irrigated agriculture deals with this by building farm dams and accessing water from high flow periods or by supplementing river water with groundwater. Nearly all uncontrolled (unregulated) streams can stop flowing during dry times and around 20% of the licensed irrigators are prohibited from pumping during these no-flow periods (EPA 1997).

There have been some important changes over the last few years to the way unregulated streams are managed in the Lachlan catchment. As noted in Section 5.2, area-based licences were converted from area-basis to volume-basis in 2000 (DLWC 1999c). This conversion provides the basis for water sharing between licences within the catchment (see conversion rates provided in Appendix 14.7). Licence holders are now limited by a volume of water rather than an area and it is expected that this conversion will help to stimulate practices that improve water use efficiency.

Trade on unregulated rivers is very limited at present and is subject to interim guidelines introduced in December 1998 (DLWC 1999f). There is a cap on the provision of new licences, making it more difficult for new or developing industries to access water. These limitations are arising as major demands for water are emerging from new developments including vineyards, cherries and olives (DLWC 1999f).

Water sharing plans are being developed for each water source in the catchment. These plans will provide water users with rules that govern access to water in the catchment.

The data presented in this section are summarised in Table 9. Of note is the lack of information on number of enterprises irrigating, crop water use, yields and value of irrigation.

Table 9. Summary of irrigation data (unregulated)

Year	Number enterprises irrigating[c]	Total irrigation area (ha)	Area of lucerne irrigated (ha)	Total water used (ML)	Water used by lucerne	Yield of lucerne (t/ha)	Value of irrigation ($m)	Value of lucerne ($m)
1988–89	-	-	-	-	-	-	-	-
1989–90	-	918[a]	296 [a]	3 801[a]	-	-	-	-
1990–91	-	546[a]	218 [a]	2 716[a]	-	-	-	-
1991–92	-	1 011[a]	232 [a]	3 382[a]	-	-	-	-
1992–93	-	783[a]	259 [a]	3 957[a]	-	-	-	-
1993–94	438	2 116 [a] 2 330[b] 68 308[c]	795[a] 1 114[b]	1 851 [a]	-	-	-	-
1994–95	-	453 [a] 2 267[b]	262[a] 1 181 [b]	1 019 [a]	-	-	-	-
1995–96	-	2 596[b]	1 196 [b]	-	-	-	-	-
1996–97	-	2 533[b]	1 290 [b]	-	-	-	-	-
1997–98	-	2 576[b]	1 216 [b]	-	-	-	-	-
1998–99	-	2 223[b]	949 [b]	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to Section	7.3	7.5	7.5	7.5	7.5	7.7	7.8	7.8

a. DLWC 1998a ④. Data on irrigation from unregulated streams were collected by crop return survey. Not all growers returned the survey to DLWC and the figures above should be used as a guide only.

b. DLWC 2000b②

c. ABS 1998②

7.2 Number of licences with the purpose of irrigating

In 1999, the total number of licences for all purposes was 583 and the number that had an authorisation to irrigate land was 317 (DLWC 1999d)①.

7.3 Number of enterprises irrigating (unregulated)

As noted in Section 6.4, the ABS in 1993–94 surveyed enterprises irrigating directly from unregulated streams and from uncontrolled rivers or schemes.

These ABS data show that there were 438 enterprises irrigating from unregulated streams (see Table 9). Caution should be applied to these data. Based on information provided in Section 6.4, the wording of questions about regulated streams made it difficult to differentiate irrigation from unregulated and regulated rivers (Appendix 14.14). Therefore, this result could be an underestimate. For an indication of where these enterprises are, see Appendix 14.15.

The number of enterprises on unregulated rivers could be determined from licence information. However, as noted in Section 6.4, this was not attempted in this Profile.

7.4 Volumetric entitlement for irrigation (unregulated)

Conversion from area to volume is being finalised across the State and, as such, the total volumetric entitlement for the catchment is not yet available. A total of 6202 ha have been authorised for irrigation in the Lachlan catchment (DLWC 1999d)①.

7.5 Area irrigated and water used (unregulated)

Area irrigated – The area irrigated from unregulated water supplies ranged from 550 ha (1990–91) to 2600 ha (1995–96) between 1989-90 and 1998–99 (Table 9) (Appendix 14.18) ④. Data from DLWC (1998a)④ attract a low reliability rating and should be treated with caution. The information was collected by voluntary survey from irrigators across the catchment and, given that not all growers returned survey cards, these data are considered to be incomplete and should be used as a guide only.

Data from DLWC (2000b) ② are more reliable and complete and show that around 2500 ha were irrigated each year between 1993–94 and 1998–99 (Table 10) (DLWC 2000b)②. Landholders were required to return data to the DLWC in order to be eligible to convert their authorised area to an entitled volume.

Where data could be compared (see Table 9):

- the 1993–94 DLWC estimates were close. The ABS estimate, however, was approximately 34 times greater. Reasons for this high ABS figure are not known. The reliability of these ABS data are questionable when compared to DLWC information.
- the 1994–95 estimates were not close. Reasons for the difference are not known (Table 9).

The crop with the largest irrigated area was lucerne, followed by orchards and summer cereals. Most crops were stable over the period between 1993–94 and 1998–99 (Table 10) with the exception of wine grapes, which increased by over 600% in irrigated area. It should be noted that the area of grapes irrigated is still relatively small compared to other crops.

Table 10. Area of crops (ha) irrigated from unregulated streams in the Lachlan catchment

Year	1993–94	1994–95	1995–96	1996–97	1997–98	1998–99	Average
Lucerne	1 114	1 181	1 196	1 290	1 216	949	1 158
Trees - orchards	407	409	448	448	450	452	436
Winter cereal	351	262	403	298	347	128	298
Perennial pasture	77	130	103	127	185	96	119
Vegetables	146	95	108	105	107	105	111
Summer cereal	104	36	158	53	68	228	108
Annual pasture	87	79	55	74	65	50	68
Vines - wine grapes	20	30	41	47	84	94	53
Fodder	18	35	78	54	40	15	40
Pulses	0	0	0	0	0	100	17
Other	3	8	3	3	10	3	5
Nuts	3	4	4	4	4	4	4
Winter oilseeds	0	0	0	20	0	0	3
Cotton	1	0	0	10	1	0	2
Total	2 330	2 267	2 596	2 533	2 576	2 223	2 421

Source: DLWC 2000b

Water used – Data on water used by irrigation from unregulated streams in the Lachlan catchment and across most the State are poor.

Information on the total water used by licences was collected using crop return cards from 1989–90. However, this practice ceased in 1991–92. As noted above, these data attract a low reliability rating, as not all growers submitted survey cards to the DLWC.

These survey data show that extraction of water ranged from a low of 1000 ML to a high of 3800 ML (DLWC 1998a)④ (Appendix 14.18 and Table 9). There were no data collected on the total amount of water used on different crops and, therefore, the amount of irrigation water applied cannot be determined. Theoretical crop water requirements must suffice until better records can be obtained. See Appendix 14.7 for the long-term average irrigation requirements for crops in the Lachlan catchment.

7.6 Irrigation methods (unregulated)

Data were unable to be obtained on methods used to irrigate crops using water from the unregulated rivers of the Lachlan catchment (see Section 5.5 for details on methods used to irrigate crops from all sources of water). Given that most unregulated licences are located in the hilly country, spray and micro-irrigation is likely to predominate.

7.7 Irrigated yields (unregulated)

The yields of irrigated crops in the Lachlan catchment reliant specifically on unregulated rivers have not been recorded (see Section 5.5 for details on yields attained from crops irrigated using water from all sources).

7.8 Value of irrigated production (unregulated)

Data were unavailable on the value of irrigation dependent on unregulated systems in the Lachlan catchment.

8. IRRIGATION FROM GROUNDWATER

8.1 About groundwater supplies

There are large areas of land in the Lachlan catchment that have low salinity, high yielding alluvial aquifers. Irrigation is located mostly on alluvial aquifers, which consist of unconsolidated sediments deposited by the path of ancient rivers. Water from other types of aquifers such as fractured rock aquifers is generally used for stock supplies and tends not to be used for irrigation due to poorer water quality.

The DLWC has broken groundwater extraction into three areas: the Lower Lachlan area downstream of Lake Cargelligo, the Upper region upstream of Lake Cargelligo and the Belubula alluvium, around the Belubula River.

Lower Lachlan region – Downstream of Lake Brewster, a considerable store of groundwater is located and is used mostly for irrigation. In the mid 1960s, groundwater around the Hillston area was viewed as a source to be developed for irrigation (Woolley & Kalf 1981). As such, a large volume of water is entitled to be extracted from this region.

The unconsolidated alluvial aquifers in this region fan out to cover Hillston and the upper sections of Willandra Creek, Marrowie Creek and the lower part of the Lachlan River and are recharged directly from the Lachlan River. The depth of the alluvial band, which spreads out north to Condobolin, is 150m. In the alluvial fan west of Hillston, the deposit reaches a depth of 300m. Bores in this area yield up to 125 litres per second.

Upper Lachlan and Belubula region – Alluvial aquifers also exist along the Koorowatha Creek, the stretch of the Lachlan River between Cowra and Condobolin and the lower portion of the Mandagery Creek and the Belubula River (WRC 1980). These stores tend to be used predominantly for drinking supply rather than irrigation. Some groundwater extraction occurs along Burrangong Creek near Young and is used to water cherry orchards (EPA 1997).

A groundwater management plan is being developed for the Lachlan catchment and will include a set of performance criteria so that management can be reviewed and adjusted as necessary (DLWC 1998c).

Currently the NSW Government is developing a Groundwater Structural Adjustment Program for the Lower Lachlan groundwater system. The program aims to assist high-level groundwater users to adjust to reduction in groundwater access over the ten years of the water sharing plan through financial assistance and supplementary water.

Irrigation data presented in this section have been summarised in Table 11. This matrix demonstrates the lack of irrigation data across all categories.

Table 11. Summary of irrigation data from groundwater supplies in the Lachlan catchment

Year	No. enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of major crop irrigated (ha)	Total water used (ML)	Water used by major crop	Yield of major crop (t/ha)	Value of irrigation ($million)	Value of major crop ($million)
1988–89	-	-	-	-	-	-	-	-
1989–90	-	-	-	-	-	-	-	-
1990–91	-	-	-	-	-	-	-	-
1991–92	-	-	-	-	-	-	-	-
1992–93	-	-	-	-	-	-	-	-
1993–94	81	4223	-	-	-	-	-	-
1994–95	-	-	-	-	-	-	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	-	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to section	9.3	9.4	9.4	9.4	9.4	8.7	8.8	8.8

a. ABS 1998 ②

8.2 Licences numbers and allocation (groundwater)

There are 456 bores licensed for irrigation in the Lachlan catchment and approximately 70% of these exist in the upper catchment (including the Belubula River).

Although there are fewer licences in the Lower Lachlan, pumping capacities and the entitlement are larger (Table 12). It is not known how many groundwater licences are actually used each year in the Lachlan catchment. Nor is it known how many ghost licences there are, that is, groundwater licence at locations where there is no groundwater to extract. Nor are there data on how much water is used on crops.

Around 60% of licence holders have a base entitlement only, while the remainder have a conjunctive use licence (Table 12).

Table 12. Number of groundwater licences and the volumetric entitlement for irrigation in the Lachlan catchment

Licences	Number with base entitlement only	G'water base entitlement (ML)	Number with conjunctive licence	Conjunctive component entitlement (ML)	Total Number of bores	Total G'water entitlement (ML)
Upper Lachlan	214	80 788	95	42 782	309	123 570
Lower Lachlan	42	156 311	45	78 456	87	234 767
Belubula alluvium	22	11 289	38	7 694	60	18 963
Lachlan total	278	248 388	178	128 932	456	377 300

Source: G. Lennox, pers. comm.. ①

8.3 Number of enterprises irrigating (groundwater)

There are 81 enterprises irrigating using water from groundwater supplies in the Lachlan catchment (ABS 1998)② and most of these exist in the SLAs of Cowra, Forbes and Young (Appendix 14.15). These areas generally correspond to the high yielding, low salinity groundwater zones noted by the WRC (1980). There appear to be many more licences for irrigation that there are enterprises that irrigate. Based on these data, a single enterprise may own five or six groundwater licences.

Of this total number of enterprises irrigating from groundwater, 30% were in Cowra SLA, 21% were in Young SLA, and 20% were in Forbes SLA (Appendix 14.15). Irrigation enterprises using groundwater supplies are also found in Cabonne and Carrathool SLAs.

8.4 Volume entitled to irrigation (groundwater)

The total volume of groundwater entitled to irrigation in the Lachlan catchment is 377 300 ML and most of this is allocated to the Lower Lachlan region (Table 12). This is despite there being many more licences for irrigation in the Upper Lachlan region.

8.5 Total area irrigated and water used (groundwater)

Area irrigated – In 1993–94, the total area irrigated was 4223 ha (ABS 1998)② while in 1980 the estimated total area irrigated was 4000 ha. These figures concur with DLWC estimates, which suggest that, from a maximum of 100 000 ha of land which can be irrigated in the catchment, 4000 ha are regularly irrigated from

underground supplies (DWR 1989). Of this total area, 52% occurred in Carrathool SLA and 20% in Forbes SLA (Appendix 14.15) [11 and 20]. Irrigation using groundwater supplies also occurs in Cowra and Cabonne SLAs.

There were no data on crop areas irrigated using groundwater.

Water used – The volume of water extracted by irrigation from groundwater aquifers remains unknown, largely due to a lack of monitoring by the DLWC. Data from 1980 show that irrigation used a small volume of water in 1980 – about 16 200 ML (Appendix 14.19). The volume extracted from bores around Hillston in 1981 was around 5000 ML (Woolley & Kalf 1981).

There were no data on the volume of water used from groundwater on crops.

8.6 Irrigation methods (groundwater)

Data were unavailable on methods used to irrigate crops with water from groundwater supplies in the catchment (see Section 5.5 for details on irrigation methods used to irrigate crops from all sources).

8.7 Irrigated yields (groundwater)

There are no data showing the irrigated yields from groundwater supplies in the Lachlan catchment (see Section 5.6 for details on the yields obtained from crops irrigated using all sources).

8.8 Total value of irrigation (groundwater)

Data were unavailable on the value of irrigation dependent on groundwater supplies in Lachlan catchment.

[20] Data on the area irrigated from groundwater are available for other years (i.e. 1987, 1990, 1991) (ABS 1998), but were collected using different EVAOs. It is therefore not possible to use these data to show trends in the area irrigated over long periods of time.

9. IRRIGATION FROM FARM DAMS

9.1 About farm dam supplies

Farm dams that are used to supply irrigation in the Lachlan catchment can be found mostly in the hilly upland sections. These structures capture and store water from overland run-off or from streams. The volume of water available to an irrigator using water from farm dams may be increased by gaining access to groundwater supplies or to water from unregulated streams.

Important developments in policy relating to farm dams have occurred in the last couple of years. In the past, a dam of up to 7 ML could be built without needing to be licensed provided the water was used for non-commercial purposes. No allowance was made for the size of the property or for climatic variation. In addition, there was no restriction on the number of dams that could be built on a property. Part 10 of the Water Act 1912, which came into operation on 1 January 1999, created a Harvestable Right. This gives landholders the right to capture and use for any purpose 10% of the average regional yearly rainfall run-off for their property, regardless of the dam's purpose (DLWC 1999e). Harvestable rights are now addressed in Chapter 3, Division 2 of the *Water Management Act 2000*.

The irrigation data in this section have been summarised in Table 13. Once again, the table demonstrates the lack of information across data categories and over time.

9.2 Number of licences with the purpose of irrigation (farm dams)

These data are not available as farm dams are currently being licensed.

9.3 Number of enterprises irrigating (farm dams)

There were 96 enterprises using water from farm dams to irrigate crops in the Lachlan catchment (ABS 1998)② in 1993–94, most of these in the SLAs of Crookwell and Young (Appendix 14.18).

Table 13. Summary of irrigation data in the Lachlan catchment (farm dams)

Year	No. enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of major crop irrigated (ha)	Total water used (ML)	Water used by major crop	Yield of major crop (t/ha)	Value of irrigation ($m)	Value of major crop ($m)
1988–89	-	-	-	-	-	-	-	-
1989–90	-	-	-	-	-	-	-	-
1990–91	-	-	-	-	-	-	-	-
1991–92	-	-	-	-	-	-	-	-
1992–93	-	-	-	-	-	-	-	-
1993–94	96	4496	-	-	-	-	-	-
1994–95	-	-	-	-	-	-	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	-	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
see Section	9.3	9.4	9.4	9.4	9.4	9.6	9.7	9.7

a (ABS 1998) ②

9.4 Area irrigated and water used (farm dams)

Area irrigated – There were 4496 ha of land irrigated using water from farm dams (93-94) (ABS 1998)② and most of this land was located in the SLAs of Forbes, Cabonne and Young. In the Forbes SLAs, irrigation enterprises using on-farm storages may have mistakenly called these structures farm dams. These structures take water that is pumped from regulated rivers or from systems that capture drainage from irrigated paddocks and are not considered 'farm dams' using the DLWC and ABS definition (see Section 3.2 and Appendix 14.14). There are no data on the crops that are irrigated with water from farm dams.

Water used – The amount of water used by irrigated agriculture and the area irrigated from farm dams is not known.

9.5 Irrigation methods (farm dams)

See Section 5.5 for details on irrigation methods used to irrigate crops from all sources of water.

9.6 Irrigated yields (farm dam)

See Section 5.6 for details on irrigation yields obtained from crops irrigated using all sources of water.

9.7 Value of irrigated production (farm dams)

There are no data on the value of irrigated production from farm dams.

10. IRRIGATION FROM RETICULATED WATER SUPPLIES

10.1 About reticulated water supplies

Irrigation from reticulated water supplies (or town water supplies) is limited in the Lachlan catchment and mainly occurs in the SLAs of Young and Forbes. There were no data on how this water was used and the only year for which data were available was 1993–94.

10.2 Number of enterprises irrigating (reticulated)

There were four irrigation enterprises using water from reticulated supplies in the Lachlan catchment and two of these were in the Young SLA (ABS 1998) ②. Forbes and Cowra had one enterprise each.

10.3 Area irrigated and water used (reticulated)

Area irrigated – There were 31 ha of land irrigated using reticulated water supplies in the Lachlan catchment and 82% or 25 ha in the SLA of Forbes (Appendix 14.18) (ABS 1998)②. There were no data on what this water was used to irrigate.

Water used – There were no data on water used in total or by crop type.

10.4 Irrigation methods (reticulated) supplies

There were no data on the methods used to irrigate crops from reticulated water supplies.

10.5 Irrigated yields (reticulated)

There were no data on irrigation yields used to irrigate crops from reticulated water supplies.

10.6 Value of irrigated production (reticulated)

Data were unavailable on the value of irrigated agriculture dependent on reticulated water supplies.

11. OPPORTUNITIES AND ISSUES

11.1 Opportunities

11.1.1 Opportunities for data collection

Opportunities for improving the quantity and quality of irrigation data will arise as new water sharing rules are implemented. The opportunity exists to collect irrigation data at more useful scales and to enable a two-way flow of information between irrigators and data collecting agencies.

- **Information on irrigation will increase as water management committees measure change as a result of new water sharing rules.** As water sharing agreements are finalised and signed-off, accurate and reliable irrigation data will be needed to assess the impact of management rules on the environment and the irrigation industry. This will ultimately help to increase the base of knowledge regarding irrigation.
- **Volumetric conversion of area-based licences will lead to better information regarding usage of water from unregulated streams.** As a result of the conversion of licences from area-basis to volume-basis, users will no longer be billed on authorised area but on the actual volume used. Water use will therefore eventually be metered and recorded by the DLWC and this will improve knowledge about crop water use and patterns of extraction along the river system.
- **Reporting data at scales that are more useful to resource managers.** The opportunity exists to provide agencies and communities with data that can be aggregated to useful scales (river reach or subcatchment) through Geographic Information Systems. The challenge would be to continue to maintain data confidentiality (licence and enterprises information) while maximising data usefulness to resource managers.
- **Developing better data-sharing partnerships between government and irrigators.** Often data are collected from irrigators for agency requirements such as billing, operational and reporting purposes and are seldom returned to irrigators. The opportunity exists to return data to irrigators in useful formats that might potentially assist them improve farm water management and productivity.
- **Developing better data-sharing partnerships between agencies.** There is an opportunity to improve linkages between agencies such as NSW Agriculture and DLWC. NSW Agriculture irrigation extension efforts would benefit greatly from being able to easily access irrigation data from DLWC. Conversely, DLWC would benefit greatly from being able to easily access information about the irrigation industry, especially given the agency's lead role in implementing natural resource planning initiatives (for example, water sharing plans).

11.1.2 Opportunities for irrigated agriculture

Opportunities for irrigated agriculture in the Lachlan catchment will arise as water is liberated through water trading or increased WUE.

- **Trading water will help shift irrigation activity from low-value to high-value enterprises.** Gross margins for enterprises such as cotton are significantly higher than traditional low-capital irrigated agricultural commodities such as pasture and wheat (DLWC 1999f). Information on trading in other States (South Australia and Victoria) has already shown that water is moving from low-value to high-value enterprises. Available evidence suggests the same is occurring in NSW catchments (DLWC 1999f).
- **Development of agroforestry.** With salinity becoming an increasing concern in the catchment, the opportunity exists to develop an agroforestry industry. Deep-rooted perennial trees could be used to reduce localised shallow watertables, minimising salinity and at the same time produce income. Agroforestry has been investigated as a possible alternative industry for the Liverpool Plains area in the Namoi catchment where salinity and waterlogging are an issue (Powell 1995). Similar investigations may prove fruitful in the Lachlan catchment.
- **Improving WUE will help liberate water.** Improved farm water management will liberate water for expansion of existing enterprises or for trade.

11.2 Issues

11.2.1 Data issues

- **Scarcity of information about irrigation.** Since the implementation of water reforms and the development of water sharing plans, a much greater range of irrigation data are needed than are currently available (such as data on crop areas, crop water use, yield, value of production and irrigation methods). In the past, agency and community data needs were fewer and, therefore, fewer data were collected. For example, details of the volume of water extracted from regulated rivers were collected by the DLWC for billing, operation or reporting purposes from each licence holder. There were no requirements to record other information and as a result these data tend to be scarce.
- **Multiple data-sets for one variable.** There were multiple data-sets for total area irrigated and water used from regulated supplies. This makes it difficult for a user unfamiliar with the vagaries of each data-set to choose the more reliable source.
- **Scarcity of data at useful scales.** Natural resource managers involved in developing water-sharing plans require data at planning scales (river-reach or subcatchment). There is a scarcity of data at, or less than, these scales, particularly with respect to yield, irrigation methods and value of production. These data are typically collected by, or determined from, either the ABARE or the ABS. The difficulty with these datasets are as follows:

- ABARE reports data for the NSW Greater Macquarie and Lachlan catchments. This presentation is much larger than that required by, for example, water management committees. These data contain potentially useful information about yields and methods of irrigation but their value is limited at this large scale.
- The ABS has been collecting data on irrigation by SLAs for a number of years. The difficulty with these data is that they do not align well with catchment and subcatchment boundaries. Consequently, the area irrigated may be underestimated or overestimated depending on the SLA composition and its relationship with catchment boundaries. To reduce this problem in the Lachlan catchment, only 76.7% of the Carrathool SLA was included when calculating catchment totals.
- The ABS ceased collecting data by SLAs in 1996–97 and began collecting information by AER in 1997–98 (Table 2). These AERs often span many catchments and cannot be disaggregated into smaller units (catchments). This reduces the usefulness of data on the number of enterprises irrigating and area irrigated. Data from AERs were not included in this Profile.

- **Data about irrigators and irrigation enterprises are limited.** Due to the difference in ABS and DLWC definitions of regulated and unregulated water supplies, the number of enterprises using water from these water sources could not be determined.
- **Data reliability ratings need to be provided by data collection agencies.**The National Land and Water Resources Audit provides reliability ratings and metadata (data about the data) for public information. There is currently no systematic data rating system, nor is there a system of providing metadata to users. These conditions make it easy for users to inappropriately manipulate and analyse the data.
- **Collection strategies can limit data usefulness.** The ABS has collected irrigation data at three different EVAOs, or survey cut-off points, over the 13-year period between 1986–97 and 2000–01 (Table 2). This means that it is more difficult to show trends in the area irrigated or enterprise number. For example, changes in the area irrigated between 1992–93 and 1993–94 may be due to a change in the EVAO rather than an actual change in the area irrigated. Only data between 1993–94 and 1996–97 were compared in this Profile.

11.2.2 Issues for irrigated agriculture

- **Irrigated agriculture is limited by social and economic factors.** Benson and Associated (1997) and MGI (1996) identified limitations to the development of the irrigation industry as competitive pressure in the marketplace, lack of organisational planning, expertise and associated infrastructure investment; and a recognition that some landowners lacked the incentive or motivation to adopt new technologies or cropping practices. The Lachlan Research and Advisory Council

(LIRAC) provides an important function in assisting irrigators to develop efficient, productive and profitable irrigation enterprises (Smith 1988).

- **Water availability.** In the Young area, cherry production is limited by lack of water (NSW Agriculture & Fisheries Division of Plant Industries 1990). Construction of farm dams and the refinement of irrigation management are needed to increase the security of investment in the district.
- **Soil salinisation of agriculture lands.** Salinity is of concern in the JI and is the result of a combination of vegetation clearance and excessive irrigation. A Land Water Management Plan has been developed to combat this problem. The plan combines a mixture of agronomic and engineering options which aim to maximise groundwater use while minimising of recharge to shallow aquifers (Anderson & Gates 1994).
- **Water salinity from the Lachlan River is of concern to irrigation.** As salinity levels rise in the Lachlan River, the yield of irrigated crops dependent on this water may be affected.
- **The development of new industries may be limited by access to water.** Trade on unregulated rivers is very limited at present and is subject to interim guidelines introduced in December 1998 (DLWC 1999f). There is also a cap on the provision of new licences, making it more difficult for new or developing industries to access water. Major demands for water are emerging from new developments such as cool-climate vineyards, cherries and olives (DLWC 1999f). For example, access to water has been noted as a factor that will limit the development of the olive industry nationally (RIRDC 1998).

  The growth of these enterprises will be dependent on the market for water, and increased trading will depend on the completion of:

  - a validation and risk assessment process
  - conversion of unregulated water licences to a volumetric basis so that there is a more effective basis for controlling access to different levels of river flows and a suitable 'currency' for trading. With the conversion of licences on unregulated rivers from area to volume-basis, inactive licences received the lowest annual entitlement (DLWC 2000c). There is some concern that there may not be enough inactive water for trade and that this may in turn stifle the development of new industries.
  - the development of appropriate river planning arrangements that, among other things, link water-trading rules with agreed river flow and water quality objectives (DLWC 1999f).
- **There is concern that trading from regulated to unregulated systems could reduce security of entitlement in the regulated system.** Users on regulated streams are resisting trading upstream to support the development of these new industries, as this would reduce regulated supply water security (DLWC 1999f). In the Lachlan catchment, permanent trading downstream and upstream of Lake Cargelligo limits the capacity of new and existing enterprises to access water.

12. SUMMARY

The most attainable and reliable information on irrigation in the Lachlan catchment related to the regulated river system. Information on irrigation from unregulated supplies was less forthcoming. For other sources (groundwater, farm dams and reticulated supplies) data were often either scarce or had never been collected.

This study highlighted various difficulties in obtaining information on irrigation in the Lachlan catchment and the need for a more comprehensive and consistent approach to the collection of irrigation statistics. Such an approach would help to ensure that data are comparable across different water sources and industries. The following aspects are needed to improve the situation:

- More comprehensive crop data (area, water used, irrigation method, yield and value) are needed to estimate WUE and IE.
- Protocols for provision of data to users are needed. For example, information providers need to attach reliability ratings to data to help users make better choices about the reliability and therefore the usefulness of the data.
- Two-way flow of information between agencies and irrigators needs to be fostered. Typically, data have been extracted from irrigators by agencies. These data need to flow back to irrigators in forms that might potentially assist them make better water management decisions. This would in turn, over time, improve the reliability of information.
- Data are needed at scales that are large enough to ensure confidentiality of individual enterprises but small enough to allow users to aggregate information to useful scales.

Finally, such a comprehensive approach can only be developed with the full involvement of the many irrigators, agencies and community groups that require these data.

SUMMARY

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ABS *see* Australian Bureau of Statistics.

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14. APPENDICES

14.1 Definitions of statistical units used by the ABS

Extract from ABS Web Page

> ABS (1999). "Australian Standard Geographical Classification (ASGC) 1999. Chapter 2. Main Structure. The spatial units Statistical Local Area (SLA)." Web page, accessed 14 February 2001, available at http://www.abs.gov.au

An SLA is a general purpose spatial unit. It is the base spatial unit used to collect and disseminate statistics other than those collected from the Population Censuses. SLAs are based on the boundaries of incorporated bodies of local government where these exist. These bodies are the Local Government Councils and the geographical areas, which they administer, are known as Local Government Areas (LGAs). In the Northern Territory, an incorporated administrative body gazetted under the Northern Territory Local Government Act can take the form of a Community Government Council (CGC). Where there is no incorporated body of local government, SLAs are defined to cover the unincorporated areas

An LGA is an SLA if:

- the LGA fits entirely within an Statistical Subdivision (SSD); and
- the LGA is broadly similar in size, economic significance and user needs for statistics to other LGAs in Australia

An LGA forms two or more SLAs when the two conditions above are not met. This can occur when:

- an LGA is divided by the boundary of one or more SSDs. The LGA is split into two or more SLAs each of which falls within the relevant SSD; or
- an LGA is substantially different in size, economic significance and user needs for statistics to other LGAs. The LGA is split into two or more SLAs which generally correspond to one or more suburbs (as occurs in the predominantly urban LGA of the City of Brisbane) or other areas of interest.

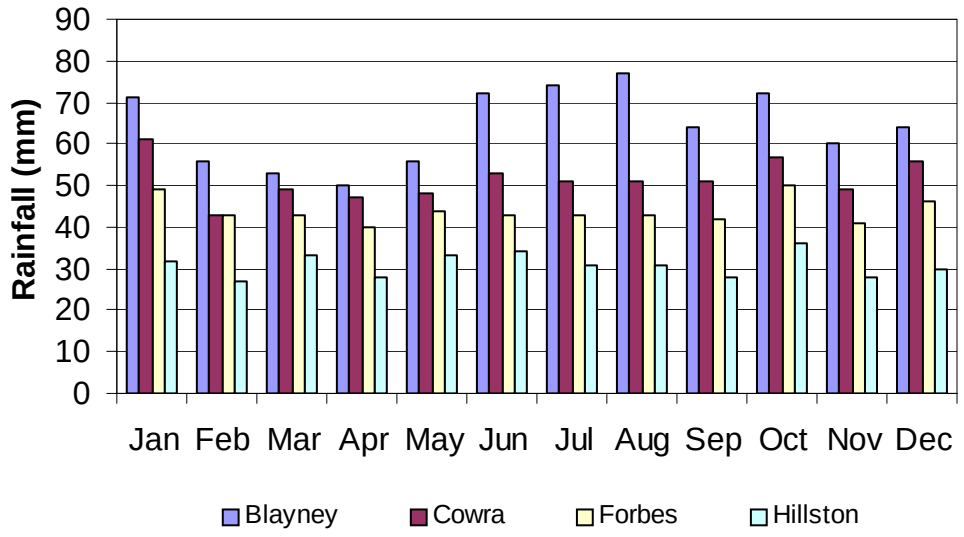
For those parts of Australia which are not administered by incorporated local government bodies, an SLA is an unincorporated area. Unincorporated SLAs cover the following areas:

- unincorporated on-shore area(s) and/or off-shore island(s) in an SSD;
- that part of an unincorporated area which is considered of sufficient economic significance as to warrant the formation of a separate SLA;
- Off-Shore Areas & Migratory SLAs, formed for census purposes for all S/Ts [states and territories] except the Australian Capital Territory and Other Territories to

encompass off-shore, shipping and migratory CDs (off-shore, shipping and migratory CDs [collection districts] are explained in chapter 2);

- the entire area of the Australian Capital Territory. Each SLA is either a suburb, a locality or the non-urban area of an SSD; and
- the unincorporated part of the Northern Territory. In some SSDs (e.g. Daly, Bathurst-Melville) the entire area is covered by one unincorporated SLA. In other SSDs (e.g. East Arnhem), the unincorporated area is split into several SLAs to distinguish an economically significant town (e.g. Nhulunbuy), island (e.g. Groote Eylandt) or administrative region.

14.2 Long-term monthly mean rainfall in selected locations of the Lachlan catchment



Source: (Clewett et al. 1999) ①

14.3 Naming conventions for SLAs

Extract from ABS Web Page

ABS (1999). "Australian Standard Geographical Classification (ASGC) 1999. Chapter 2. Main Structure. The spatial units Statistical Local Area (SLA)." Web page, accessed 14 February 2001, available at http://www.abs.gov.au

An SLA which is a whole LGA adopts the name of the LGA including its LGA status as a suffix. Thus, Northam (S) and Northam (T) in Western Australia are separate SLAs. The various LGA types currently in use by States and the Northern Territory are specified in chapter 3.
For example:

- Ballina (A) — New South Wales Area;
- Queenscliffe (B) — Borough;
- Liverpool (C) — City;
- Coomalie (CGC) — Community Government Council;
- Mid Murray (DC) — District Council;
- Roxby Downs (M) — Municipality;
- Murray Bridge (RC) — Rural City;
- Broome (S) — Shire; and,
- Roma (T) — Town.

An SLA which is part of an LGA may adopt a hyphenated name the first part of which is the name of the LGA. For example:

- the LGA of Stirling (C) in Western Australia is split into three SLAs;
- Stirling (C) – Central;
- Stirling (C) – Coastal; and,
- Stirling (C) - South-Eastern.

If the name includes - Pt A, - Pt B, or - Pt C, this indicates the SLAs were formed by splitting an LGA between one or more SSDs (see example below). In this case, - Pt A usually denotes the more urban part of the split LGA.

If the name includes - Pt A, - Pt B, or - Pt C, this indicates the SLAs were formed by splitting an LGA between one or more SSDs (see example below). In this case, - Pt A usually denotes the more urban part of the split LGA. For example:

- the LGA of the Municipality of Latrobe in Tasmania is split into two SLAs;
- Latrobe (M) - Pt A; and,
- Latrobe (M) - Pt B.

An SLA which is part of an LGA may adopt a locality or suburb name. For example:

- the LGA of the City of Brisbane in Queensland is split into many SLAs, including:Acacia Ridge; Albion; Yeronga; and Zillmere.

An SLA which covers an unincorporated area does not contain LGA type. In New South Wales, Queensland and South Australia the SLA name may include Unincorp:

- West Arnhem (in Northern Territory);
- Bruce (in Australian Capital Territory); and,
- Unincorp. Far West (in New South Wales).

A small number of SLA names are duplicated across S/Ts and one SLA name is duplicated within an S/T. These names become unique when used in conjunction with SLA codes.

- City (Queensland and Australian Capital Territory);
- City - Inner (Queensland and Northern Territory);
- City - Remainder (Queensland and Northern Territory);
- Kingston (Queensland and Australian Capital Territory);
- Oxley (Queensland and Australian Capital Territory);
- Red Hill (Queensland and Australian Capital Territory); and,
- West End (Townsville (C) and Brisbane (C)).

14.4 Change in the number of irrigated enterprises and area irrigated between 1993–94 and 1996–97 in the Lachlan catchment

	1993–94		1995–96		1996–97	
SLA	**Area irrigated (ha)**	**Number of enterprise irrigating**	**Area irrig'd (ha)**	**Number of enterp's irrigating**	**Area irrig'd (ha)**	**Number of enterp's irrigating**
Balranald	2 167	10	597	7	782	9
Bland	3 451	12	80	1	180	2
Blayney Pt A	69	7	25	4	18	3
Blayney Pt B	1 268	15	129	9	335	12
Boorowa	848	10	42	5	67	7
Cabonne Pt C	3 078	52	1,376	33	1 627	35
Carrathool	35 933	74	24 198	43	32 439	64
Cobar	2 710	10	2180	6	2 131	6
Cootamundra	632	5	10	2	43	5
Cowra	4 595	72	4 598	49	3 481	50
Crookwell	1 002	36	191	25	293	24
Forbes	27 927	179	18 892	125	20 649	143
Gunning	974	14	32	5	18	4
Hay	6 783	15	3 570	11	6 672	15
Lachlan	13 697	82	8 787	57	11 605	72
Parkes	1 963	16	107	2	242	2
Temora	1 270	9	48	2	17	2
Weddin	868	6	228	4	232	5
Young	2 807	53	921	37	1 005	55
TOTAL	**112 041**	**678**	**66 012**	**426**	**81,836**	**515**

Source: (ABS 1998) ⎚

14.5 Lachlan allocation announcement history

Carcoar Dam

Year	Date announced	Allocation announced (%)	Overdraw	Carryover	
			Next season	Last season	Used by
1981–82[a]	20/11/1981	75	0		
	19/02/1982	100	0		
1982–83 [a]	23/07/1982	40	0		
	12/01/1983	0	0		
1983–84 [a]	22/07/1983	0	0		
	5/12/1983	10	0		
	22/12/1983	15	0		
	15/02/1984	60	0		
1984–85 [a]	8/08/1984	75	0		
	12/09/1984	100	0		
1985–86 [a]	19/07/1985	100	0		
1986–87 [a]	30/07/1986	70	0		
	26/08/1986	85	0		
	3/10/1986	100	0		
1987–88 [a]	13/07/1987	100	0		
1988–89 [a]	18/07/1988	90	0		
	11/10/1988	100	0		
1989–90 [a]	31/07/1989	100	0		
1990–91 [a]	23/08/1990	100	0		
1991–92 [b]	26/07/1991	100	0		
1992–93 [b]	3/07/1992	100	0		
1993–94 [b]	12/07/1993	100	0		
1994–95 [b]	18/08/1994	100	0		
1995–96 [b]	2/08/1995	100	0		
1996–97 [c]	9/08/1996	80	0	20	31/10/96
1997–98c	1/07/1997	45	0	20	31/12/97
1998–99	25/09/1998	85	0	15	

Source: (DLWC 2000a)① Announced by [a]Minister, [b] Manager, [c]Regional Director. In 1982–83, a ban was imposed on low-security irrigation.

Wyangala Dam

Year	Date announced	Allocation announced	Overdraw	Carryover	
			Next season	Last season	Used by
1980–81[a]	5/08/1980	50	0		
1981–82[a]	25/08/1981	60	0		
	25/09/1981	75	0		
	27/11/1981	85	0		
	2/02/1982	100	0		
1982–83[a]	6/07/1982	40	0		
	12/01/1983	0	0		
1983–84[a]	21/07/1983	0	0		
	21/09/1983	10	0		
	13/10/1983	15	0		
	24/10/1983	20	0		
	10/11/1983	25	0		
	14/12/1983	50	0		
	10/01/1984	60	0		
	20/02/1984	100	0		
1984–85[a]	26/07/1984	60	0		
	30/07/1984	100	0		
1985–86[a]	22/07/1985	100	0		
	2/12/1985	120	0		
1986–87[a]	10/07/1986	90	0		
	26/08/1986	100	0		
	15/10/1986	120	0		
1987–88[a]	13/07/1987	100	0		
	10/11/1987	120	0		
	4/03/1988	120	20		
1988–89[a]	18/07/1988	100	0		
	11/10/1988	120	0		
1989–90[a]	31/07/1989	120	0		
1990–91[a]	23/08/1990	120	0		
1991–92[b]	26/07/1991	100	0		
	23/09/1991	120	0		
1992–93[b]	3/07/1992	120	0		
1993–94[b]	12/07/1993	100	0		
	16/09/1993	120	0		
1994–95[b]	18/08/1994	80	0		
1995–96[b]	2/08/1995	50	0		

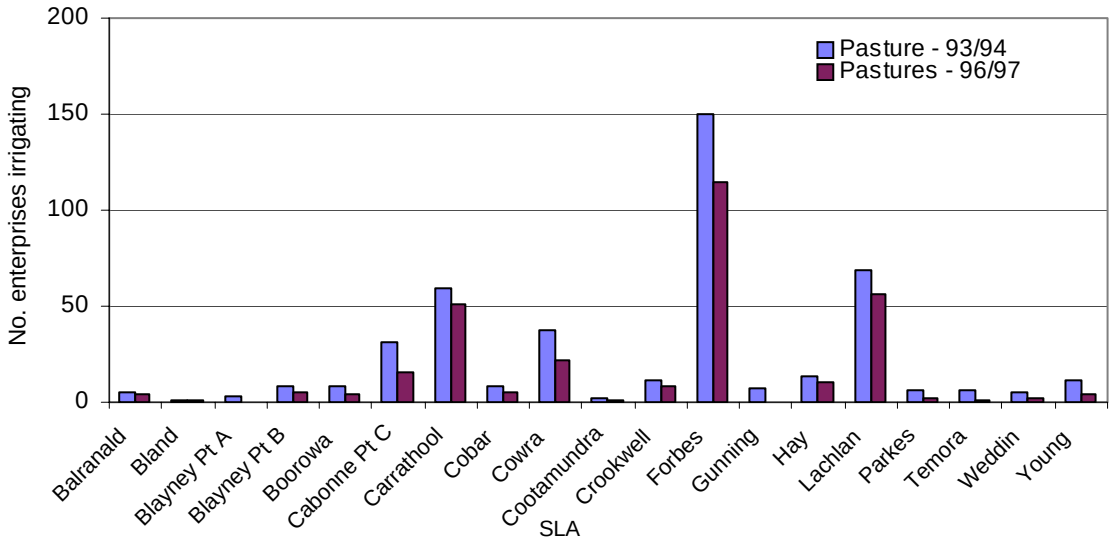
Year	Date announced	Allocation announced	Overdraw	Carryover	
			Next season	Last season	Used by
	27/09/1995	80	0		
	2/11/1995	90	0		
	18/11/1995	100	0		
1996–97 [c]	9/08/1996	70	0	20	31/10/1996
	31/10/1996	100	0	0	
1997–98 [c]	1/07/1997	40	0	20	31/12/1997
	12/09/1997	55	0	20	31/12/1997
	1/10/1997	65	0	20	31/12/1997
1998–99 [c]	7/08/1998	60	0	15	
	25/09/1998	100	0		

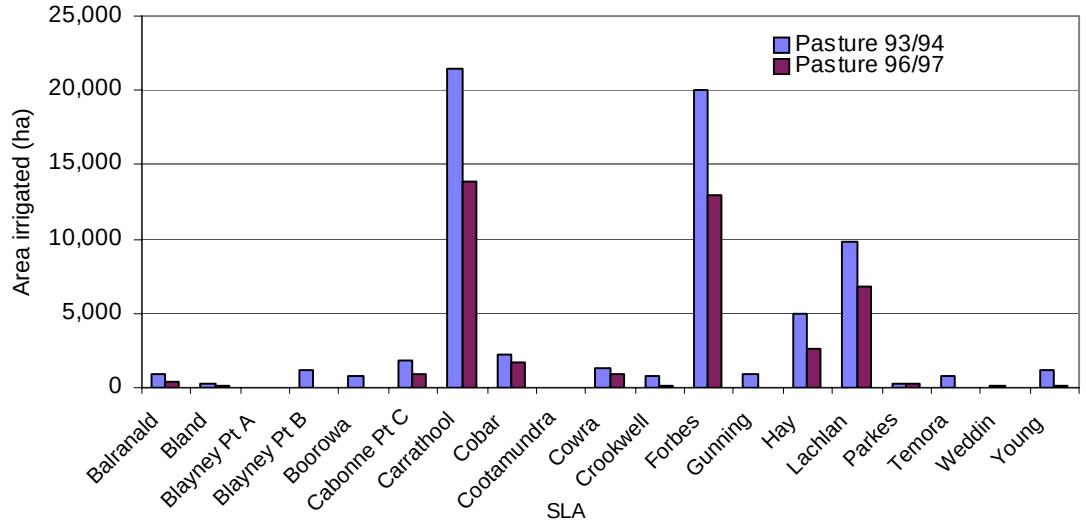
Source: (DLWC 2000a)ⓓ Announced by,

a Minister. In 1982-83, a ban was imposed on low security irrigation

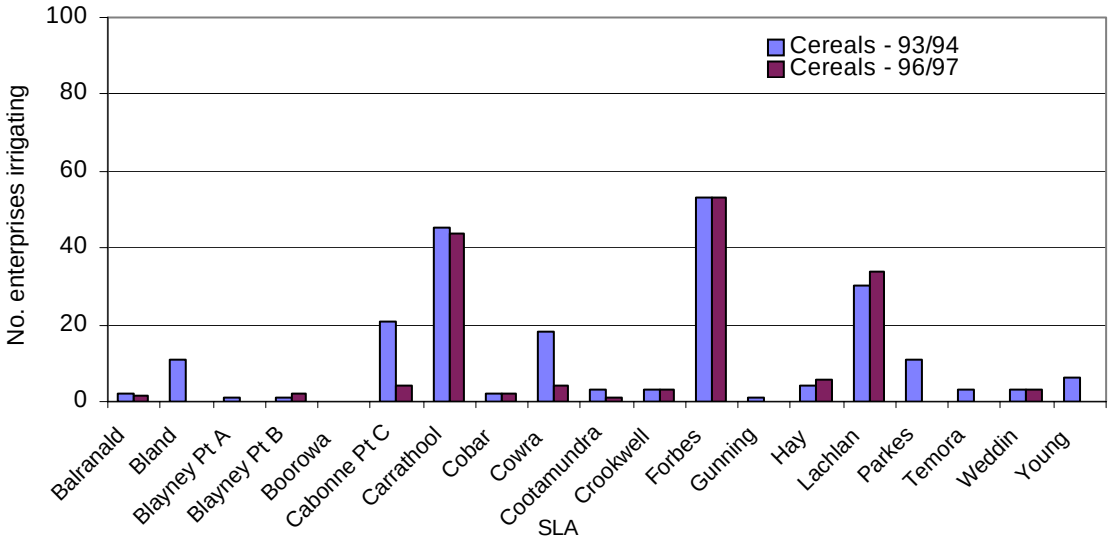
b Manager. In 1991-92, all valley storages were full. In 1996-97, Wyangala Dam spilled, therefore carryover cancelled. [c]Regional Director

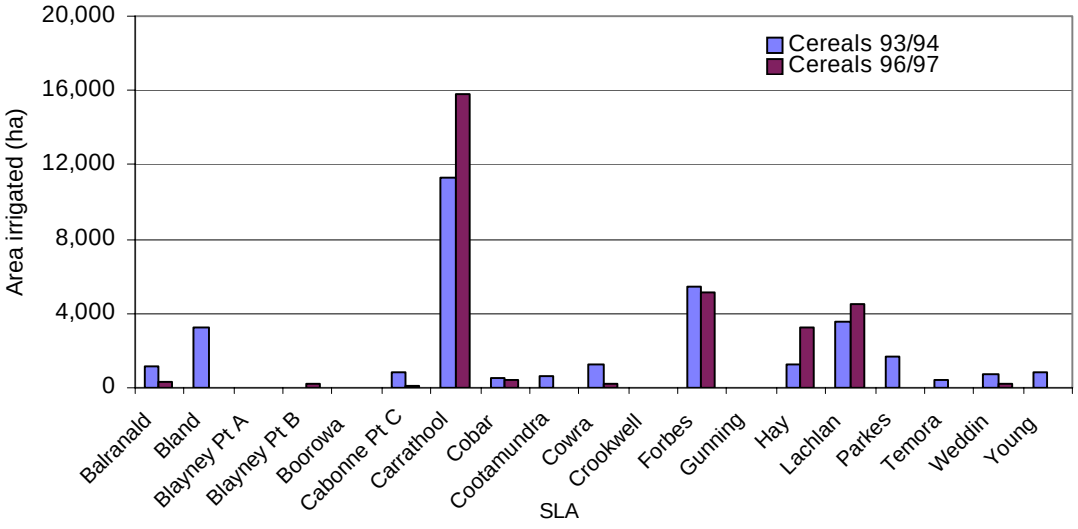
14.6 Crop areas irrigated and the number of enterprises in the Lachlan catchment



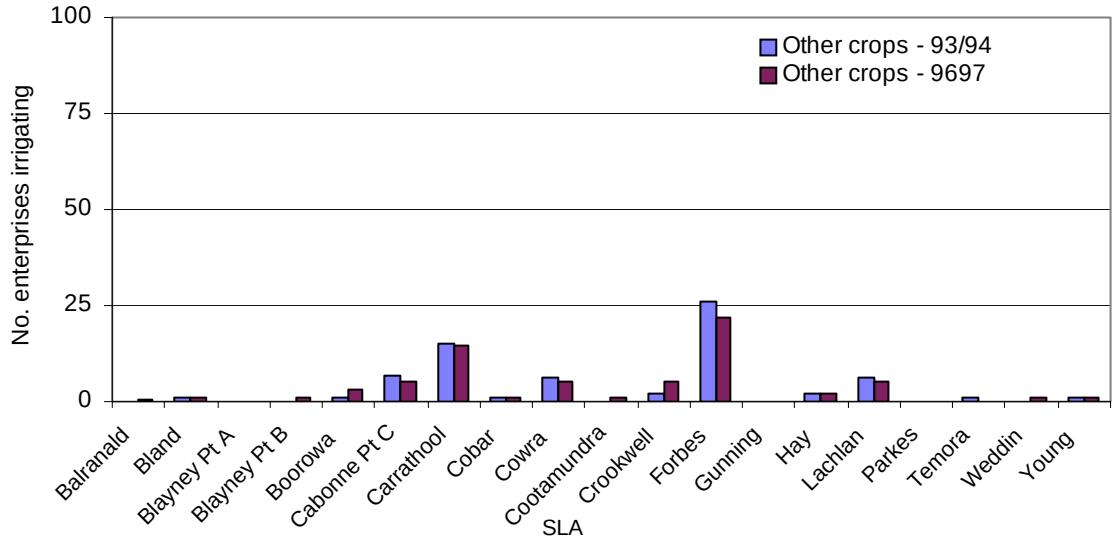


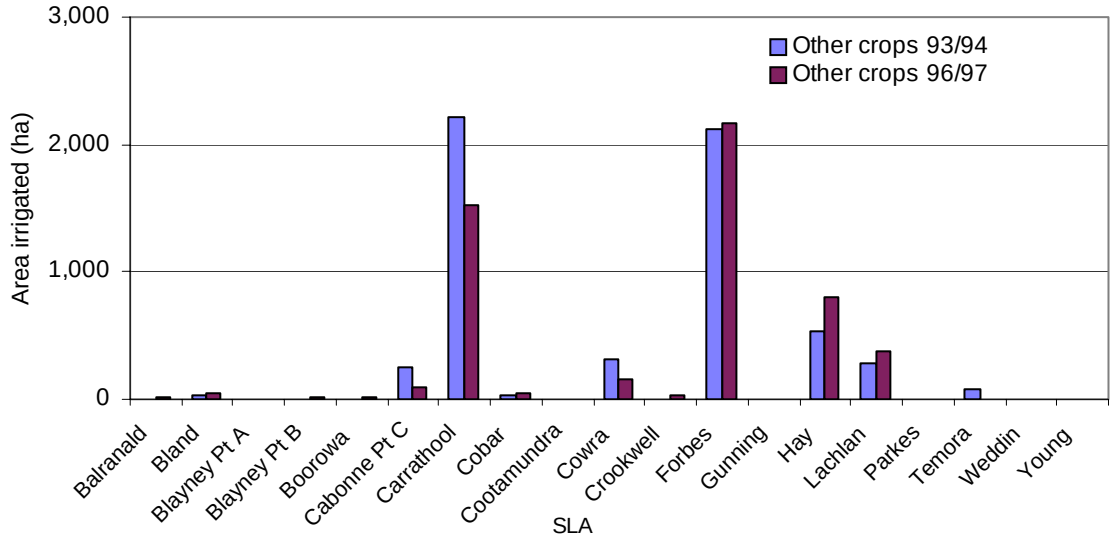
Source: (ABS 1998)





Source: (ABS 1998) ②





Source: (ABS 1998) ②

14.7 Theoretical estimates of crops in the Lachlan catchment NSW.

The theoretical amount of irrigation water required by crops is provided in Table 14 (DLWC 2000c). Estimates are for well-watered, disease-free, pest-free crops. See Figure 17 for location of climatic zones.

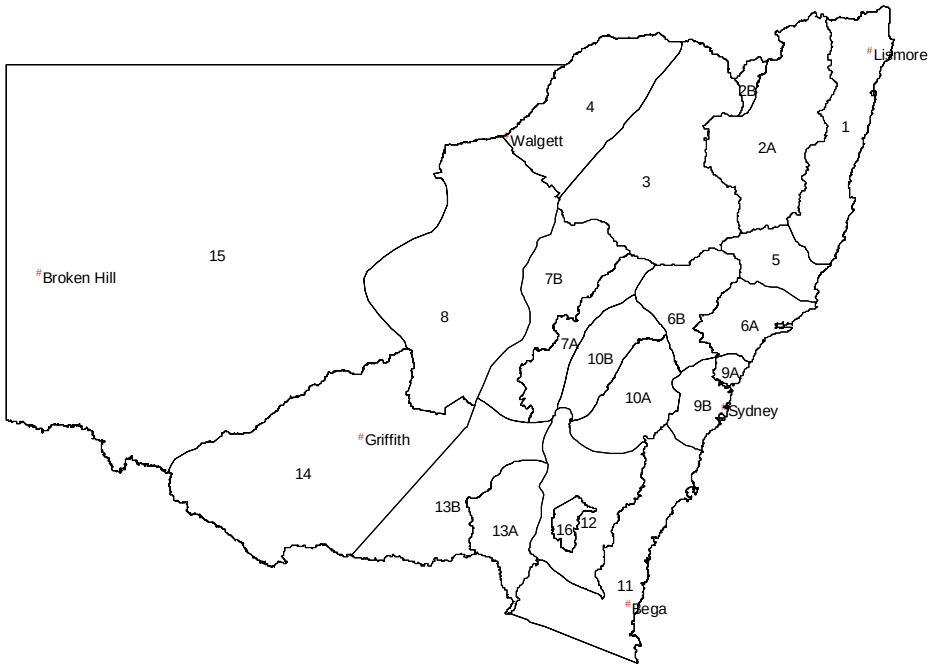
Table 14. Irrigation requirements [21] of crops in the Lachlan catchment (ML/ha)

Climatic Zone	7A	7B	8	10A	10B	12	13A	13B	14
Nurseries	20	20	20	20	20	20	20	20	20
Vines	9	10	15		6	6	6	10	15
Rice									13
Orchards	8.5	9.5	12.5	5	6	6.5	7.5	9	12
Turf	11	11.5	12.5	8.5	11	10.5	9.5	11.5	
Citrus							4.5		10
Cotton		9	10						
Summer cereal	6	6.5	8.5	3.5	4	5.5	5	7	9.5
Olives		7.5			4		4.5	6.5	9
Perennial pasture (dairy)	7	7.5	8	7	7	7	7.5	7.5	8
Summer oilseeds	6		9				5	6.5	8
Vegetables	6.5	7.5	10	3.5	4.5	5.5	3.5	5.5	8
Nuts					6	6.5	7.5		
Lucerne	6	6.5	7	5	6	6	6	6.5	7
Perennial pasture, (extensive grazing)	5.5	6	6	5	5	5	5.5	5.5	6
Pulses		5	7		3		2	3.5	5.5
Cut flowers	5	5.5				4.5			
Annual pasture	3	3.5	4.5	1.5	2	1.5	1.5	1.5	3
Winter cereal	3	3.5	4.5	1.5	2	2	1.5	1.5	3
Winter oilseeds	-	3.5	4.5		2	1.5	1.5	-	2.5

Source: (DLWC 2000c) ③. [a] Crop class refers to the grouping of like crops (such as wheat and oats) within a generic crop class (eg, cereals).

[21] The irrigation requirement is the depth of water required to satisfy crop water requirement, leaching requirement and system inefficiencies (conveyance, distribution, and application). Essentially the depth of water that must be delivered *to the farm* to ultimately satisfy actual crop water use (ML/ha or mm).

Figure 17. Climatic zones used for volumetric conversion



14.8 Irrigated crop information for the Lachlan catchment

Crop class[a]	Cereals					Fibres	Oil seeds			Pasture		
	Grain sorgh.	Maize	Millet	Oats	Wheat	Cotton	Canola	Soy beans	Sun flow's	Ann.	Lucerne	Perennial (seed lucerne)
CWR [b] avg (ML/ha)												
CWR min (ML/ha)												
CWR max (ML/ha)												
IR[c] avg (ML/ha)	11	12	8	3.5	3	14	3	13	9	3	7	
IR min	10	10	6	1.5	2.5	12	2.5	12	8	1	3	

Crop class[a]	Cereals					Fibres	Oil seeds			Pasture		
	Grain sorgh.	Maize	Millet	Oats	Wheat	Cotton	Canola	Soy beans	Sun flow's	Ann.	Lucerne	Perennial (seed lucerne)
(ML/ha)												
IR max (ML/ha)	12	14	11	5	4	16	4	14	11	4	12	
Y[d] avg (t/ha)	6	8	1.5	3	3.6		1.6	1.9	1.8	3	7	
Y min (t/ha)	4	6	1	2	2.4		1.3	1.2	1.4	2	4	0.4
Y max (t/ha)	8	15	2.5	4.5	5.5		2.7	2.9	2.8	4	12	0.7
Root depth (m)	1.5	1.5	1.3	1.5	1.2	1.2	1.2	0.9	0.8	0.6	3	
Sowing date [e]	15-Oct	15-Sep	15-Aug	15-Mar	15-May	15-Sep	15-May	15-Nov	15-Sep	15-Mar	15-Apr	1-Dec
Time of growth Total[f]	160	140	130	193	177	180	180	148	135	275	365	100
System[g]	rows – (flood)	rows (flood)	rows (flood)	bordercheck	bordercheck	rows	rows and check	rows and check	rows and check	bordercheck	bordercheck	

Source: (Hope 1999)④

a Crop class refers to a category under which similar crops can be grouped.

b CWR – Crop Water Requirement is the depth of water needed to meet the water loss through evapotranspiration of a disease-free crop, growing in a large field under non-restricting soil conditions including soil water and fertility and achieving full production potential under the given growing environment. Note, this figure excludes leaching fractions and does not allow for system inefficiencies. Average, minimum, and maximum figures correspond to water requirements in normal, wet and dry seasons respectively.

c The depth of water required to satisfy crop water requirement, leaching requirement and system inefficiencies (conveyance, distribution, and application). Essentially the depth of water that must be delivered *to the farm* to ultimately satisfy actual crop water use. Average, minimum, and maximum figures correspond to irrigation requirements in normal, wet and dry seasons respectively.

d Y Avg, Min and Max – Average, Minimum and Maximum Yield or the total seasonal production derived from the irrigated crop. The unit being considered should be specified (eg. dry matter, grain, fibre etc).

e Date on which annual crops are typically sown.

f For field and vegetable crops, the total number of days between sowing and harvesting. For perennial crops usually 365 days.

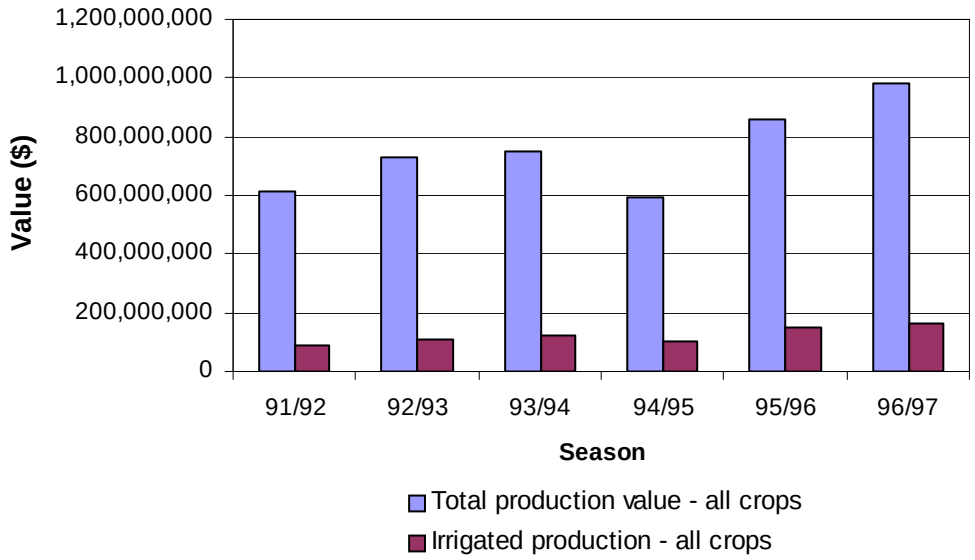
g System refers to irrigation system used.

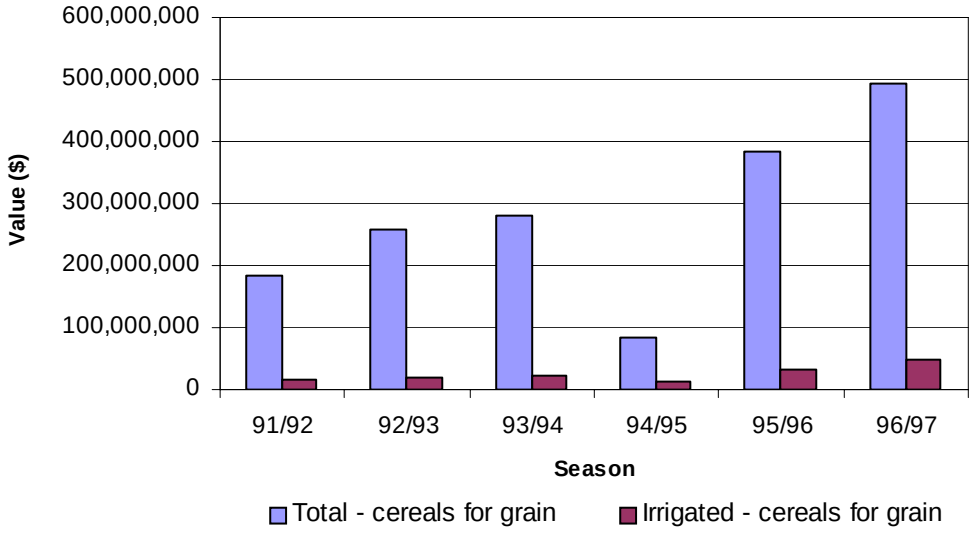
14.9 Irrigation methods in the Central West – broadarea and dairy enterprises only

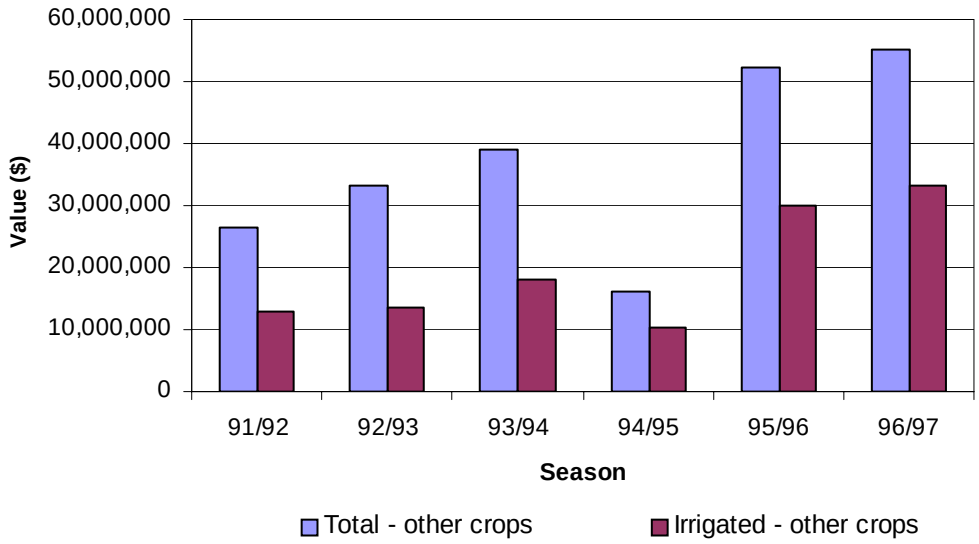
Irrigation method	State %	Central West %
surface	91.3	91.2
moveable spray	3.5	2.3
travelling irrigator	4.4	5.6
trickle/drip/sub-surface	0.2	0.7
fixed low throw sprinkler	0.02	0.0
fixed micro sprays	0.3	0.0
fixed overhead sprinkler	0.2	0.2
other	0.1	0.0

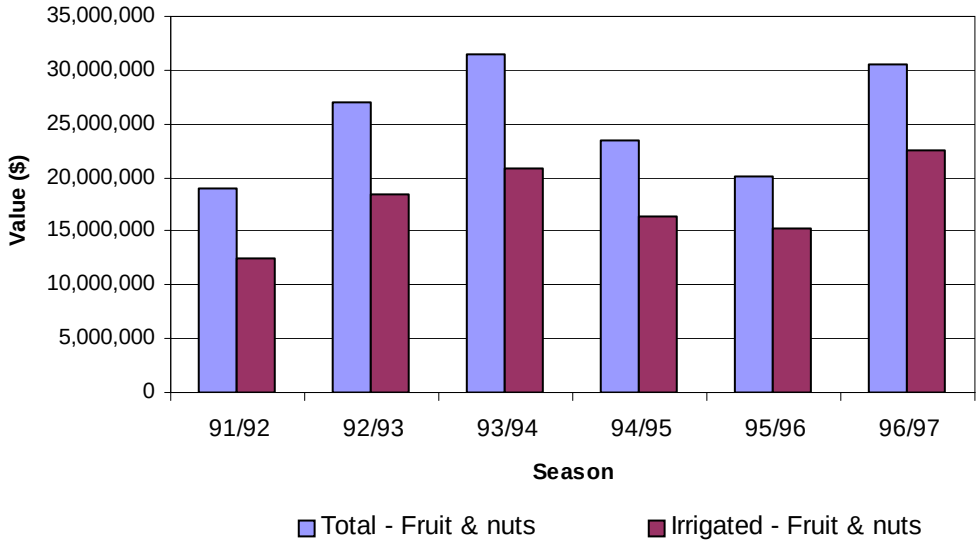
Source: (ABARE 2000) ③ Central West refers to the Lachlan and Macquarie catchment

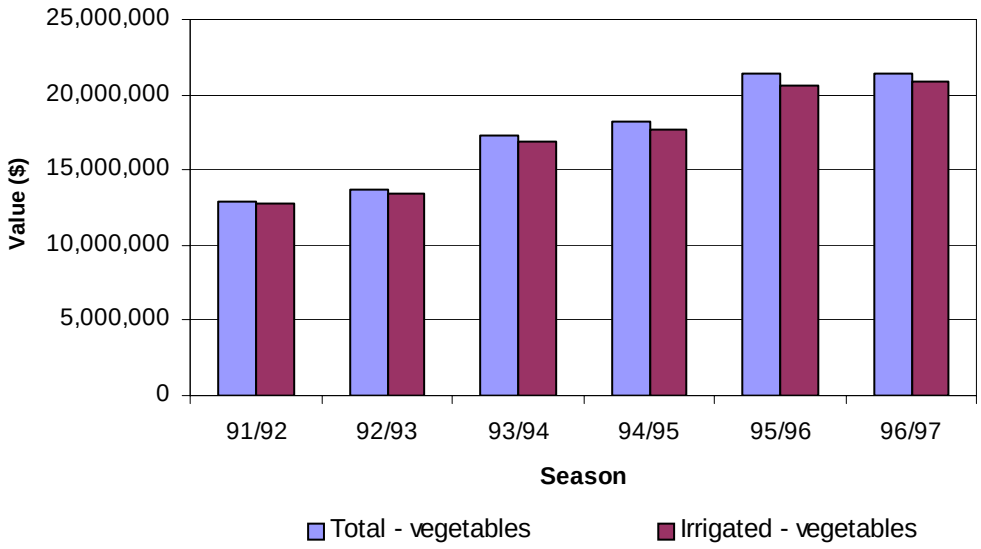
14.10 Value of irrigated agriculture production for major crops in the Lachlan catchment






60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
Value ($)
91/92
92/93
93/94
94/95
95/96
96/97
Season
Total - other crops
Irrigated - other crops


35,000,000
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Value ($)
91/92
92/93
93/94
94/95
95/96
96/97
Season
Total - Fruit & nuts
Irrigated - Fruit & nuts



Source: (Donovan 2000) ③

14.11 Area irrigated and water used (regulated supplies) in the Lachlan catchment, from DLWC 1998a

Area irrigated (ha)

	1989–90	1990–91	1991–92
Winter pasture	11 618	18 242	16 653
Summer pasture	11 817	12 619	15 574
Lucerne	11 784	8 751	8 737
Wheat	2 789	3 719	4 951
Sorghum	1 255	1 259	2 305
Winter cereal	1 531	1 451	2 282
Oats	1 035	2 540	1 744
Millet	647	674	1 738
Legumes	97	0	1 698
Vegetables	1 964	1 865	1 523
Rape	72	1 453	1 487
Summer cereal	322	1 840	1 403
Cotton	981	360	1 160
Soya beans	1 719	1 265	812
Barley	560	182	704
pre irrigation	174	1 098	685
Citrus	468	410	430
Sudax	371	212	380
Orchard	411	432	266
Vines	398	244	232
Sunflower	338	242	204
Chickpeas	233	40	80
Storage	0	0	40
Lupins	0	100	10
Nursery	11	14	4
Maize	1 561	0	0
Mung beans	60	40	0
Summer grains	0	0	0
Triticale	24	0	0
Total	52 238	59 051	65 100

Source: (DLWC 1998a)

Water used by irrigation (ML)

	1989–90	1990–91	1991–92
Summer pasture	59 885	59 235	69 892
Winter pasture	35 282	50 054	62 311
Lucerne	60 363	47 677	49 397
Wheat	7 522	12 162	17 993
Millet	4 372	4 269	10 444
Sorghum	8 347	5 178	9 824
Legumes	336	0	9 811
Cotton	6 573	2 710	9 806
Summer cereal	1 194	9 795	9 252
Vegetables	10 035	10 647	8 053
Winter cereal	2 807	2 997	4 252
Rape	223	2 895	4 182
Soya beans	6 431	5 915	3 854
Citrus	2 753	3 527	3 693
Oats	1 918	6 176	3 618
Sudax	860	762	3 349
Barley	1 252	337	2 836
Orchard	1 867	1 961	1 734
Vines	1 160	1 841	1 307
Storage	75	1 491	1 167
Pre-irrigation	224	1 707	1 015
Sunflower	750	1 020	935
Chickpeas	258	230	132
Nursery	69	70	35
Lupins	0	45	30
Maize	7 533	0	0
Mung beans	210	150	0
Nuts	0	0	0
Triticale	30	0	0
Total	222 328	232 850	288 921

Source: (DLWC 1998a) crop water use ②, total water use ①

14.12 Water use and area irrigated information, from DLWC 2001b

		1991–92	1992–93	1993–94	1994–95	1995–96	1996–97	1997–98	1998–99
Fruit & veg	Area (ha)	2 773	1 634	1 532	1 981	2 286	2 467	1 419	1 581
	Water use (ML)	28 088	18 486	26 620	28 981	34 945	33 229	28 171	30 193
Grain legumes	Area (ha)	1 824	2 831	2 439	1 156	1 492	2 206	2 003	785
	Water use (ML)	13 199	20 625	16 786	8 124	10 354	14 702	11 884	4 894
Lucerne	Area (ha)	13 596	18 410	19 478	19 230	19 054	16 790	16 321	14 490
	Water use (ML)	64 346	89 053	93 425	92 695	93 904	84 389	79 520	71 838
Oilseeds	Area (ha)	3 047	3 411	4 878	4 199	3 853	7 459	8 303	13 788
	Water use (ML)	18 718	25 935	37 620	23 047	30 085	58 568	58 514	35 506
Other	Area (ha)	4 850	4 617	3 872	9682	5 979	4 936	4 941	4 985
	Water use (ML)	34 333 *(6 972)*	27 443 *(1 620)*	14 866 *(780)*	62 493 *(12 242)*	25 020 *(0)*	22 270 *(0)*	25 802 *(8 400)*	113 930 (97 316)
Summer cereals	Area (ha)	2 715	2 284	2 211	6 035	6 255	7 268	8 698	5 573
	Water use (ML)	22 121	19 534	17 641	51 100	49 337	62 455	71 617	42 385
Summer pasture	Area (ha)	10 340	11 381	10 361	12 555	8 060	9 088	8 274	5 621
	Water use (ML)	61 968	67 440	62 166	75 066	48 150	54 144	49 380	33 726
Winter cereals	Area (ha)	15 174	16 813	12 772	13 476	21 710	31 553	24 031	13 143
	Water use (ML)	47 100	52 033	39 471	41 139	65 997	95 899	73 369	40 492
Winter pasture	Area (ha)	22 655	23 840	23 239	20 024	15 029	18 021	20 345	12 208
	Water use (ML)	39 940	41 016	41 366	35 935	25 680	31 229	36 514	21 937
Total area		**76 974**	**85 221**	**80 782**	**88 338**	**83 718**	**99 788**	**94 335**	**72 174**
Total water use		**329 812**	**361 564**	**349 960**	**418 578**	**383 470**	**456 884**	**434 769**	**394 900**

Source: (DLWC 2001b)@ Numbers in brackets are cotton water use figures

14.13 Crop area (ha) irrigated from regulated supplies in the Lachlan Valley

Year	Crop statistics reports (1a & 1b)	Lachlan activity reports (2)	Diversion return cards for the Lachlan DLWC (3)	Crop statistics R-Base data DLWC (3)	Water resources of the Lachlan (4)	Adopted data-set
1983–84			39 220	24 455	37 200	37 200
1984–85			39 000	38 378	56 700	56 700
1985–86			39 307	42 454	62 100	62 100
1986–87			43 596	62 266	85 100	85 100
1987–88				52 534	75 000	75 000
1988–89	82 585			31 682		82 585
1989–90	88 571			52 695		88 571
1990–91	80 929			59 254		80 929
1991–92	77 250	77 074		65 324		77 250
1992–93	86 432	86 116				86 432
1993–94	80 822	80 782		80 782		80 822
1994–95	88 211					88 211
1995–96	83 938					83 938
1996 –97	95 145					95 145
1997–98	94 335					94 335
1998–99	72 174					72 174

Source: (DLWC 1998b) ***1a****. (DWR 1995)* ***1b****. (DLWC 1999a)* ***2****. (DWR 1994)* ***3****.(DLWC 1994 Circa)* ***4.*** *(DWR 1989)*

14.14 ABS Question profile

Part 8. Do you irrigate or use any artificial fertilisers or soil conditioners

No ☐ Go to part 9

Yes ☐ *show details below*

a. Pastures and Crops Irrigated – Season 1993-94

Where any area of pasture or crop was irrigated more than once during the season, show this area once only

	Hectares
• Pasture (native or sown)	.....
• Cereals	.....
• Vegetables for human consumption	.....
• Fruit (including nuts)	.....
• Grapevines	.....
• All other crops	.....

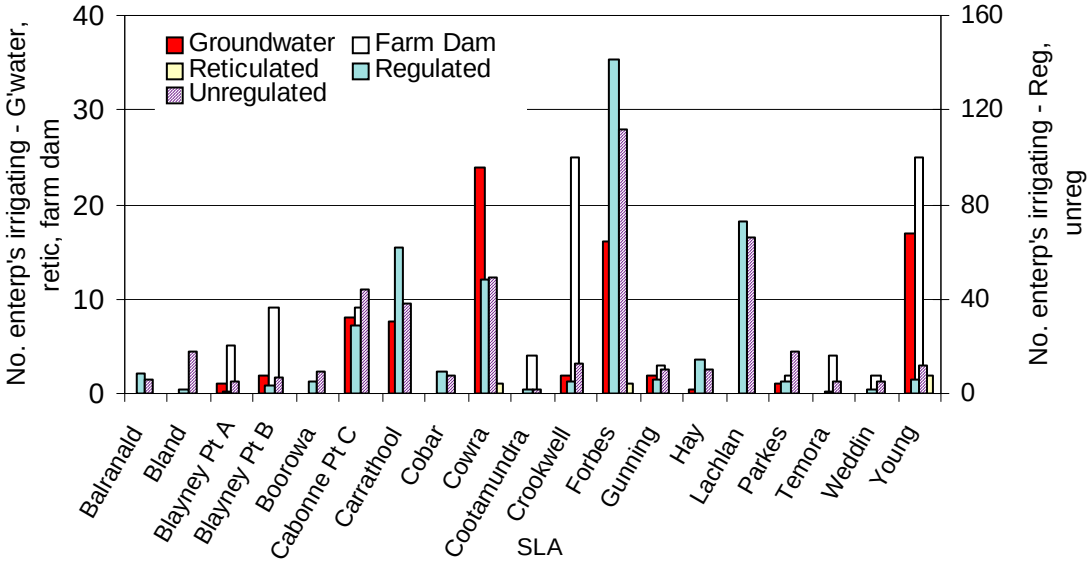
b. Source of water – season 1993-94

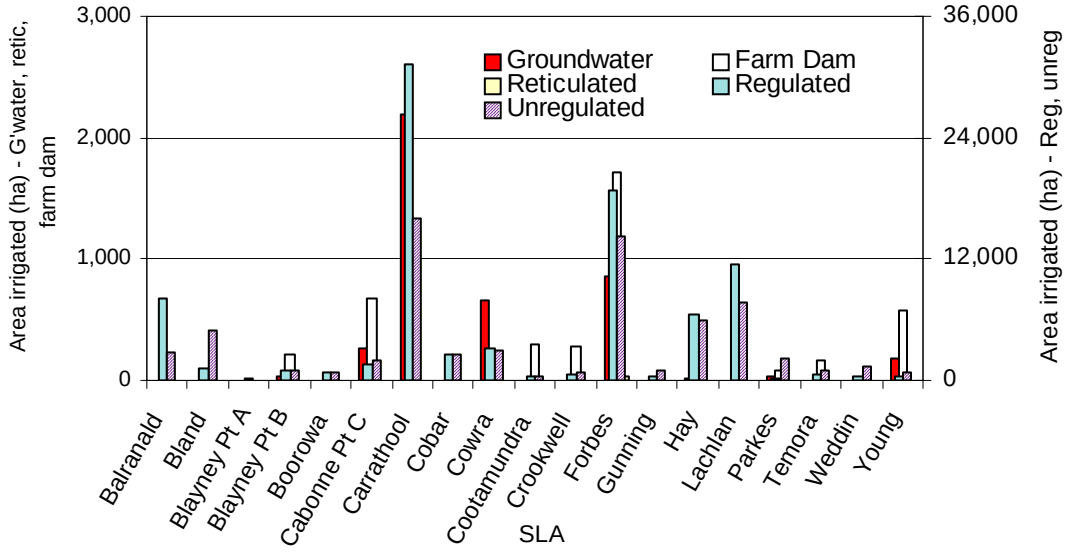
Where more than one source of water is used on a particular area of pasture or crop, show the area only once according to the main source.

Area irrigated using:	Hectares
• Channel or pipe supply in an irrigation area or district	.....
• Other surface water (*Include* • private group schemes)	.....
• A river or stream controlled by water board or a water resources commission dam or weir	.....
- An uncontrolled river or scheme	.....
- A farm dam with its own catchment and not filled by pumping from a river or stream	.....
• Underground water supply (e.g. bore, spear, well)	
- Within State schemes	.....
- Other	.....

Source: (ABS 1994)

14.15 Number of enterprises and area irrigated by source of water, from DLWC 1998a ④.





Source: (ABS 1998) ②

14.16 Irrigation method by crop in 1993–94 (regulated supplies)

Crop	Spray (ha)	Surface (ha)	Total (ha)	% Spray	% Surface
Adzuki beans	75	80	155	48	52
Asparagus	155	40	195	79	21
Barley	484	1 727	2 211	22	78
Canary seed		227	227	0	100
Canola	229	2 438	2 667	9	91
Cotton		1 166	1 166	0	100
Citrus	154	85	239	64	36
Deciduous fruit	106	255	361	29	71
Grapes	24	575	599	4	96
Lucerne	3 988	16 971	20 959	19	81
Lupins	15	875	890	2	98
Maize	10	3 558	3 568	0	100
Oats	823	4 986	5 809	14	86
Other crops	80	732	812	10	90
Other vegetables	73	114	187	39	61
Perennial pastures	1 129	11 431	12 560	9	91
Sorghum	277	2270	2 547	11	89
Soybeans		154	154	0	100
Summer forage	615	6588	7 203	9	91
Sweet corn	596	311	907	66	34
Tomatoes	148	8	156	95	5
Wheat	2 036	3 830	5 866	35	65
Winter pasture	1 062	24 994	26 056	4	96

Source: (DWR 1996) ②

14.17 Stressed stream classification in the Lachlan catchment

An environmental stress rating or each of the freshwater subcatchments within the Lachlan was determined using the following environmental indicators:

- extent of riparian vegetation
- geomorphological health
- presence of major dams
- barriers to fish passage
- gully erosion
- dryland salinity
- presence of acid sulfate soils
- water quality (indicative purposes only – not used in decision tree)

Following the analysis of these indicators an overall environmental stress rating for each subcatchment was made. The environmental stress was determined using a decision tree method. This method was used for both the estuarine and freshwater indicators. Where two-thirds of the environmental indicators returned a high classification for a particular subcatchment, the overall environmental stress was assessed to be high. Where two thirds of environmental indicators returned a low classification for a particular subcatchment, the overall environmental stress was determined to be low. The remaining subcatchments were classified as being of medium environmental stress.

The hydrological stress of a subcatchment was calculated as the estimated proportion of daily flow that has been made available for extraction under existing licences. This required estimation of streamflow and water use.

Streamflow estimation was made using information available through DLWC's flow gauging network and a range of hydrologic predictive techniques to extend estimates into rivers without local gauging sites. Estimates of the peak monthly water extractions have been made using the surface water returns lodged by licence holders. However, not all survey cards are returned to DLWC and the volumes were adjusted for the proportion of licence holders who have chosen not to lodge a return. A hydrologic index (indicating hydrologic stress) was derived for each subcatchment for current use and full water use development by proportioning estimated water extraction to the estimated streamflow. Each subcatchment was then classified as being of low (0 to 30% extraction of flow), medium (40 to 60% extraction) or high (70 to 100% extraction) hydrologic stress. The data that were used to generate hydrological and environment stress ratings and therefore management options were not always reliable. For example, the hydrological stress rating was determined using crop return card information and is a source that is known to be unreliable. Despite underlying difficulties and concerns with the data, the assessment provides the most comprehensive overview of the land and water resources of subcatchments in the Lachlan catchment.

The matrix showing stress categories and the ratings given to individual subcatchments in the Lachlan catchment are provided in Table 15 and Table 16 respectively.

Table 15. Stress matrix

	Low environmental stress	Medium environmental stress	High environmental stress
High proportion of water extracted	CATEGORY U1. Despite high levels of water extraction, the river seems reasonably healthy. However, more detailed evaluation should be undertaken to confirm. It is also likely that conflict between users may be occurring during critical periods.	CATEGORY S3. Water extraction is likely to be contributing to environmental stress.	CATEGORY S1. Water extraction is likely to be contributing to environmental stress.
Medium proportion of water extracted	CATEGORY U2. There is no indication of a problem and, therefore, such rivers would be a low priority for management action.	CATEGORY S4. Water extraction may be contributing to environmental stress.	CATEGORY S2. Water extraction may be contributing to environmental stress.
Low proportion of water extracted	CATEGORY U4. There is no indication of a problem and, therefore, such rivers would be a low priority for management action.	CATEGORY U3. Environmental stress is likely to be due to factors other than water extraction and, as stress is not high, these rivers would be a low priority for management action.	CATEGORY S5. While environmental stress is likely to be due to factors other than water extraction, the high level of environmental stress means it is important to ensure extraction is not exacerbating the problem.

Source: (DLWC 1999d)

Table 16. Stress ratings for unregulated subcatchments in the Lachlan catchment

NAME	Environmental Stress	Hydrologic stress	Management class	Future risk
Lachlan River above Reid's Flat	high	high	S1	none
Crookwell River	medium	low	U3	none
Abercrombie River above Wyangala	medium	low	U3	none
Boorowa River and Hovell's Creek	medium	high	S3	none
Waugoola Creek	medium	high	S3	none
Belubula River above Carcoar Dam	medium	high	S3	none
Belubula tributaries below Carcoar Dam	medium	high	S3	none
Mandagery Creek	high	high	S1	none
Kangarooby Creek	high	medium	S2	none
Goonigal Creek	high	high	S1	none
Tyagong Creek	high	low	S5	none
Burrangong Creek	high	high	S1	none
Crowther Creek	high	high	S1	none
Western Bland Creek	medium	high	S3	none
Ooma Creek and tributaries	high	medium	S2	none
Lake Forbes and Back Yamma Creek	low	low	U4	none
Goobang - Billabong Creeks	medium	high	S3	none
Gunningbland and Yarrabandai	high	low	S5	none
Bogandillon and Manna Creeks	high	low	S5	none
Humbug Creek	medium	low	U3	none
Mt Hope Area	low	low	U4	none
Lake Cargelligo and Lake Brewster	low	low	U4	none
Unregulated effluent creeks	low	low	U4	none

Source: (DLWC 1999d) Unres = unresolved

14.18 Area irrigated and water used (unregulated supplies)

Crops	1989–90	1990–91	1991–92	1992–93
Lucerne (ha)	296	218	232	259
Other (ha)	130	81	87	156
Winter pasture (ha)	165	65	238	120
Winter cereal (ha)	20	84	26	88
Summer pasture (ha)	245	19	230	56
Wheat (ha)	0	0	0	50
Vegetables (ha)	25	55	117	27
Summer cereal (ha)	13	17	9	25
Citrus (ha)	24	2	68	0
Vines (ha)	1	5	6	0
Total area (ha)	918	546	1 011	783
Water usage (ML)	3 801	2 716	3 382	33 957

Source: (DLWC 1998a)

Crops	1993–94	1994–5
Lucerne (ha)	795	262
Winter pasture (ha)	472	90
Sunflower (ha)	0	70
Soybeans (ha)	0	18
Summer pasture (ha)	163	8
Other vegetables (ha)	15	5
Citrus (ha)	2	0
Grapes (ha)	5	0
Oats (ha)	70	0
Orchard (ha)	270	0
Other crops (ha)	85	0
Potatoes (ha)	59	0
Sorghum (ha)	27	0
Summer cereal (ha)	34	0
Triticale (ha)	4	0
Turf (ha)	21	0
Wheat (ha)	40	0
Winter grains (ha)	55	0
Total area irrig (ha)	2 116	453
Water usage (ML)	1 851	1 019

14.19 Annual usage from groundwater (1980) in the Lachlan catchment (ML)

Extraction by salinity category	Urban	Irrigation	Other	Total
0–1 000 mg/L	2 100	15 900	8 400	26 400
1000–3000 mg/L	0	1 300	5 200	6 500
3 000–7 000 mg/L	0	0	3 300	3 300
7 000–14 000 mg/L			200	200
Total	2 100	16 200	17 100	36 400

Source: (WRC 1980)