Border Rivers (NSW) Catchment Irrigation Profile

compiled by Meredith Hope and Robert Bennett
for the Water Use Efficiency Advisory Unit, Dubbo

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NSW Agriculture, Locked Bag 21, ORANGE NSW 2800 AUSTRALIA
http://www.agric.nsw.gov.au/

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1. EXECUTIVE SUMMARY

The *Border Rivers (NSW) Catchment Irrigation Profile* was developed from a study to obtain regional 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data were collected from State and Commonwealth sources, from published research and industry reports and from unpublished reports.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 NLWRA (National Land and Water Resources Audit 1999).

The Profile details by catchment and, where possible, by water source, 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
- irrigated crop yields
- the value of irrigated agriculture in the Border Rivers catchment.

This Profile does not attempt to calculate WUE and IE from these data. 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.

1.1 Overview of irrigation in the Border Rivers catchment

The Border Rivers catchment lies west of the Great Dividing Range and straddles the New South Wales and Queensland border. The total catchment area, including the NSW and Qld sections, is 49,500 km^2. The NSW section alone is 25,580 km^2.

The catchment has summer-dominant rainfall with high variability, which markedly affects river flow from season to season. The construction of storage facilities has reduced the impact of this variability and the existence of a relatively secure supply of water has enabled the irrigation industry to thrive in the catchment.

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[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).

EXECUTIVE SUMMARY

The catchment is heavily dependent on income from agriculture, specifically from dryland livestock (beef cattle), dryland and irrigated cereals and irrigated cotton.

Total agricultural output of the entire Border Rivers catchment (NSW and Qld) was $824 million in 1996–97. Of this, irrigated agriculture contributed $271 million (around 30%) and irrigated cotton (as estimated from the 'other crops' category) was $168 million (Table 1). Output figures for the NSW section alone were not available, but since roughly 60% of the catchment's water is used in NSW, around 60% of the total value can be attributed to irrigation in this section.

Table 1. Overview of irrigation in the Border Rivers (NSW) catchment in 1996–97

Source of water	Total irrigated area (ha)	Total water used by irrigated agriculture (ML)	Number irrigation licences	Number enterprises irrigating	Yield of major irrigated crop (t/ha)	Value of irrigation ($ million)
NSW total	1,150,000	7,700,000	24,000	7,850	Cotton 1.8	2,500
All sources	37,000 90% area is cotton.	No data *Est. 175,000 – 180,000*	445	151	Cotton 1.6	271 (NSW plus Qld) 62% cotton.
Regulated	34,400 92% area is cotton.	169,500 Most water used on cotton.	150	no data *325 from surface supplies (1993–94)*	Cotton 1.6	No data Most of total value attributable to regulated supplies.
Unregulated	3,300 30% irrigated area is lucerne.	no data *2,000 to 5,000 used each year between 1989–90 & 1994–95*	280		no data	no data
Groundwater	no data *Around 6,828 (1993–94)*	no data *5,000 (1993–94)*	65 - 46 are conjunctive	no data *30 (1993–94)*	no data	no data
Farm dams	no data *539 (1993–94)*	no data	NA	no data *28 (1993–94)*	NA	no data
Reticulated supplies	no data *2 (1993–94)*	no data	NA	no data *1 (1993–94)*	NA	no data

NA - not applicable. 1996–97 was the most recent year with the greatest amount of data. Where data were unavailable, other years were used. This sometimes resulted in the inclusion of data.

There are 445 irrigation licences in the NSW section of the catchment, representing roughly 2% of the State total. In 1996–97 only 2% of enterprises irrigating in NSW, or 151, were in this catchment (see Table 1).

Between 15,000 and 40,000 ha are irrigated in the Border Rivers (NSW) catchment. In 1996–97, the area was 37,000 ha (Table 1). Most of this irrigation used water from the regulated system, with smaller areas irrigated from unregulated rivers and groundwater supplies.

The volume of water used by irrigated agriculture in the catchment is not accurately known. Data were scant on sources of water other than regulated supplies. The total volume is likely to be between 175,000 and 180,000 ML, which is the sum of the volume extracted from regulated, unregulated, groundwater, farm dams and reticulated supplies (Table 1). (Where possible, data from 1996-97, that is, data on regulated supplies, were used to calculate this total. For the other water sources, data from years prior to 1996-97 were used.)

Cotton grown on the riverine plains uses a significant proportion of the total water extracted for irrigation on the NSW side of the catchment. Approximately 33,000 ha of cotton were grown using water from all sources in the Border Rivers (NSW) catchment in 1996–97.

Cotton, which is heavily dependent on regulated water, is irrigated mostly by surface methods, although some drip and centre pivot systems are also used. Lucerne, grown on the tablelands along the small but fertile river flats, is spray-irrigated. Wine grapes, also grown in the tablelands region, are generally irrigated with drip systems.

1.2 Data issues

Issues raised in the Border Rivers (NSW) catchment relate to the general scarcity and reliability of irrigation data and the scarcity of data at useful scales.

- Information on crop areas and water use, yields, irrigation methods and the value of irrigation is needed to assist in the development of these agreements. However, in many cases such data are often either scant or have never been collected.
- Point-scale data collected by the ABS and ABARE are confidential and have been reported at SLA, catchment or Agro-Ecological Region (AER) scales. These scales limit the usefulness of data to natural resource managers who are often working at much finer scales and need information at subcatchment or river-reach scale.
- The reliability of data varied according to water source. For example, regulated supplies provided more reliable data than unregulated or groundwater supplies.

1.3 Conclusion

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

- Collection of crop data, for example, water use, irrigated area, yields and value. These data would assist water management planning processes.
- Protocols similar to those used by the National Land and Water Resources Audit are needed for the provision of data to the public by State agencies and private authorities.
- Two-way flow of information between agencies and irrigators needs to be fostered. Data need to flow back to irrigators in forms that might potentially assist them make better water management decisions.
- Data need to be collected at scales that are large enough to ensure confidentiality of individual enterprises but small enough to allow users to aggregate useful information.

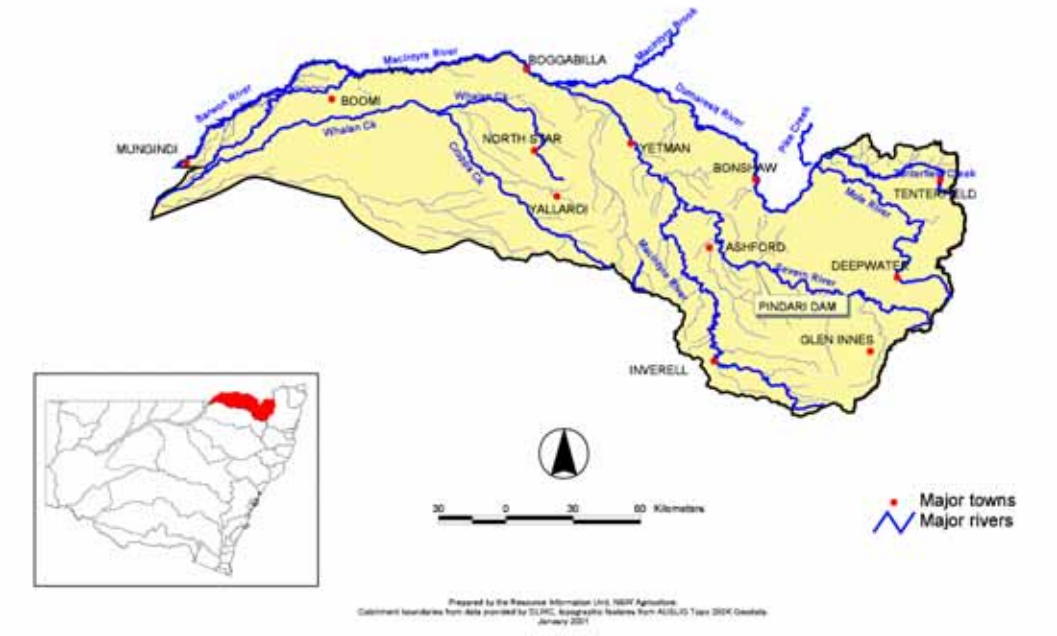
This comprehensive approach can only be developed with the full involvement and support of the many agencies and irrigator groups that require these data.

2. INTRODUCTION

During 1998, a desktop study was undertaken to develop a comprehensive database of NSW irrigation statistics. This was done to obtain regional and industry-based assessments of on-farm water use efficiency (WUE). From this study, Irrigation Profiles, or situation statements of irrigation, were developed for each of the major regions in NSW.

This Profile focuses on the Border Rivers catchment in northern inland NSW (Figure 1) and attempts to document 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.

Figure 1. The Border Rivers (NSW) catchment



2.1 Background

Irrigation data have been collected by various organisations over the last 50 years.

1980 The Water Resource Commission (1980) undertook an inventory of water resources in NSW. The water used by irrigation from surface and groundwater supplies was reported on a catchment-by-catchment basis.

1986 The WRC (1986) undertook a comprehensive assessment of irrigation and WUE in NSW. The study highlighted a lack of data on crop areas irrigated, water used, irrigated yields and financial returns.

1990 More recently, Deborah Wilson Consulting (DWC 1990) provided a comprehensive report on crop areas, irrigated yields and the values of individual irrigated commodities in NSW between 1980 and 1989.

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

2000 The Australian Bureau of Agricultural Resource Economics (ABARE 2000) completed a survey of broadarea and dairy enterprises in each of the major catchments in NSW.

current The Australian Bureau of Statistics (ABS 1998) has been collecting information on irrigation for various years since 1986.

current The NSW Department of Land and Water Conservation (DLWC) and its predecessors have also collected information over the last 50 years on the area irrigated and water used by irrigated agriculture across NSW.

Despite the apparent collection of ample statistics in NSW over the last two decades, a basic description of the irrigation industry remains elusive. A review commissioned by the Murray-Darling Basin Commission (Crabb 1997a; Crabb 1997b) highlighted a lack of data on

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 have been added to the list: the crop type, the irrigated yields that are being obtained, the irrigation methods being used and the value of irrigation.

2.2 Who needs irrigation data?

The importance of historical and current reliable 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 aim to introduce processes to enable better sharing between users and the environment, for trading water between users, for better defining a water right to users, and finally for recovering the real cost of storing and supplying water to users. A number of activities depend heavily on historical information and the future collection of reliable irrigation data.

- Water Management Committees (WMCs), set up by the NSW Government to develop water-sharing plans, comprise representatives from government agencies and community bodies. These committees need accurate and reliable irrigation data for planning purposes and for assessing the future impact of management rules on the irrigation industry.

- 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. Monitoring the impact of these plans on the environment and other water users (for example, irrigators) has to be undertaken. Irrigation data will need to be collected as part of the Water Sharing Plan implementation phase.

- Catchment Blueprints are being developed and finalised by Catchment Management Boards (CMB) in each major catchment or region in NSW. These plans are designed to improve the management of natural resources across the State and are operational for 10 years. These plans require data on irrigation to enable the impact of these plans to be assessed in the future.

- In all Australian states including NSW, programs have been initiated to increase WUE in irrigated agriculture. In NSW an incentive package aims to assist irrigators adjust to new water management sharing arrangements jointly managed by NSW Agriculture and the NSW Rural Assistance Authority. These programs desperately need these essential irrigation data to underpin debates regarding industry and catchment levels of WUE.

In summary, there is a pressing need to obtain more accurate and reliable irrigation data in order to aid decision-making about sharing water in NSW and to help strategically focus efforts to address inefficient water use.

INTRODUCTION

3. METHODS

3.1 Summary of data collection

A desktop study was undertaken in 1998 to review readily accessible irrigation data about the Border Rivers (NSW) catchment. Information was collected from the following State and Commonwealth databases:

1. the ABS Irrigation Statistics Catalogue, AgStats (ABS 1998). The ABS collected information by Statistical Local Area (SLA) until 1996–97 and in most instances these units can be aggregated into the Border Rivers (NSW) catchment (Figure 2)[3].

   Only the most current years (1993–94, 1995–96 and 1996–97) with the same Estimated Value of Agricultural Operations (EVAO)[4] have been compared. For the grouping of SLAs used in this *Profile*, see Figure 2.

   Between 1997–98 and 1999–2000, the ABS collected information by Agro-Ecological Regions (AER) (Table 2). These regions are large and often cross many catchments and cannot be used to build catchment snapshots of irrigation. In 2000–01, the ABS is returning to collecting information by SLA.

[3] Note: SLAs are the same as Local Government Areas (LGA) in the NSW Border Rivers catchment. However, some SLAs may overlap catchment boundaries. For a definition of an SLA see Appendix 13.1.

[4] The population to be surveyed is determined from the Estimated Value of Agricultural Operations (EVAO). This is estimated from a procedure that takes into account the value of the area of crops sown and the number of livestock on holdings at a point in time as well as the crops produced and the livestock turnoff during the year. The resultant aggregation of these commodity values is termed the EVAO.

Figure 2. The Border Rivers (NSW) catchment related to ABS SLAs

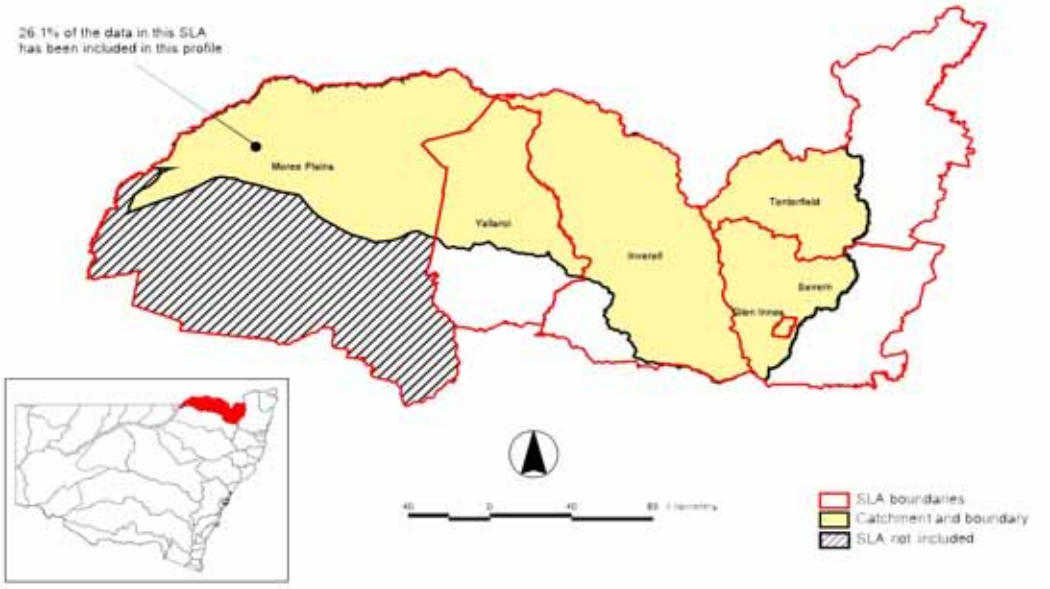


Table 2. EVAOs used by the ABS to collect NSW irrigation data

Year	EVAO ($)	Collection Unit
1986–87	20,000	SLA
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
1998–99	22,500	AER
1999–2000	22,500	AER
2000–01	5,000	SLA

When SLA data are aggregated, catchment totals may be over-estimated where SLAs cross into other catchments. For example, the Moree Plains SLA spanned both the Border Rivers (NSW) catchment, as described in this Profile, and the Gwydir catchment. A licence-based concordance was used to apportion the data in the Moree Plains SLA between these two catchments. For example, 26.1% of the data in the Moree Plains SLA was apportioned to the Border Rivers (NSW) catchment (Table 3 and Figure 2), with the remainder in the Gwydir catchment. For all other SLAs, 100% of the data were included when aggregating figures for the catchment. The amount of irrigation occurring in these SLAs is relatively small compared to Moree Plains SLA. The impact of proportioning SLA data on total catchment figures in the way described above would be insignificant.

Table 3. Proportion of surface licences within the SLAs of the Border Rivers (NSW) catchment and the Gwydir catchment

SLA	Border (NSW)	Gwydir
Glen Innes (M)	100%	
Inverell (S) - Pt A	90.3%	9.7%
Inverell (S) - Pt B	100%	
Moree Plains (S)	26.1%	67.7%
Severn (S)	77.6%	
Tenterfield (S)	56.1%	
Yallaroi (S)	23.1%	79.9%

See Appendix 14.1 for description on an SLA.

2. ABARE's 1996–97 Irrigated Farm Survey, which formed part of its Primary Industry, Resources and Energy (ASPIRE) database (ABARE 2000). The Barwon region (which includes the Namoi, Gwydir and Border Rivers (NSW) catchments) is the reporting unit for this survey, and these data cannot be disaggregated into smaller units such as SLAs or catchments.

3. a DLWC database of crop area and water use (DLWC 1998a). The DLWC has collected information on water use and area by crop type and by licence. These data can be aggregated to different scales.

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

Data were also obtained from research and industry reports and NSW Agriculture staff in regional offices. As these staff uncovered regional data (such as unpublished reports), this information was incorporated into the Profiles.

In this report, irrigation data are arranged at SLA, subcatchment and catchment levels.

3.2 Structure of this Profile

The availability and reliability of data in the Border Rivers (NSW) catchment has been summarised for five water sources: regulated rivers, unregulated rivers, groundwater, farm dam supplies and reticulated supplies. Data are presented in this manner because availability and reliability varied markedly for different sources. (This Profile has been prepared before the full implementation of the *Water Management Act 2000* but with knowledge of its provisions. A description of these sources follows.

Regulated rivers[5] are those rivers that have been declared by the Minister of Land and Water Conservation, by order published in the *Gazette*, to be a regulated river. Regulated rivers have their flows controlled by major government-owned rural dams (*Water Management Act 2000* (NSW). These capture water that is then released to users downstream when needed (DLWC 1999c). The Macintyre, Dumaresq and Severn rivers are the only regulated rivers in the Border Rivers (NSW) catchment.

Unregulated rivers[5] are all other rivers that are not regulated rivers (*Water Management Act 2000* (NSW)). Many 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 (*Water Management Act 2000* (NSW)).

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

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

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[5] **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) or 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

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

1. number of licences with the purpose of irrigation
2. number of irrigated enterprises
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.

3.3 Rating data reliability

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

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

2 **Class B –** 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 (that is, a survey that lacks detailed investigation or modelling, a preliminary survey).

4 **Class D –** derived without investigation; figures estimated from other data in nearby catchments or extrapolated or 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 Border Rivers (NSW) catchment was 151 (ABS 1998, ②)'.

METHODS

4. REGIONAL IRRIGATION OVERVIEW

4.1 Catchment description

The Border Rivers Catchment is located in the far north and north-west of NSW and extends into southern Qld. The total catchment area (NSW and Qld) is 49,500 square kilometres. Approximately 51% (Arthington 1995) or 25,580 square kilometres lies within NSW (DWR 1995). This Profile focuses on the NSW portion of the catchment (Figure 1).

Principal streams of the Border Rivers (NSW) catchment include the Macintyre, Dumaresq and Severn rivers. The catchment has three distinct zones with widely varying topography: upland, billabong and riverine plains (Peasley and Emery undated). In this Profile, these zones will be called the tablelands, slopes and plains regions.

- The tablelands region lies east of Texas and Ashford and is characterised by granite and basalt tablelands.
- The slopes region lies west of Ashford and Texas and is characterised by undulating country with numerous permanent and semi-permanent billabongs. This zone extends to about 20 km downstream of Boggabilla (Peasley and Emery undated).
- The plains region is downstream of Boggabilla where the terrain is undulating to flat. Floodplains stretch west towards Mungindi.

Floodplain management is an issue in the Border Rivers (NSW) catchment. Major floods have occurred on average once in 20 years over the last 80 years (State Catchment Management Coordinating Committee 1990). Occasionally large tropical depressions or cyclones penetrate south. When these combine with upper air disturbance, or southerly cold fronts, torrential rains can lead to major flooding (DWR 1995). Levee bank construction diverts floodwaters along floodways, thereby minimising damage to agricultural lands (MDBMC 1998).

Agriculture has been the main source of income for the catchment since the area was first settled. Approximately 63% of businesses in the catchment were partially or wholly reliant on agriculture, and agriculture directly employed about 25% of the catchment's workforce (Donovan 2000).

Historically, the area produced wheat, tobacco, sheep and cattle. Tobacco is no longer a major crop but wheat continues to be grown. Sheep and cattle are still grazed over much of the catchment (DWR 1995).

4.2 Climate

The western part of the Border Rivers (NSW) catchment has lower rainfall, higher evaporation and higher temperatures than the eastern portion (Table 4).

Table 4. Climate of the Border Rivers (NSW) catchment

Climate factors	Great Dividing Range (east)	Mungindi (west)
Average rainfall (mm)	800	500
Evaporation (pan) (mm)[a]	1,200	2,000
Long-term average max. summer temperature (°C)	27	35
Long-term min. summer temperature (°C)	14	20
Long-term max. winter temperature (°C)	23	20
Long-term min. winter temperature (°C)	1	5
Number of frosts per year	80	20

Source: (McCosker 1996; DWR 1995) [a]US Class A pan evaporation

Irrigation water is needed during summer when the evaporative deficit[6] is the greatest. Crops in the west have both a greater physiological demand for water and a greater requirement for irrigation water than crops in the east (Figure 3).

As with most river systems in inland NSW, stream flows are highly variable. Total annual rainfall can vary greatly from year to year. At Boggabilla, annual rainfalls have ranged from 174 mm in 1902 to 1,041 mm in 1950 representing 30 to 170% of the mean annual rainfall of 600 mm (DWR 1995). At Boggabilla, recorded annual flows have ranged from zero to five times the average of 930,000 ML/yr (DWR 1995).

[6] The evaporative deficit is the difference between reference evapotranspiration and rainfall and gives some indication of when irrigation water is needed by crops. Reference evapotranspiration is the amount of evaporation and transpiration of a grass reference crop and was determined using the FAO 56 methodology (Allen et al. 1998). Climatic data were obtained from the (Bureau of Meteorology 2000).

Figure 3. Evaporative deficit at Mungindi (west) and Inverell (east)

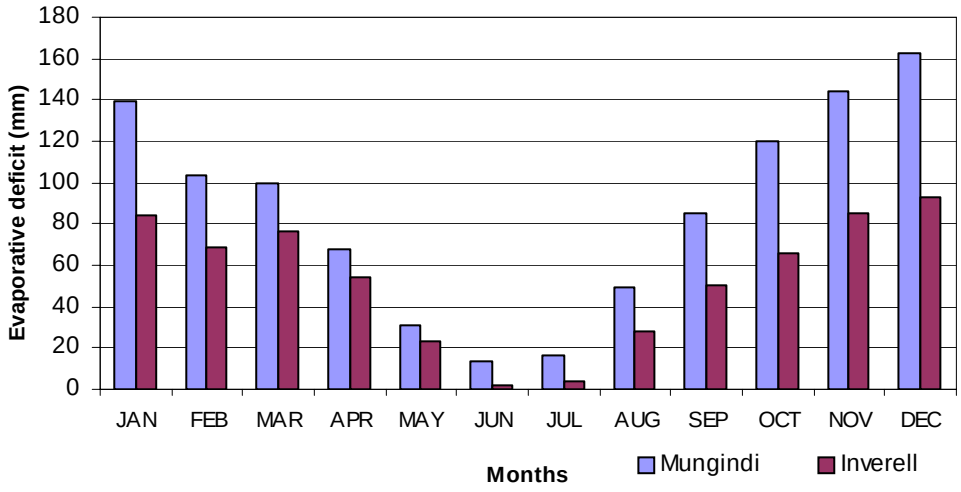


Table 5 provides a relative indication of river flows in the Qld and NSW Border Rivers catchment.

Table 5. Average yearly flows in the Border Rivers (Qld and NSW) catchment

Stream	Gauging station	Average annual flow (ML/yr)
Severn R. (NSW)		90,000
Mole R. (NSW)	Donaldson	130,000
Pike Creek (Qld)	Glenlyon Dam	80,000
Dumaresq R. (Border)	Bonshaw Weir	440,000
Severn R. (NSW)	Pindari Dam	180,000
Macintyre R. (NSW)	Wallangra	135,000
Macintyre R. (Border)	Boggabilla	930,000
Barwon R. (Border)	Mungindi	635,000
Boomi R. (NSW)	Neeworra	220,000

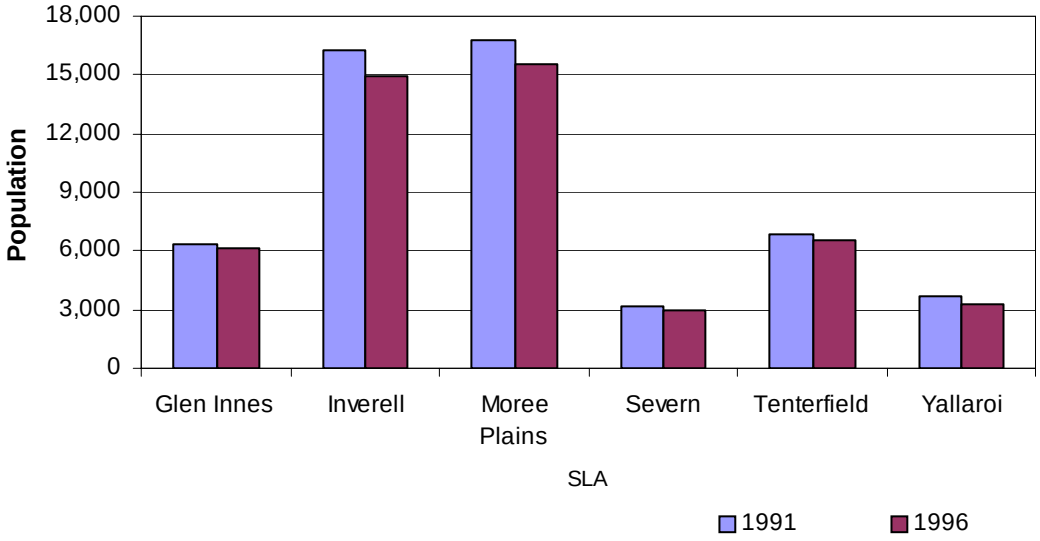
Source: (DWR 1995)

The change in seasonal stream flows, resulting from the demands of irrigation, has not been as marked in the Border Rivers (NSW) catchment as in the Namoi and Gwydir catchments, as summer rainfall is more dominant in the Border Rivers (NSW) catchment (Appendix 14.2). Approximately 55% of annual rain occurs between November and March, which coincides closely with peak irrigation demands from summer crops like cotton (DWR 1995).

4.3 Population

The total population in the NSW Border Rivers catchment declined from 52,968 to 49,188 between 1991 and 1996 (ABS 2000) ①[7], reflecting a population decline in all SLAs (Figure 4). Most of the catchment's population is in the east, with major centres being Inverell, Glen Innes and Tenterfield. Inverell is the largest centre with a population of approximately 10,000 (EPA 1997).

Figure 4. Population change in the Border Rivers (NSW) catchment SLAs between 1991 and 1996



The western area is served by smaller centres such as Boggabilla and Mungindi. Boggabilla is the largest of these with approximately 750 people (EPA 1997; McCosker 1996). Goondiwindi lies just over the Qld border from Boggabilla and has a population of about 4,500. This town also provides ginning facilities for cotton and services the irrigation industry on both sides of the Macintyre River. Further information on demographics can be found in DLWC 1999b.

[7] These data were collected by census survey and attract the highest reliability rating.

5. IRRIGATION FROM ALL SOURCES

5.1 Description of irrigation in the catchment

Before the construction of major storage facilities, riparian land use and irrigation focused on livestock, grain and fodder. Sheep grazing occupied much of the higher country and cattle were grazed on the river flats (Bourne 1980).

Since construction of major dams, the area of irrigated land has been steadily increasing. In 1969, most irrigation occurred along the Dumaresq River east of Glenarbon Weir (QDPI and IWSC 1969). Crops such as lucerne, tobacco (Dunlop 1980), wheat and oats were grown and sheep and cattle grazing continued to be economically important for the area (QDPI and IWSC 1969).

In 1976, approximately 8,500 ha in the Border Rivers (NSW) catchment was put on issue or approved for irrigation (DWR 1995) but only 2,000 to 3,000 ha of the licensed area were actually irrigated (DWR 1995 ②; DLWC 1996 ②). This occurred despite 107 properties having access to river frontage.

Irrigation commenced on a larger scale with the completion of Glenlyon Dam on the Pike Creek (Qld) in 1976 and access to regulated water supplies. Water resources continued to be accessed from traditional supplies (unregulated streams, overland flows and groundwater).

By 1984, summer crops such as cotton, grain, sorghum, soybeans and winter cereals were being regularly irrigated (Ring *et al.* 1984).

Irrigated agriculture within the Border Rivers (NSW) catchment now sustains a variety of cropping enterprises such as grain, fibre crops and fodder crops (Peasley and Emery undated). Cotton occupies the greatest proportion of irrigated land within the catchment but its range is limited to the lower, flatter, western portion of the valley. On the Macintyre floodplains, past Boggabilla, the soil type most suitable to irrigated agriculture is the deep, grey cracking clay (Northcote 1966). The growth of the cotton industry has been limited by water shortages rather than by a lack of suitable land (Arthington 1995)[8].

Due to the variability in climate, on-farm storages are essential to ensure adequate water supply during droughts. These storages take advantage of large off-allocation flows (Dowling 1992) and capture farm drainage from both rainwater and irrigation tailwater (DWR 1995). They are also essential for the management of on-allocation water. Information from a DLWC database known as the Licence Administration System (LAS) shows the region to have a large on-farm storage capacity totalling 146,000 ML (D Barma, pers. comm.).
Most storage facilities hold between 1,000 ML to 5,000 ML with a few as large as 18,000 ML (DWR 1995).

[8] The location of cotton growing areas has been mapped by Peasley (nd).

IRRIGATION FROM ALL SOURCES

In the east of the catchment, irrigation occurs mostly on small river flats (CWPR 1990). The narrow floodplains of the upper catchment mainly consist of highly fertile alluvial deposits of loamy black soils (TCM undated). Lucerne is the major irrigated crop of the upper catchment but horticulture and viticulture are emerging as new enterprises. Pasture is also irrigated for fattening cattle.

Water sharing in the Border Rivers (NSW) catchment is governed by the NSW–Qld Border Rivers Agreement. The agreement is administered by the Dumaresq-Barwon Border Rivers Commission, which is responsible for:

- conserving and sharing the waters of the Dumaresq River upstream of Mingoola
- regulating the Border Rivers downstream of Mingoola
- equitable distribution of the waters of the streams which intersect the Qld and NSW border west of Mungindi (also known as the 'intersecting streams')
- the overall management of groundwater resources in the region (DWR 1995).

The Border Rivers (NSW) catchment is also affected by the MDB Cap on diversions, which effectively limits further expansion of irrigation in the area (MDBC 1998). The cap value has not yet been determined. It is anticipated that a final figure will be arrived at following discussions regarding a suitable uplift factor for the enlarged Pindari Dam.

Table 6 summarises the most reliable data on irrigation in the Border Rivers (NSW) catchment. It demonstrates the lack of available data, especially regarding total water used.

Table 6. Summary of irrigation data in the Border Rivers (NSW) catchment

Year	No. enterprises irrigating [a]	Total irrigated area (ha) [a]	Area of cotton irrigated (ha)	Total water used by irrigated agriculture (ML)	Total water used on cotton (ML)	Yield of cotton (t/ha)	Value of irrigation ($/m) [f](Qld & NSW)	Value of cotton ($/m) [f](Qld & NSW)
1988–89	-	25,500[b]	24,000 [b]	-	-	1.8 [d]	-	-
1989–90	-	28,000[b]	26,500[b]	-	-	1.6 [d]	-	-
1990–91	-	30,000[b]	27,000[b]	-	-	1.7 [d]	-	-
1991–92	-	27,000[b]	24,000[b]	-	-	1.6 [d]	199	121
1992–93	-	31,000[b]	26,000[b]	-	-	1.8 [d]	164	90
1993–94	228	30,723 [a] 25,500[b]	12,547 [a] 21,000[b]	-	-	1.7 [d]	122	47
1994–95	-	30,000[c] 14,500[b]	13,000[b]	-	-	1.8 [d]	136	55
1995–96	107	17,248 [a] 17,500[b]	34,000 [b]	-	-	-	194	99
1996–97	151	27,159 [a] 37,000[b]	22,287[a] 33,000[b]	-	-	1.6 [e]	271	168
1997–98	-	39,000[b]	34,500[b]	-	-	-	-	-
1998–99	-	39,000[b]	35,000[b]	-	-	-	-	-
1999–00	-	40,000[b]	37,000[b]	-	-	-	-	-
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. Cotton areas were taken from the ABS 'other crop'[9] category.

[b] (*pers. comm.* D. Barma) ②. [c](DWR undated; DLWC 1996)②. [d](Hearn and Cameron Agriculture 1997)③. Numbers refer to the Qld and NSW Border Rivers catchment.

[e](ABARE 2000) ③. [f](Donovan 2000).

[9] 'Other crops' refers to field peas, chick peas, lupins, nursery production, canola, soybean, sunflowers, peanuts, tobacco and other. Most of this category is largely cotton.

5.2 Number of licences

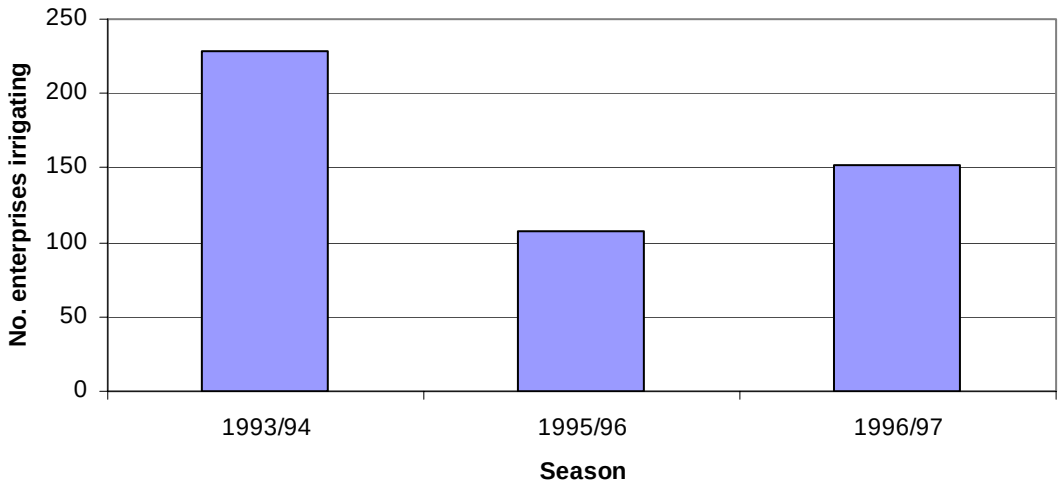
There are 445 licences with the purpose of irrigating in the Border Rivers (NSW) catchment. This figure was estimated by summing the number of regulated, unregulated and groundwater licences and then subtracting the number groundwater licences with conjunctive use from this total.

- regulated supplies: 146 (DLWC 1999b)①
- unregulated supplies: 280 (DLWC 1999b)①
- groundwater supplies: 65 (DLWC 1996)①. 46 of these have conjunctive use.

5.3 Number of enterprises using irrigation

There were 151 enterprises using irrigation in the Border Rivers (NSW) catchment in 1993–94. Of these, 32% were in Inverell (Part A)[10] SLA, 29% were in Tenterfield, and 18% were in Moree Plains (Appendix 14.3) ②. Over the period between 1993–94, 1995–96 and 1996–97, there was a decline in the number of enterprises irrigating in most SLAs (Figure 5) (Appendix 14.3) ② with the 1995–96 season having the smallest number. This decline is a statewide trend and should be treated with caution.

Figure 5. Number of enterprises irrigating in SLAs of the Border Rivers (NSW) catchment



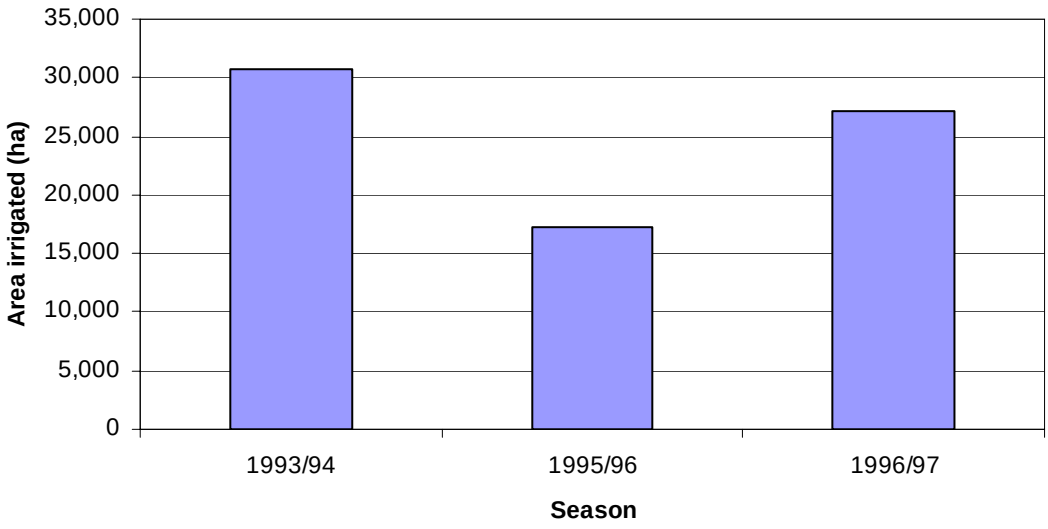
Source: (ABS 1998) ②

[10] Inverell SLA has been split into Part A and Part B, the result of the Local Government Area (LGA) being split into Statistical Divisions. Part A usually denotes the more urban part of the split.

5.4 Area irrigated and water used

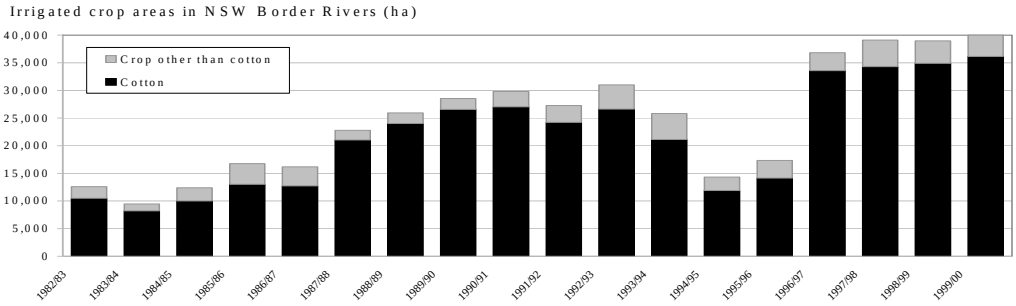
Area irrigated – The total irrigated area in the Border Rivers (NSW) catchment ranged between 15,000 ha and 40,000 ha between 1988–89 and 1999–2000 (Table 6). Where comparisons between different references could be made, figures were reasonably close in some instances (for example, 1993–94) and quite different in others (for example, 1996–97) (Table 6). According to the ABS figures, the total area irrigated decreased slightly between 1993–94 and 1996–97 (Figure 6 and Table 6). This trend contradicts other references which show an increase in area irrigated (Figure 7). The situation makes it difficult for a user unfamiliar with the vagaries of each data-set to choose the most reliable information.

Figure 6. Area irrigated (ha) in SLAs of the Border Rivers (NSW) catchment



Source: (ABS 1998)②

Figure 7. Total area irrigated[11] and the area sown with irrigated cotton in the Border Rivers (NSW) catchment

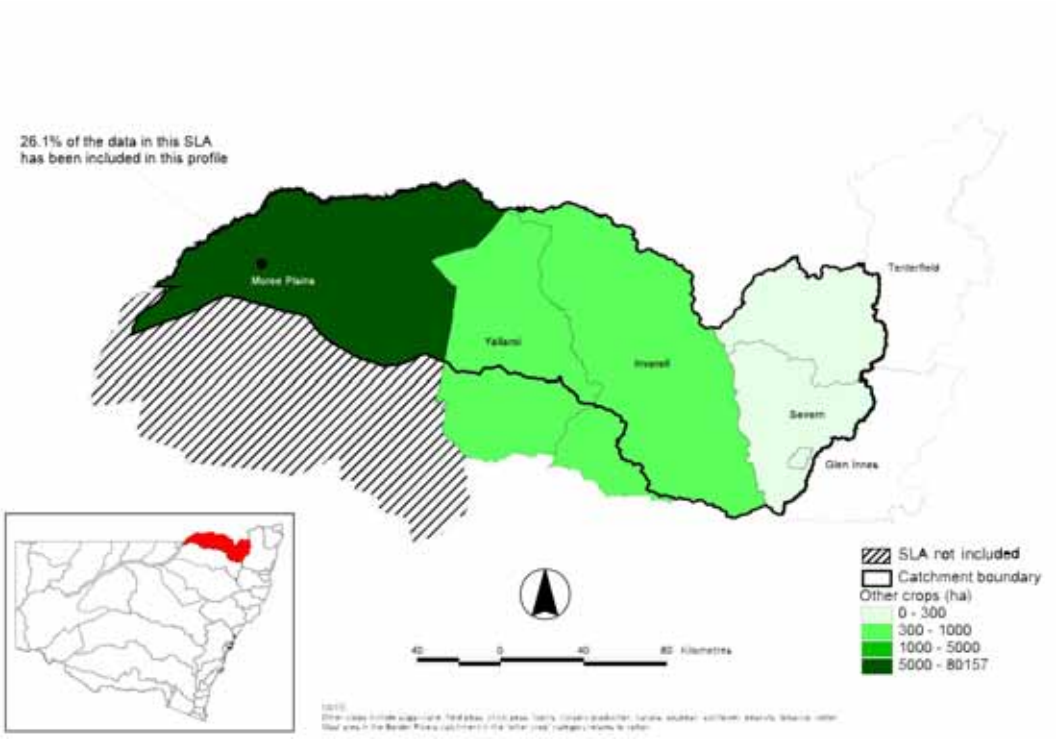


Source: (pers. comm. D. Barma) ②.

Cotton was the main irrigated crop grown in the Border Rivers (NSW) catchment and between 13,000 ha and 37,000 ha were irrigated (1988–89 and 1999–00) (Table 6). Cotton was grown mostly on the flat riverine plains of the catchment (NSW) encompassed by the Moree Plains SLA (Figure 8). Where comparisons between ABS figures and DLWC figures could be made, figures were quite different (Table 6). Both datasets show an increase in the area irrigated between 1993-94 and 1996-97.

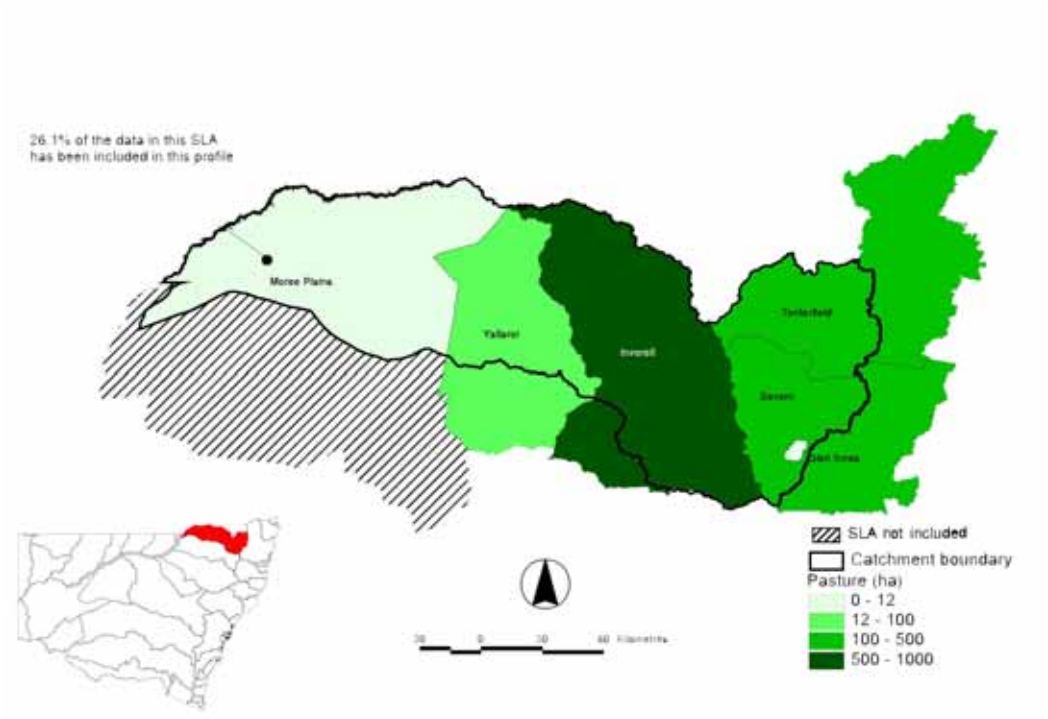
[11] Crop area estimates are based on farmer surveys conducted by DLWC metering staff.

Figure 8. Area of 'other crops' (mostly cotton) irrigated in the Border Rivers (NSW) catchment



After cotton, pasture had the next largest irrigated crop area in the NSW Border Rivers catchment. Pasture was mostly concentrated in Inverell SLA (Figure 9). Unlike irrigated cotton areas, irrigated pasture areas dropped between 1993–94 and 1996–97 (Appendix 14.4).

Figure 9. Area of irrigated pasture in the Border Rivers catchment (NSW)



Water used – It was not possible to determine accurately the total volume of water used by irrigated agriculture due to difficulties in obtaining a year where there was a complete set of data for all water sources[12]. For example, in 1996–97, it was estimated that between 175,000 and 180,000 ML ④ of irrigation water was used, based on data shown in Table 1. Data were available for a series of years for the regulated system. However, information for unregulated supplies, groundwater, farm dams and reticulated water supplies were non-existent, scant or unreliable. Data from other years had to be used to obtain this estimate.

Data on volumes of water applied to most crops in total and on a per hectare basis were virtually non-existent. Hearn and Cameron Agriculture (1997) attempted to estimate the amount of water used on cotton from all sources. Their figures suggest that a mean of 171,544 ML was used between 1988–89 and 1994–95 for the entire Border Rivers catchment (NSW and Qld). Hearn and Cameron Agriculture (1997) suggest that the application of irrigation water on cotton ranged from 6.1 to 20.9 ML/ha over this period. This upper figure appears exceptionally high and may be the result of extracting water from the river in one year and using it in another.

[12] Data from the (ABARE 2000) survey show that the Barwon Region (of which the Border Rivers catchment is a part) used approximately 551, 000 ML in 1996–97 ③. These figures are for dairy and broadarea enterprises only and do not include fruit, vegetables and horticultural crops.

For crops other than cotton, the availability of application rates is hampered by a lack of information regarding volumes used on crops from groundwater and unregulated supplies. In addition, the ability to estimate crop application rates post-1995 is limited by a paucity of crop water use information from all water sources including the regulated system. Theoretical estimates of irrigation requirements (see Table 7) or estimates of water use (Appendix 14.5) must suffice.

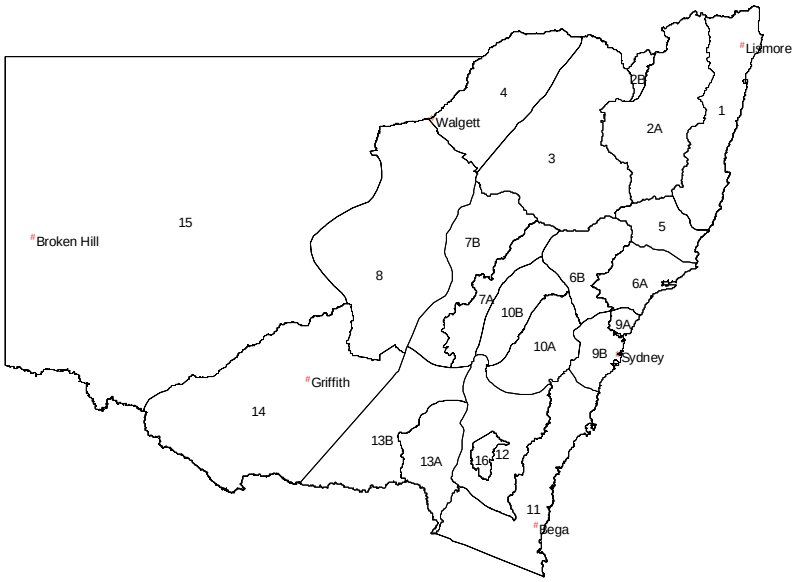
Table 7. Annual irrigation requirement of crops in the Border Rivers (NSW) catchment

Crop	Tablelands (ML/ha)[a]	Slopes (ML/ha)	Plains (ML/ha)
Turf	11	11.5	
Orchards	5–5.5	9	
Nuts	5	9	
Citrus	4.5–5.5	8.5	
Vegetables	3.5–6.5	8	
Cotton		7.5	9
Perennial pasture (dairy)	7–7.5	7.5	
Lucerne	5–6	6.5	7
Summer cereal	3–3.5	6	8.5
Summer oilseeds	3	6	8
Perennial pasture (non dairy)	5.5–6	6	
Pulses	3.5	5.5	8
Vines	1.5–2	4.5	
Annual pasture	3–3.5	4.5	
Winter oilseeds	3.5	4	
Olives	4		
Winter cereal	2.5	3	4

Source: (DLWC 2000c)③.

[a] Information on zones can be found in DLWC (2000c). Climatic zones are shown in Figure 10. The figures for the tablelands are an amalgamation of data for Climate Zones 2a and b. The figures for the slopes are from Climate Zone 3. The figures for the plains are from Climate Zone 4.

Figure 10. Climatic zones in the Border Rivers (NSW) catchment



5.5 Irrigation methods

An estimated 91% of the area irrigated on broadarea and dairy enterprises in NSW was irrigated using surface methods (ABARE 2000) ③ (Appendix 14.6). Figures for the Barwon region, of which the Border catchment (NSW) is a part, were only slightly greater.

In the tablelands, fixed spray or bike shift systems are used for lucerne. Much of the berry fruits, wine grapes, pome and stone fruits and some vegetables are irrigated using the drip systems. Vegetables are also irrigated with sprinkler systems.

On the floodplains of the Border Rivers (NSW) catchment, most broadarea crops (for example, cotton, cereals, legumes, and oilseeds) are supplied with water in furrows. Cotton irrigated using drip tape has been trialled (Anthony 1996; Anthony 1993). On undulating country, cotton is also irrigated using centre pivots (Browne 1982). Vegetable crops are irrigated using centre pivots, spray systems or drip, while pasture is irrigated by spray systems (Appendix 14.5).

5.6 Yields of irrigated crops

Information on irrigated yields from all sources of water is poor and most data were obtained through personal communication or published reports (Table 8). Some data were obtained from the 1996–97 ABARE survey of broadarea and dairy enterprises.

Irrigated cotton has achieved:

- 1.75 t/ha as the long-term average yield (1988–89 and 1994–95) (Hearn and Cameron Agriculture 1997) (Table 8); and
- 2 t/ha in a good season and 1.1 t/ha in a poor season (Powell 1996).

Boyce (1997) estimated that with continually improving varieties, yields of 2.25 t/ha are a realistic goal for cotton farmers. Yields will vary from season to season with changing water availability and factors such as pests, diseases and nutrition.

Typical irrigated yields for wheat were around 2.5 t/ha to 4.0 t/ha in the early 1970s (Kerr 1971). More recent estimates (1999) show that irrigated wheat is attaining 5 t/ha on the floodplains of the Barwon region around Moree and between 6 and 9 t/ha in the tablelands around Inverell (see Appendix 14.5). There were no data on horticultural and vegetable yields.

A summary of available information on irrigation yields for irrigated crops is shown in Table 8.

Table 8. Irrigated crop yields in the Border Rivers (NSW) catchment

Crop	Average (t/ha)	Range (t/ha)	Reference	Reliability rating
Barley	6	4–8	J Lowien, pers. comm.	④
	4.2		(Coulton 1979, *pers. comm.* G. Shaw and J. Kneipp, *pers. comm.* L Hyson)	④
Grain sorghum	7.5	6–10	(Coulton 1979, *pers. comm.* G. Shaw and J. Kneipp, *pers. comm.* L Hyson)	④
	2.9		(ABARE 2000) [a]	③
	6.26		(Coulton 1979, *pers. comm.* G. Shaw and J. Kneipp, *pers. comm.* L Hyson)	④
Maize	10	7.3–12	J Lowien, pers. comm.	④
	6		(*pers. comm.* J. Spenceley)	④
	8		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④
Oats	5	4–8	J Lowien, pers. comm.	④
Triticale	4	3–7	J Lowien, pers. comm.	④
Wheat	7	6–9	J Lowien, pers. comm.	④
		2.5–4	Kerr 1971	

Crop	Average (t/ha)	Range (t/ha)	Reference	Reliability rating
	4.5		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④
Soybeans	3.6	2.5–5	J Lowien, pers. comm.	④
	2.5		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④
Pasture – annual	10	6–12	J Lowien, pers. comm.	④
Pasture – perennial	8	4–12	J Lowien, pers. comm.	
Lucerne	6.4		ABARE 2000 [b]	③
	12		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④
Cotton	1.8	1–2.9	J Spenceley (Moree)	④
	1.6		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④
		1.1–2	Powell 1996	
	1.75	1.6–1.8	Hearn and Cameron Agriculture 1997	③[13]
Sunflower	2.25		Coulton 1979; G Shaw, J Kneipp, L Hyson pers. comm.	④

[a] **grain sorghum** – relative standard error (%) (RSE[14]): tonnes, 40 and hectares, 42.

[b] **lucerne** – RSE (%) : t, 28 and ha 23.

[13] Data on the area and production of cotton and other crops were obtained from the ABS, supplemented by statistics published by *The Australian Cotton Grower* magazine (Hearn and Cameron Agriculture 1997).

[14] The Relative Standard Error (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

Information presented in this section refers to the combined value of the Qld and NSW sections of the Border Rivers catchment. Data for the NSW section only were unavailable. However, since two thirds of the water is used on the NSW side of the catchment, then two thirds of the value of irrigated agriculture could be attributed to NSW.

The Border Rivers catchment economy is based mainly on agriculture, the value of which has changed markedly over the last decade. In the 1993–94 season, the total value of agriculture was either $523 million (Donovan 2000) ③ or $328 million (DLWC 1996) (reliability unknown). By 1996–97, the total value was $824 million (Donovan 2000) ② (Figure 11).

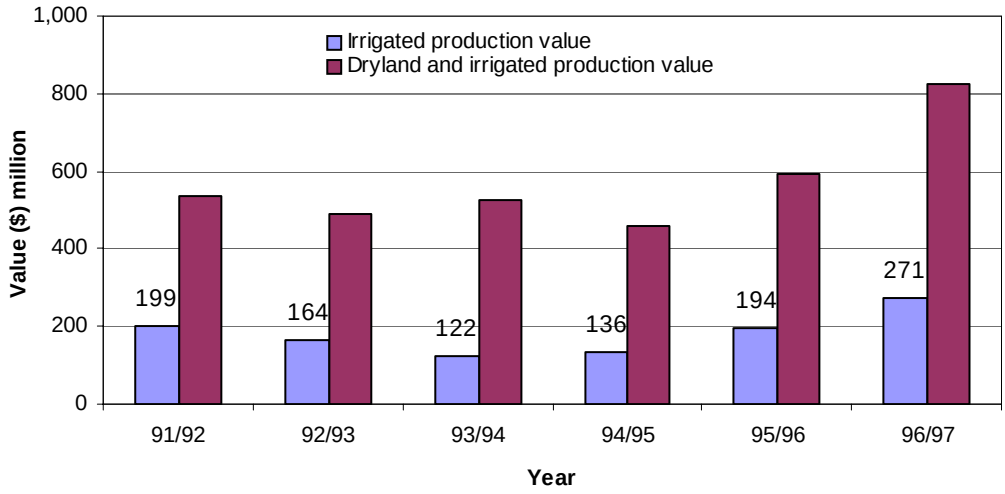
Estimates for the total value of irrigated agriculture range from $132 million (Powell *et al.* 1993) to $164 million (Donovan 2000) ③ (1991–92), with the more recent figure of $271 million (1996–97) (Donovan 2000) ③.

Of the total value of agriculture estimated each year by Donovan (2000), between 23% and 37% could be attributed to irrigated agriculture ③ .

Figures on the value of irrigated agriculture from Donovan (2000) were synthetically generated. The individual irrigated commodity values for Australia were derived by estimating the percentage of the total commodity value that could be attributed to irrigation. The irrigated percentage was determined from agency reports and consultation with industry bodies (DWC 1990) (reliability unknown). 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 2000②). 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 likely to be more 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.

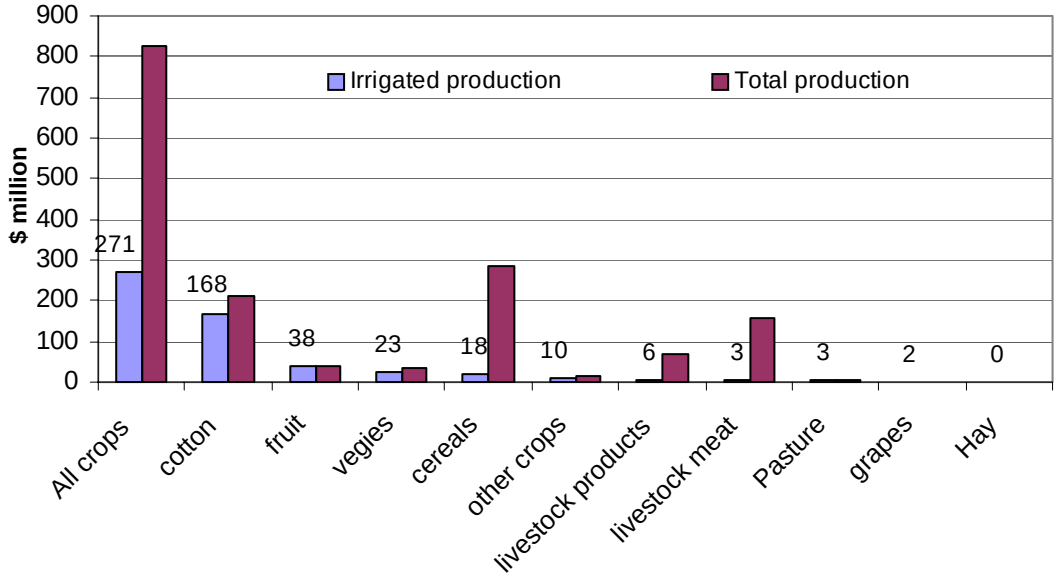
Figure 11. Total value of produce that can be attributed to irrigation in the Border Rivers catchment (Qld and NSW)



Source: Donovan (2000) ③.

Cotton returns the greatest income in the catchment (Figure 12) and the value of this industry has been increasing. In 1991–92, irrigated cotton was worth either $121 million (Donovan 2000) ③ or $123 million (Powell *et al.* 1993) (reliability unknown). The first figure was estimated using the methodology described above. The second figure was determined for the major irrigated cotton-producing lands of the Lower Border Rivers Catchment. The study region extended from 10 km east of Goondiwindi to Mungindi and 5 to 10 km either side of the Macintyre River (Powell *et al.* 1993). By 1996–97, cotton was either $168 million (Donovan 2000) ③ (Figure 12) or $166 million (EPA 1997) ④. Cotton underwent a slump in value over the drought period between 1993 and 1995. Since that period, values have returned to and exceeded pre-drought period levels (Appendix 14.7).

Figure 12. Value of irrigated production in the Border Rivers catchment (Qld and NSW) in 1996–97



Source: (Donovan 2000) ③. 'Other crops' refers to field peas, chick peas, lupins, nursery production, canola, soybean, sunflowers, peanuts, tobacco and other.

The next most valuable irrigated crop category was fruit & nuts (excluding grapes) (Figure 12). A high value horticulture industry is concentrated in the Qld granite belt area of the tablelands. Like cotton, this category underwent a slump in value during the drought and dropped from around $34 million in 1990–91 to approximately $26 million in 1993–94. By 1996–97, the values had climbed to $38 million (Appendix 14.7) (Donovan 2000) ③.

Vegetables were the third most valuable irrigated industry in the area. Unlike fruit & nuts and cotton, vegetable values steadily increased over the period between 1991 and 1996 from $19 million to $30 million and by 1996-97 was $ 23 million (Appendix 14.7) (Donovan 2000) ③. Furthermore, this category maintained value regardless of drought. In each year, between 89% and 92% of the total value of vegetables could be attributed to irrigation from regulated rivers.

6. IRRIGATION FROM REGULATED SUPPLY

6.1 Description of the regulated water supply

Regulated watercourses in the Border Rivers (NSW) catchment include the Dumaresq, Severn and Macintyre rivers. These are controlled by storages and weirs at the top of the catchment that capture and release water for irrigation downstream. Pindari Dam regulates the Severn and Macintyre rivers. Glenlyon Dam regulates a short section of Pike Creek in Qld, the Dumaresq River and the Macintyre River.

Water extraction in the Border Rivers (NSW) catchment has been controlled to some extent by interstate water-sharing agreements. The Dumaresq-Barwon Border Rivers Commission was formed in 1946 to oversee sharing between NSW and Qld users. The commission has constructed river-regulating works that control the flow of water to both states (Table 9).

Table 9. Major structures for river regulation in the Border Rivers catchment

Structure	Completed	Capacity (ML)	Location	Sharing
Glenlyon Dam	1976	253,000	Pike Ck, Qld	Qld & NSW
Pindari Dam	1969	37,000	Severn R, NSW	NSW only
Pindari Dam enlargement	1994	312,000	Severn R, NSW	NSW only
Coolmunda Dam		75,400	Macintyre Brook, Qld	Qld only

Sources: (DWR undated; EPA 1997; Dumaresq-Barwon Border Rivers Commission 1984; DWR 1995).

A series of weirs control the flow of water along the major rivers in the catchment (Table 10) (DWR 1995). For a description of water-sharing arrangements between the Qld and NSW see (DWR 1995) and (EPA 1997).

The irrigation industry in the catchment has developed over many decades. In the 1930s, members of the Ashford Shire Council proposed the first irrigation development in the Upper Darling Basin (Bourne 1980). This proposal was followed by a public meeting in Narrabri in 1935, where the Premier of NSW promised funds to investigate options for the construction of dams in the Upper Darling Basin, including the Border Rivers System (Sommerlad 1978). Despite continued lobbying, little action was taken until 1968, when an amendment to the Border Rivers Agreement allowed for the construction of small dams on tributaries within the catchment (Bourne 1980). Because of this amendment, work began on the Glenlyon Dam on Pike Creek to provide regulated water for downstream irrigation expansion.

The enlargement of Pindari Dam in 1994 was intended to fix supply problems within the catchment. It was expected that after an 8-fold increase in dam capacity, security of entitlements to irrigators would increase from 45% of entitlement in 45% of years to 100% of entitlement in 70% of years (DWR 1995).

Table 10. Major regulating weirs in the Border Rivers catchment

Weirs	River	Capacity (ML)	Main purpose
Mungindi	Barwon	730	Town water supply
Boomi	Macintyre		Diversion
Goondiwindi	Macintyre	1,660	Town water supply
Boggabilla	Macintyre	5,400	Irrigation
Glenarbon	Dumaresq	350	Irrigation
Cunningham	Dumaresq	540	Irrigation
Bonshaw	Dumaresq	620	Irrigation

Sources: (DWR undated; EPA 1997; Dumaresq-Barwon Border Rivers Commission 1984; DWR 1995).

Table 11 summarises the most reliable sources of information only.
Other, less reliable data are referred to in the discussion.

Table 11. Summary of irrigation data from regulated supplies

Year (Oct–Sep)	Number enterprises irrigating	Total irrigated area (ha)	Area of cotton irrigated (ha)	Total water used by irrigated agriculture (ML)	Total water used by cotton (ML) (incl. vol. pumped to storages) [b]	Yield of cotton (t/ha)	Value of irrigation ($/m)	Value of cotton ($/m)
1988–90	–	24,260 [a] 27,000[f]	23,000 [a] 23,000[f]	143,166[f]		1.8 [d]	–	–
1989–90	–	26,875 [a] 36,907 [b] 30,000[f]	25,535 [a] 34,870 [b] 25,000[f]	157,358[b] 158,573[f]	149,474	1.6 [d]	–	–
1990–91	–	28,150 [a] 32,628 [b] 30,000[f]	26,000 [a] 27,758 [b] 25,800[f]	148,216 [b] 155,800 [c] 153231[f]	135,049	1.7 [d]	–	–
1991–92	–	25,580 [a] 28,116 [b] 26,000 [f]	23,200 [a] 25,108 [b] 23,200[f]	177,207 [b] 170,900[c] 175053f	164,000	1.6 [d]	–	–
1992–93	–	28,324 [a] 31,042 [b] 27,700[f]	24,600 [a] 28,594 [b] 24,690[f]	138,647 [b] 128,200 [c] 132,879[f]	125,319	1.8 [d]	–	–
1993–94	–	23,156 [a] 21,965 [b] 21,500[f]	19,088 [a] 20,473 [b] 19,000[f]	111,647 [b] 106,700[c] 107,306[f]	103,502	1.7 [d]	–	–
1994–95	–	11,670 [a] 12,372 [b] 10,400[f]	9,840 [a] 10,251 [b] 9,800[f]	54,734 [b] 56,800 [c] 57,504[f]	49,618	1.8 [d]	–	–
1995–96	–	14,650 [a] 25,000[f]	12,134 [a] 19,600[f]	138,500[c] 136,802[f]	–	–	–	–
1996–97	–	34,163 [a] 34,400[f]	31,555 [a] 31,600[f]	169,500 [c] 169,812[f]	–	1.6 [e]	–	–
1997–98	–	36,867 [a] 37,647[f]	34,247 [a] 34,247[f]	188,000 [c] 187,643[f]	–	–	–	–
1998–99	–	38,165[f]	34,600[f]	164,331[f]	–	–	–	–
1999–00	–	39,927[f]	36,172[f]	177,350[f]	–	–	–	–
2000–01	–	39,245[f]	36,200 [f]	232,418[f]	–	–	–	–
Refer to Section	6.4	6.5	6.5	6.5	6.5	6.7	6.8	6.8

[a](DLWC 1999a)② local database – Goondiwindi Office, DLWC

[b](DLWC 1998a)② State database from LAS

[c](DLWC 1998b)① State database for Cap determination

[d] (Hearn and Cameron Agriculture 1997)③

[e] (ABARE 2000) ③

[f] (BRFF 2002) ②

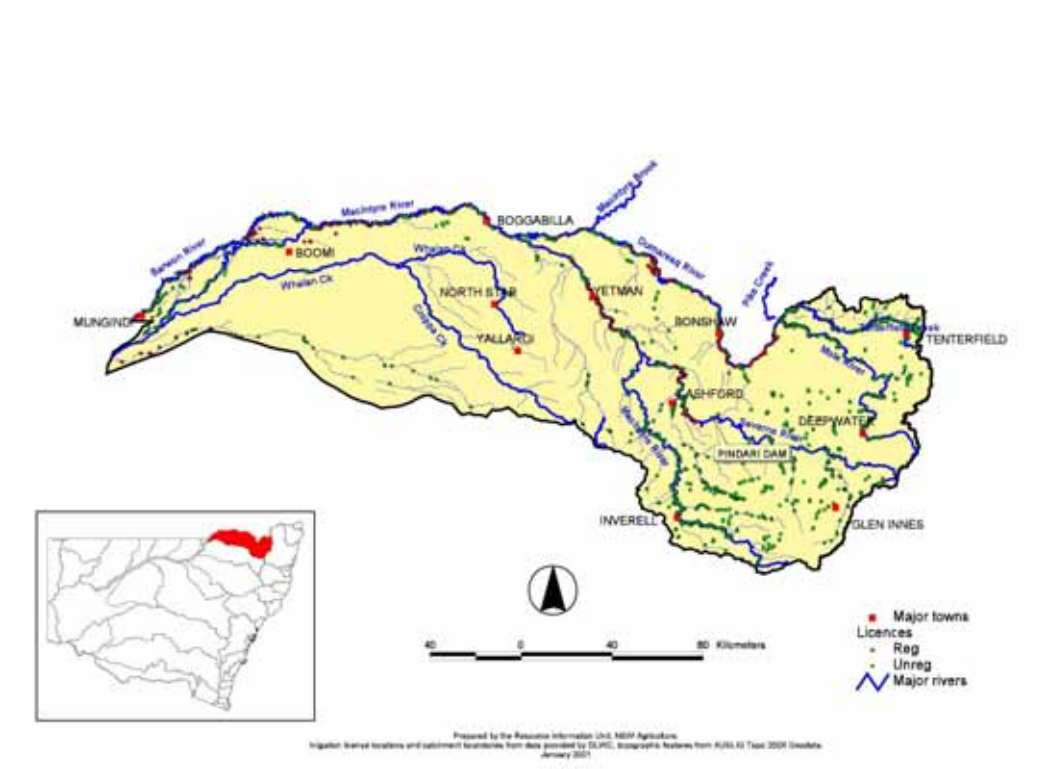
6.2 Number of volumetric licences

The total number of licences for all purposes in the Border Rivers (NSW) catchment is 157 (DLWC 1999b)①.

Most irrigation licences are spread out along the Severn, Dumaresq and Macintyre rivers.

Of the 157 licences for all purposes, there are 146 with the purpose of irrigation ①. The location of these licences using water from the regulated system is shown in Figure 13.

Figure 13. Location of surface licences with the purpose of irrigation in the Border Rivers (NSW) catchment



6.3 Volumetric entitlement

The total entitlement for all purposes from the Border Rivers (NSW) catchment regulated river system is 270,188 ML (Table 12) (DLWC 1999b)①. Almost 99% of the surface water entitlement is for irrigation purposes (DLWC 1999b). In 1981 a system was introduced which effectively treated the first 60 ML of licensed entitlement as high security water. General security users would be allocated:

- an 'A' component, or up to 60 ML, of their entitlement in the initial announced annual allocations, followed by;
- a 'B' component, or the announced percentage, of the available water over 60 ML of entitlement.

In most years, users could be assured of receiving at least 60 ML of licensed entitlement. The availability of water over 60 ML would be subject to climatic conditions and the amount of water stored in dams (DWR 1995).

The amount of water allocated for irrigation varies from season to season and is dependent on the availability of water supplies. For example, in 1999–2000 an allocation of 60% was announced in late November which, when combined with 40% carryover from the 1998–99 season, provided a total resource availability of 265,000 ML, not including off-allocation (D Barma, pers. comm.) ① [15]. Carryover water[16] could be used in addition to any water received as part of the annual allocation for the next season. Continuous accounting was introduced for the 2001–02 season as a five year trial. This means that individual licence holders now manage their own carryover.

Table 12. Number of licences and entitled volume

Purpose	Number of licences	Entitlement volume (ML)
Augmentation	4	
Domestic	32	312
Horticulture	2	355
Industrial	6	868
Irrigation	146	267,106[a]
Receation – high security	1	10
Recreation – low security	1	20
Stock	47	897
Town water	3	620
Total		**270,188**

Source: (DLWC 1999b)①. Note some licences have multiple purposes and therefore the number of licences by different purpose cannot be added together to obtain a total. [a]BRFF uses a figure of 265,000 ML (B. McCollum pers. comm).

In 1993–94 limits were placed on off-allocation extraction to provide for inter-user equity and environmental requirements (DWR 1995). Off-allocation flows are those which are considered to be surplus to all consumptive needs: that is, when high flows

[15] A reliability rating of ① has been assigned to this information. These data have been sourced from the Licence Administration System (LAS) and from regional staff.

[16] Carryover water - When part or all of an entitlement is 'carried over' from one year to the next

occur within a regulated stream, the water manager may announce the availability of off-allocation water, which will not be debited against regulated allocations. Large on-farm storages have been installed on many lower catchment irrigation farms to store and take advantage of off-allocation flows. The maximum off-allocation cap for the Border Rivers (NSW) catchment is 120,000 ML.

6.4 Number of enterprises irrigating

There are no data on the number of enterprises irrigating from regulated supplies in the Border Rivers (NSW) catchment. In 1993–94, the ABS conducted a survey to show how many enterprises were using water from the different water sources. The questionnaire did not clearly differentiate between unregulated and regulated systems (Appendix 14.8). As a result, some SLAs have recorded usage from regulated streams where there are no regulating structures present[17]. The estimated number of enterprises irrigating from regulated and unregulated supplies was 325 (Table 1).

6.5 Area irrigated and water used

Area irrigated: The total area irrigated from regulated supplies has ranged from a high in 1999–2000 of nearly 40,000 ha to a low of 10,400 ha (1994–95) ② (see Table 11). Area planted can usually be directly related to announced allocations and this is reflected during 1994–95 when allocations were zero (Appendix 14.9).

A comparison between figures obtained from DLWC at different times and from different locations (*ie.* Goondiwindi and Sydney) shows figures are mostly close. Reasons for the small differences between figures are not known. The 1995–96 season was an exception and again the cause of the difference is not known.

Cotton had the largest irrigated area representing between 80 and 90% of the total area irrigated. Cotton irrigated area figures from different references were mostly close. Again, there was some difference between area figures for 1995–96 and 1989–90 (Table 11)② and the reasons for these difference are not known.

Following cotton, lucerne had the second largest crop area averaging 741 ha between 1989–90 and 1994–95 ② (DLWC 1998a) ② (Appendix 14.10).

Water used: The amount of water used from regulated supplies varies from season to season. A minimum of 54,734 ML ①[18] was used in 1994–95 (Table 11) and a maximum of 232,418 ML was extracted during 2000–01 (Table 11). There is a heavy reliance on storages in the catchment.

There is a significant difference in the pattern of water use during wet and dry years. With only about 13% of the catchment's area contributing runoff into dams, tributary

[17] In most cases, SLAs had both regulated and unregulated licences within their boundaries. Unregulated-only SLAs could not be separated from regulated-only SLAs.

[18] Total water diversions receive a reliability rating of ① since these data were from metered information.

inflows are considerable in wet years. This off-allocation water is used in preference to on allocation water from the dams, which is left there for future use. The relative proportion of on and off allocation usage thus changes from season to season, with on-allocation featuring more prominently in drier periods.

Typically water (on and off-allocation) is pumped from the river into a storage and then onto a crop. Water may be held in large on-farm storages to be used in subsequent years. Any estimation of application rates for a particular year *(*water use divided by area), may therefore be misleading. Analysis of application rates needs to be undertaken over a series of years rather than just one year. The analysis would need to account for volumes of water captured in one year and then used on a crop in subsequent years.

A large proportion of the total extracted volume was used to irrigate cotton directly or stored for future use on cotton. Consequently, actual use on cotton from the regulated system would be close to the subtotal figures shown in Table 13 (titled cotton water use). The reliability of these figures would be reduced given there is a lack of information regarding the volumes of water taken from storage dams on used on cotton.

Table 13. Amount of water used (ML) by cotton in the Border Rivers (NSW) catchment between 1989–90 and 1994–95

Crops	1989–90	1990–91	1991–92	1992–93	1993–94	1994–95
Cotton (ML) ②[20]	83,977	49,576	115,941	121,982	47,455	28,204
Storage (ML) ②[20]	65,497	85,473	48,059	3 337	56,047	21,414
Cotton water use (Sum of cotton plus storage volume (ML) ③)	149,474	135,049	164,000	125,319	103,502	49,618
Total water use (ML) ① [19]	**157,358**	**148,216**	**177,207**	**138,647**	**112,647**	**54,734**
% of total WU that was used on cotton (actual use plus storage volume)	95.0	91.1	92.5	90.4	91.9	90.7

Source: (DLWC 1998a)①

The volume of water pumped into on-farm storages within the catchment varies considerably from year to year depending on factors such as the availability of off-allocation or surplus waters. The capacity of on-farm storages in the Border Rivers (NSW) catchment has increased markedly between 1989 and 1995. In 1989, the total

storage capacity in NSW was 50,500 ML (CWPR 1990) (reliability unknown). By 1994–95 between 135,000 ML and 141,000 ML could have been pumped into on-farm storages in the Border Rivers (NSW) catchment (DLWC 1996; McCosker 1996) (reliability unknown). The estimated total on-farm storage capacity in the catchment has changed very little over the last five seasons, with a total volume at the start of the 1999–2000 season of 146,000 ML (*pers. comm*. D. Barma) ①[19].

Lucerne was the second largest user of water recording a maximum of 6,518 ML ②[20] or around 5% of total regulated water extractions in 1992–93 (Appendix 14.10).

6.6 Irrigation methods

There were no data on irrigation methods used by enterprises extracting water from regulated rivers only. See Section 5.5 for information on methods generally used in the catchment.

6.7 Yields of irrigated crops

There were no data on the yields of irrigated crops grown using water from regulated supplies only. As most of the cotton grown in the catchment is reliant on water from regulated supplies, data in Section 5.6 can be used.

6.8 Value of irrigated production

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

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[19] A reliability rating of ① has been assigned to this information. These data have been sourced from the Licence Administration System (LAS) and from regional staff.

[20] The total volume of water used on individual crops receives a reliability rating of ②. These data were estimated by meter inspectors.

7. IRRIGATION FROM UNREGULATED SUPPLY

7.1 Description of the unregulated water supply

Flows in unregulated streams in the Border Rivers catchment follow the summer-dominant rainfall pattern with high flows from December to February and low flows from April to May (WRC 1980). (See Table 14 for a list of unregulated streams.)

Irrigation is generally confined to small alluvial flats and access to water is highly variable. Unregulated rivers in the Border Rivers (NSW) catchment have few, if any, regulating structures. This is in stark contrast to some coastal unregulated rivers, for example, the Hawkesbury-Nepean River, which is highly controlled for city and industrial water needs.

Table 14. Major unregulated streams in the Border Rivers (Qld and NSW) catchment

Stream	State	Unregulated section
Frazers Creek	NSW	Entire length
Macintyre River	NSW	Upstream of junction with the Severn River
Ottleys Creek	NSW	Entire length
Whalan Creek	NSW	Entire length
Severn River	NSW	Upstream of Pindari Dam
Beardy River	NSW	Entire length
Mole River	NSW	Entire length
Tenterfield Creek	NSW/Qld	Entire length
Weir River	Qld	Entire length
Severn River	Qld	Upstream of junction with the Mole River
Pike Creek	Qld	Upstream of Glenlyon Dam
Macintyre Brook	Qld	Upstream of Coolmunda Dam
Canning Creek	Qld	Upstream of Coolmunda Dam
Callandoon Creek	Qld	Entire length.

Source: (Resource Science Centre undated) Note Callandoon Creek is also a source for regulated water obtained from the trunk stream.

The way water is managed in the Border Rivers (NSW) catchment has changed markedly over the last decade.

- In 1993, an embargo was placed on the issue of any licences for areas greater than 10 ha (DWR 1995). This has reduced irrigation development in the catchment.
- Since 1998, Water Management Committees have been developing water-sharing plans in each catchment across NSW. Subcatchments were assessed for levels of stress in 1999 and these ratings are helping the development of water-sharing plans for the NSW section of the Border Rivers catchment (see Appendix **Error! Reference source not found.**).
- Licences on unregulated streams were converted from area-basis to volume-basis in 2000 and it is expected that in future the volume of water used will be metered (DLWC 2000c).

Table 15 summarises irrigation from unregulated rivers in the NSW Border Rivers catchment based on the most reliable sources of information only.

Table 15 . Summary of irrigation data – unregulated water supply

Year	Number enterprises irrigating	Total irrigated area (ha)	Area of lucerne irrigated (ha)	Total water use by irrigated agriculture (ML)	Water use by lucerne (ML)	Yield of lucerne (t/ha)	Value of irrigation ($/m)	Value of lucerne ($/m)
1988–89	-	-	-	-	-	-	-	-
1989–90	-	986[a]	270[a]	2,761	-	-	-	-
1990–91	-	873 [a]	333 [a]	2,549	-	-	-	-
1991–92	-	1,080 [a]	319 [a]	3,218	-	-	-	-
1992–93	-	902 [a]	302 [a]	4,899	-	-	-	-
1993–94	-	1,682 [a] 2,671[b]	489 [a] 1,261 [b]	2,020	-	-	-	-
1994–95	-	2,287 [a] 3,051 [b]	554 [a] 1,349 [b]	2,761	-	-	-	-
1995–96	-	3,148 [b]	1,202 [b]	-	-	-	-	-
1996–97	-	3,343 [b]	1,003 [b]	-	-	-	-	-
1997–98	-	3,618 [b]	991 [b]	-	-	-	-	-
1998–99	-	3,483 [b]	911 [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) ③ [b](DLWC 2000b)②

7.2 Number of licences for irrigating

There are 344 licences using water from unregulated streams and of these, 280 have the purpose of irrigation (Table 16). The location of these is shown in Figure 13**.**

Table 16. Number of licences using water from unregulated streams

Purpose	Number of licences
Augmentation	10
Changing course	1
Conservation of water	6
Domestic	41
Farming	2
Industrial	5
Industrial – sand and gravel	3
Irrigation	280
Mining	16
Pisciculture	1
Recirculation	1
Recreation – low security	7
Stock	55
Town water supply	4

Source: (DLWC 1999b) ①. Note some licences have multiple purposes and therefore the number of licences by different purposes cannot be added to obtain a total.

7.3 Number of enterprises irrigating

There were no data on the number of enterprises irrigating with water from unregulated supplies in the Border Rivers (NSW) catchment. As noted in the Section 6, the ABS questionnaire did not clearly differentiate between unregulated and regulated systems (Appendix 14.8). As a result, some SLAs have recorded usage from regulated streams where there are no regulating structures present; this usage should have been classified as unregulated.

7.4 Volumetric entitlement to irrigation

Licences on unregulated streams have been converted from area-basis to volume-basis. The total volumetric entitlement is not yet available. Before conversion, 7,918 ha were authorised for irrigation (DLWC 1999b)①.

7.5 Area irrigated and water used

Area irrigated: The total area irrigated from unregulated streams in the Border Rivers (NSW) catchment ranged from around 2,700 ha to 3,600 ha between 1993–94 and 1998–99 ② (Appendix 14.12). These data are also summarised in Table 15. Where comparisons can be made, these were generally close (Table 15). Even so, caution should be exercised when viewing DLWC data (DLWC 1998a) ③. These data were collected from growers by crop return surveys and the return rate was often poor. No attempt was made to scale the data or to estimate the area irrigated from growers who failed to return survey forms.

DLWC (2000b) ② data shown in Table 15 are considered to be more complete and more reliable than DLWC (1998a) data ③. The information shows an increase for the period from 1993-94 to 1998-99. These data were collected by written survey as part of the volumetric conversion process outlined in DLWC (2000c). As part of this process, growers were asked to supply DLWC with information regarding areas irrigated *etc.* to ensure a reasonable conversion of their irrigation licence from area-basis to volume-basis. On an individual crop basis, the area irrigated for cotton, winter cereals and pulses increased while that for vegetables, lucerne and summer oilseeds decreased (Table 17).

Table 17. Changes in the area irrigated from 1993–94 to 1998–99

Crop	Change in area irrigated from 1993–94 to 1998–99 (%)
Cotton	524
Winter cereal	210
Pulses	120
Annual Pasture	69
Vines – wine grapes	40
Trees – Orchards	37
Summer cereal	25
Turf	23
Other	8
Fodder	3
Trees – other	3
Vines – table grapes	2
Perennial Pasture	1
Olives	1
Nurseries	0
Vegetables	-6
Lucerne	-28
Summer oilseeds	-100
Grand total	30

Source: DLWC (2000b)

Water used: Data on water use from unregulated streams in the Border Rivers (NSW) catchment are very poor. The DLWC collected information from growers by crop return cards between 1988–89 and 1994–95. The data attract a low reliability rating as not all growers submitted returns. These data show that extraction of water ranged from 2,000 ML in 1993–94 to nearly 5,000 ML in 1992–93 ④ (Appendix 14.13). These figures are summarised in Table 15. There are no data on the total amount of water used on different crops.

7.6 Irrigation methods

There were no data on methods used to irrigate crops with water from the unregulated sections of the Border Rivers (NSW) catchment. Refer to Section 5.5 for further details of methods used in the catchment generally.

7.7 Yields of irrigated crops

Information relating specifically to irrigated yields from unregulated sources in the catchment has not been collected. See Section 5.6 for yields from all sources.

7.8 Value of irrigated production

There were no data on the value of irrigated production from unregulated sources.

8. IRRIGATION FROM GROUNDWATER

8.1 Description of groundwater

There has been limited development of groundwater resources in the Border Rivers (NSW) catchment by irrigated agriculture. There are an estimated 350,000,000 ML in storage in the alluvial Dumaresq Valley Groundwater Area on the NSW side of the catchment (DWR 1995). However, only a fraction of the exploitable reserves (less than 1%) have been used (DWR 1995). The estimated average annual recharge of the alluvium in the combined Qld and NSW Border Rivers catchment is 30,000 ML/yr – the NSW portion has half this figure. The potential estimated annual yield or the sum of the recharge in any year and an acceptable rate of depletion is estimated to be 61,500 ML/yr (DWR 1995). According to the WRC (WRC 1980), the exploitable annual yield in 1980 was 190,000 ML (Appendix 0).

The largest source of groundwater in the Border Rivers (NSW) catchment is the Great Artesian Basin (GAB). The GAB intake beds on the western slopes of the Great Dividing Range provides a sources of water that is suitable for irrigation. Most of the water from the GAB is unsuitable for irrigation. While the salinity is quite low and is less than 1,563 EC units (DWR 1995), the water is highly alkaline. Prolonged use of water high in dissolved minerals can adversely affect plants and soils (DWR 1995).

Alluvial aquifers are more important sources of water to irrigators than the GAB. The narrow and variable alluvial deposits along the Dumaresq River and Ottleys Creek have been developed for irrigation to some extent[21] (WRC 1980). A draft water sharing plan for the GAB is being finalised.

Currently the NSW Government is developing a Groundwater Structural Adjustment Program for the Lower Border 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.

Table 18 provides a summary of data that are available on groundwater use in the Border Rivers (NSW) catchment.

[21] A comprehensive description of the groundwater resources of the Border Rivers system is provided by the DWR (1995) and the Water Resources Commission's NSW State Water Plan Task Force (1984).

Table 18. Summary of irrigation from groundwater supplies

Year	Number enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of lucerne irrigated (ha) [a]	Total water used by irrigated agriculture (ML)[b]	Water use by cotton (ML)	Yield of cotton (t/ha)	Value of irrigation ($/m)	Value of cotton ($/m)
1988–89	–	250[b]	–	1,900	–	–	–	–
1989–90	–	200 [b]	–	–	–	–	–	–
1990–91	–	400 [b]	–	–	–	–	–	–
1991–92	–	100 [b]	–	–	–	–	–	–
1992–93	–	–	–	–	–	–	–	–
1993–94	30	6,828[a] 1,010[b]	–	5,000	–	–	–	–
1994–95	–	–	–	–	–	–	–	–
1995–96	–	–	–	–	–	–	–	–
1996–97	–	–	–	–	–	–	–	–
1997–98	–	–	–	–	–	–	–	–
1998–99	–	–	–	–	–	–	–	–
1999–00	–	–	–	–	–	–	–	–
2000–01	–	–	–	–	–	–	–	–
Refer to Section	8.3		8.5					

[a](ABS 1998)② [b](DWR 1995)④

8.2 Number of licences for irrigation

There are 65 irrigation bore licences in the Border Rivers (NSW) alluvium. Nineteen are groundwater only and 46 are conjunctive use licences (DLWC 1996) ①.

8.3 Number of enterprises irrigating

There were 30 enterprises irrigating from groundwater supplies in the Border Rivers catchment (ABS 1998) ② and 40% of these enterprises were in the Inverell (Part A) SLA (Appendix 0).

8.4 Volume entitled to irrigation

A volumetric allocation scheme operates in the Border Rivers (NSW) catchment. Entitlements are based on the area of the property and are independent of the number of bores on each property. The entitlement for each property was calculated on historical usage during 1980 and 1988 or the previous area authorised for irrigation using groundwater multiplied by 6 ML/ha, whichever was the greater volume. For new groundwater irrigators, the property entitlement was 6 ML/ha with an upper limit of 1,000 ML per year (DWR 1995). Upstream of Keetah, a small number of irrigators are using groundwater in conjunction with surface water. These irrigators have an upper entitlement of 1,000 ML per property. When surface water allocations are less than 100%, groundwater can be used to cover the difference. This system will be changed to a scheme where conjunctive licences will be split into regulated and groundwater licences.

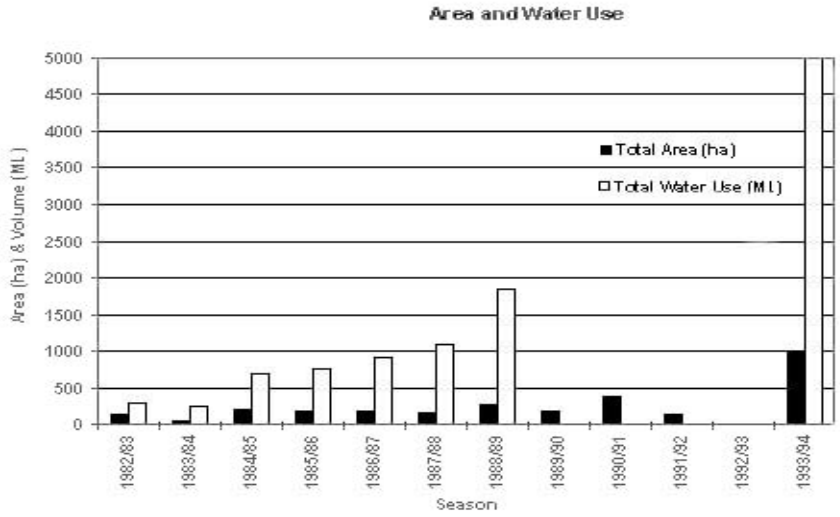
8.5 Area irrigated and water used

Area irrigated - The area irrigated from groundwater in the Border Rivers (NSW) catchment in 1993–94 was either 1,010 ha (DWR 1995) ④ (Table 18) or 6,828 ha (ABS 1998) ②. The first figure was determined from crop return cards and may be unreliable due to a poor return rate. The second figure was determined from a census of all irrigation enterprises with an EVAO of greater than $5,000.

Groundwater is used to irrigate cereals, cotton, lucerne, pasture, fodder, orchards, vegetables and other crops. Moree Plains SLA had the greatest area irrigated with 5960 ha.

Water used - There was a maximum groundwater use of 5,000 ML in the 1993–94 season (DWR 1995) ④ and a minimum of 250 ML (1983–84) (Figure 14). As a percentage of total use from all sources (surface and groundwater), groundwater use accounted for roughly 3% (DWR 1995) ④.

Figure 14. Water use and area irrigated from groundwater sources in the Border Rivers (NSW) catchment 1982–83 to 1993–94



Source: (DWR 1995)[22]

8.6 Irrigation methods

Data on methods used to irrigate from groundwater supplies in the region were unavailable. See Section 5.5 for irrigation methods from all sources.

8.7 Yields of irrigated crops

There was no information on yields from crops irrigated from groundwater supplies. See Section 5.6 for yields from all sources.

8.8 Total value of irrigation

Data were unavailable on the value of irrigation from groundwater supplies.

[22] Data for seasons with zero use or area are not available. These data are to be used as an indication only based on voluntary return cards.

9. IRRIGATION FROM FARM DAMS

9.1 Description of farm dam supplies

Irrigation using water from farm dams is limited in the Border Rivers (NSW) catchment. Most enterprises using this water supply were in the Tenterfield SLA (ABS 1998)②. Irrigation enterprises on the riverine plains that pump water into large on-farm storages are not considered to be 'on-farm' storages in this *Profile*. Farm dams are those structures that capture water by gravity from watercourses or from overland run-off.

There have been considerable changes in the way farm dams are managed by the DLWC recently. In the past, a dam of up to 7 ML could be built without a licence providing the water was used for non-commercial purposes. This limit was considered inappropriate in many areas of NSW because there was no allowance for the size of the property or for climatic variation, and 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 of the *Water Management Act* 2000.

Table 19 is a summary of the availability of irrigation data from farm dams. The table demonstrates a paucity of information regarding this source of water.

Table 19. Summary of irrigation data: farm dams

Year	Number enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of major crop irrigated (ha) [a]	Total water used by irrigated agriculture (ML)	Water use by major crop (ML)	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	28	539	-	-	-	-	-	-
1994–95	-	-	-	-	-	-	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	-	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-		-	-	-	-
Refer to Section:	9.3		9.4					

[a](ABS 1998)②

9.2 Number of licences for irrigation

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

9.3 Number of enterprises irrigating

There were an estimated 28 enterprises irrigating using farm dams in the Border Rivers (NSW) catchment (ABS 1998)② in 1993–94. These enterprises were in Inverell, Moree Plains, Severn and the Tenterfield SLAs (ABS 1998)② (Appendix 0).

9.4 Area irrigated and water used

Area irrigated: In 1993–94, there were 539 ha irrigated using water from farm dams (ABS 1998)②. There were no data on the area of crops irrigated from farm dams.

Water used: Data on water used in total and by crop type have not been collected.

9.5 Irrigation methods

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

9.6 Yields of irrigated crops

See Section 5.6 for details on irrigated yields from all sources.

9.7 Value of irrigated production

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

10. IRRIGATION FROM RETICULATED SUPPLY

10.1 Description of irrigation from reticulated water supplies

The irrigation of crops from reticulated water supplies is virtually non existent in the Border Rivers (NSW) catchment. In 1993–94, the Glen Innes SLA reported the only use of water from this source.

Table 20 provides an overview of irrigation from reticulated water supplies in the Border Rivers (NSW) catchment.

Table 20. Summary of irrigation data in the NSW Border Rivers catchment – reticulated water supplies

Year	Number enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of major crop irrigated (ha) [a]	Total water used by irrigated agriculture (ML)	Water use by major crop (ML)	Yield of cotton (t/ha)	Value of irrigation ($/m)	Value of major crop ($/m)
1988–89	-	-	-	-	-	-	-	-
1989–90	-	-	-	-	-	-	-	-
1990–91	-	-	-	-	-	-	-	-
1991–92	-	-	-	-	-	-	-	-
1992–93	-	-	-	-	-	-	-	-
1993–94	1	2	-	-	-	-	-	-
1994–95	-	-	-	-	-	-	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	-	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-		-	-	-	-
Refer to Section	10.2		10.3					

[a](ABS 1998)②

10.2 Number of enterprises irrigating

There was only one enterprise irrigating using reticulated water supplies in the Glen Innes SLA (ABS 1998) ②.

10.3 Area irrigated and water used

Area irrigated - There were 2 ha of land irrigated from reticulated water supplies in the Glen Innes SLA (ABS 1998) ②. There are no data on crop areas irrigated.

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

10.4 Irrigation methods

See Section 5.5 for details on methods used to irrigate from all sources

10.5 Yields of irrigated crops

See Section 5.6 for details on irrigation yields from all sources.

10.6 Value of irrigated production

Data were unavailable on the value of irrigated production, but given the very small area irrigated the value is likely to be insignificant.

11. OPPORTUNITIES AND ISSUES

11.1 Opportunities

11.1.1 Improving irrigation data

- **Information on irrigation will be needed to help measure change as a result of the new sharing rules.** As new water sharing agreements are finalised, accurate and reliable data will be needed to assess their impact 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 provide better information regarding usage of water from unregulated streams.** Irrigators will be billed on the volume they use, rather than on authorised area and water use will eventually be metered and recorded by the DLWC. This will improve knowledge regarding crop water use and patterns of extraction, which will in turn improve management of unregulated rivers.
- **Reporting data at useful scales.** 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 confidentiality while maximising data usefulness to resource managers.
- **Data collected by DLWC from irrigators could be used to help promote WUE and IE.** DLWC crop area and water use information collected from NSW regulated rivers between 1989/90 and 1994/95 is the most comprehensive in the state. However, these data are no longer collected. Should collection resume, the information could be returned to irrigators in formats that might potentially stimulate interest in farm WUE. For example efficiencies could be calculated and provided as benchmarking material to irrigators each year. Crop area and water use data could help direct extension efforts (for example, WaterWise on the Farm) to where water is being used inefficiently.

11.1.2 Other opportunities for irrigated agriculture

Opportunities for irrigated agriculture in the Border Rivers (NSW) catchment will arise as water is liberated through water trading or increased water use efficiency (WUE).

- **Expansion of olives** - The opportunity exists to expand the olive industry that has already been established in the catchment (Magner 1997). Olives are suited the well-drained soils (RIRDC 1998) in the area and there is local infrastructure to support the industry at Inverell. Further development will depend on markets, access to water and funding.
- **Expansion of wine grapes** - The area planted with wine grapes has been growing steadily. When irrigated efficiently, wine grapes do not require large

amounts of water, and are a high value crop that can be grown on a small area of land. Further development will depend on access to water.

- **Redevelopment of the apple industry** - There may be opportunities to redevelop the apple industry that previously operated in the New England area, and to expand the stonefruit industry that is still active around Tenterfield. These industries may be able to take advantage of the pome and stonefruit infrastructure available in Qld's granite belt. Further development will depend on access to water.

- **Water trading** - 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 shown that water is moving from low-value to high-value enterprises. Available evidence suggests the same is occurring in NSW (DLWC 1999f).

11.2 Issues

11.2.1 Data issues

- **Irrigation data scarcity** - The implementation of water reforms requires a much greater range of irrigation data than is currently available (for example, data on crop area and water use, yield, production value and irrigation methods).

- **Collection scales** - Natural resource managers involved in developing water-sharing plans require data at planning scales, i.e., river-reach or subcatchment. There is a scarcity of data at or less than these scales, particularly with respect to yield, irrigation method and value of production. These data typically come from the ABARE or the ABS and present the following difficulties:

➢ The ABARE reports data for the Border Rivers (NSW), Gwydir and Namoi catchments as the Barwon region. This presentation is much larger than that required by, for example, WMCs. The survey results contain potentially useful information about yields and methods of irrigation but are of limited value at this scale.

➢ The ABS has been collecting data on irrigation by SLAs for a number of years. However, SLAs do not align well with catchment and subcatchment boundaries and consequently the area irrigated may be overestimated depending on the SLA composition and their relationship with catchment boundaries. This problem was partially overcome in this Profile by using a licence-based concordance. Only 26.1% of the data from Moree Plains SLA was included when calculating catchment totals.

➢ The ABS ceased collecting data by SLAs in 1996–97 and began collecting information by AER (Table 2). These AERs often span many catchments and cannot be disaggregated into smaller units such as catchments.

- **Difficulties with definitions** – In 1993-94, different ABS and DLWC definitions of regulated and unregulated water supplies meant the number of enterprises using water from these sources could not be accurately determined.
- **Lack of continuity in data collection** - The ABS has collected irrigation data at three different EVAOs or survey cut-off points over the last 13 years (Table 2). This makes it 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 actual change in the area irrigated. Only data between 1993–94 and 1996–97 were compared in this *Profile*.
- **The ability to calculate crop WUE and IE in the Border Rivers (NSW) catchment is limited.** The last time DLWC collected crop area and water use information for the regulated system in the Border Rivers (NSW) catchment was in 1994/95. Data on crop areas irrigated and water used from unregulated rivers, groundwater aquifers, farm dams and reticulated water supplies have never been collected.
- **Irrigators are being over-surveyed by agencies.** Up to three agencies have collected information from irrigators within the same year (*eg*. DLWC, ABS and ABARE). This may cause frustration in the irrigation community.

11.2.2 Other issues

- **The development of new industries may be limited by access to water.** New and developing industries such as cool-climate vineyards, cherries and olives (DLWC 1999f) are being restricted by access to water. Access to water has been noted as a factor that will limit the development of the olive industry nationally (RIRDC 1998). One of the only ways in which enterprises can obtain water is through trade. (There is a currently a cap on the provision of new licences. In other words, irrigators are now precluded from buying a completely new irrigation licence). However, there is an embargo on trading water from unregulated rivers to regulated rivers and vice versa. This is currently being considered in the development of water sharing plans. Trade from unregulated river to unregulated river is subject to interim guidelines introduced in December 1998 (DLWC 1999f).

  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.

12. SUMMARY

This Profile advocates a more comprehensive and consistent approach to the collection of irrigation statistics. An integrated data monitoring program could be developed which might have the following characteristics:

- a well defined method for collection and storage of irrigation data. Methods to ensure that data are of high quality are critical;
- protocols for the provision of irrigation data to the public by State agencies and private authorities. For example, reliability ratings and metadata (data about the data) could be attached to information;
- a single outlet or shop-front for irrigation data. This would reduce the problem of multiple databases arising from within the same organisation;

This Profile also advocates that two-way flow of information between agencies and irrigators be fostered. Data need to flow back to irrigators in forms that might potentially assist them make better water management decisions. This could in turn, over time, help improve WUE.

Two-way flow of information between data collecting agencies also needs to be facilitated in order to minimise the chances of duplicating of effort. Data also need to be collected at scales that are large enough to ensure confidentiality of individual enterprises but small enough to allow users to aggregate useful information.

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

SUMMARY

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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.

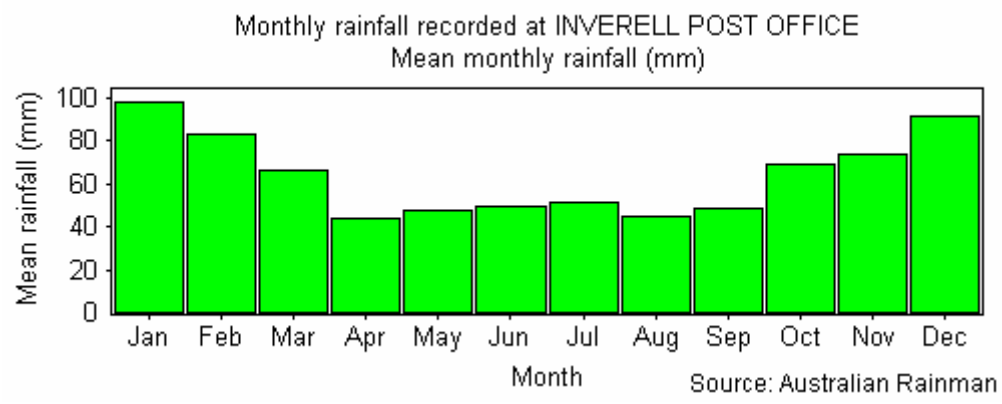
For those parts of Australia which are not administered by incorporated local government bodies, an SLA is an unincorporated area. Unincorporated SLAs cover the following areas:

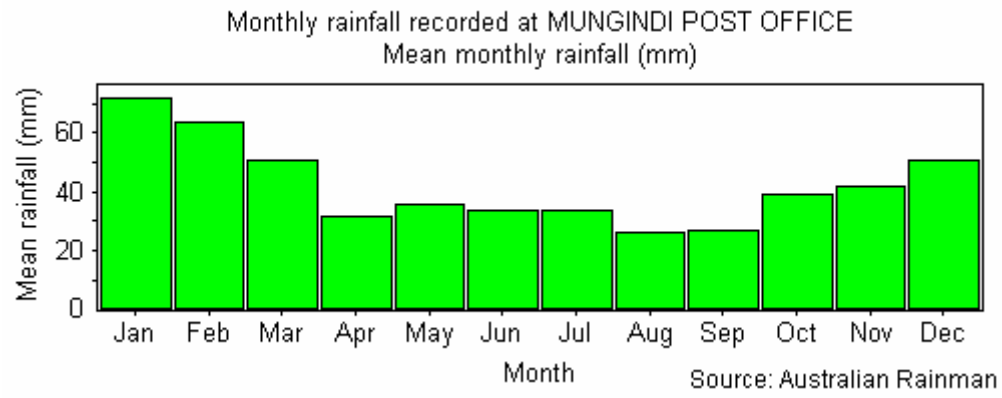
- unincorporated on-shore area(s) and/or off-shore island(s) in an SSD;
- that part of an unincorporated area which is considered of sufficient economic significance as to warrant the formation of a separate SLA;
- Off-Shore Areas & Migratory SLAs, formed for census purposes for all S/Ts except the Australian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

shipping and migratory CDs (off-shore, shipping and migratory CDs 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 Monthly rainfall in the Border Rivers (NSW) catchment



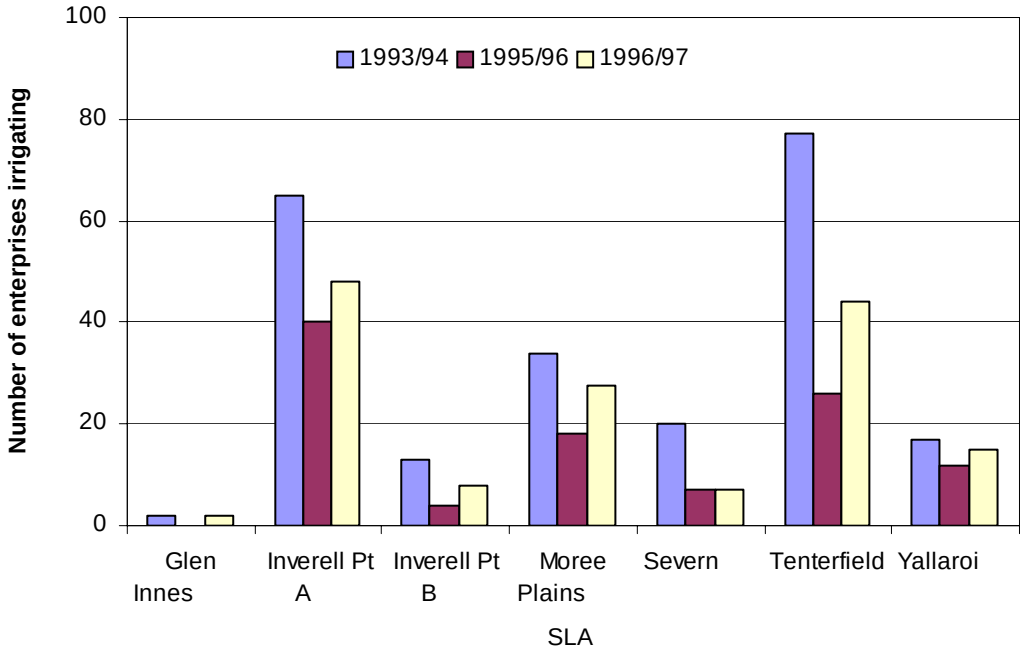


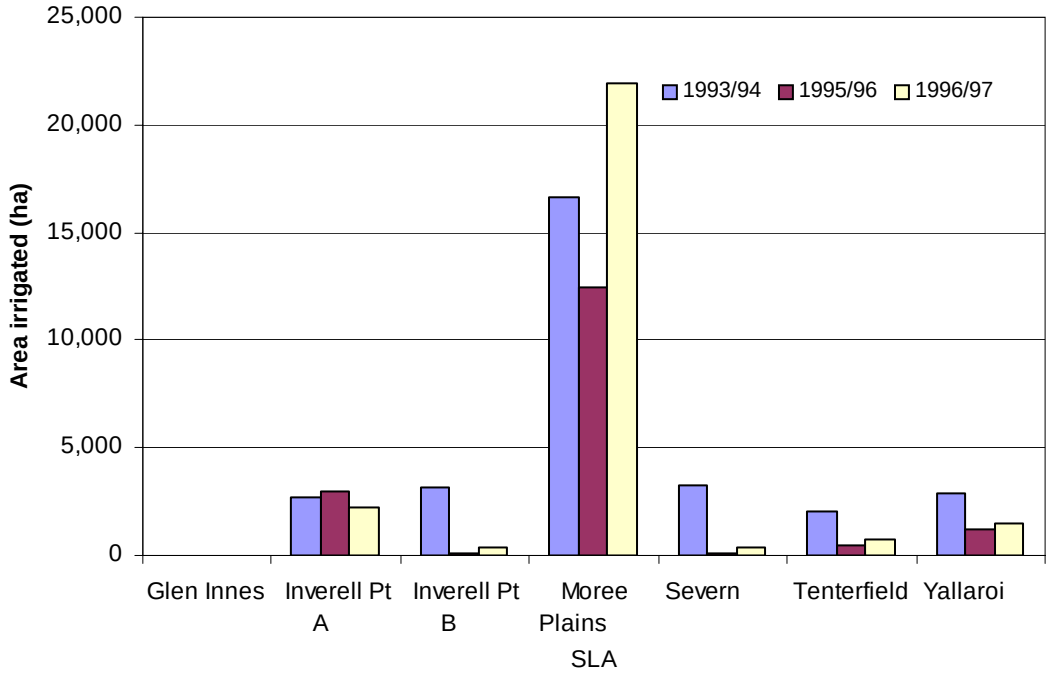
Source: (Clewett et al. 1999)

14.3 Number of irrigated enterprises and area irrigated in the Border Rivers (NSW) catchment in 1993–94, 1995–96 and 1996–97

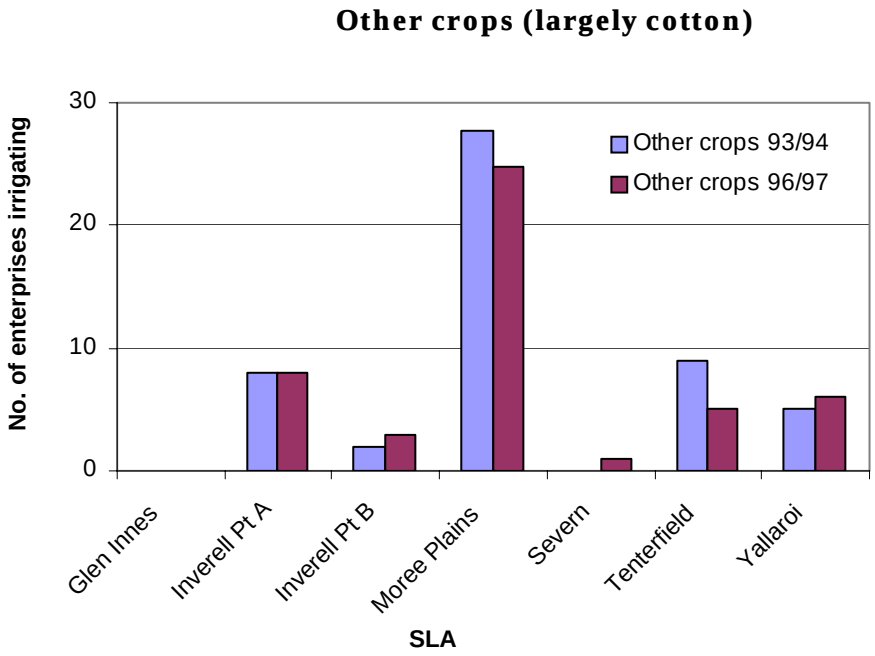
	1993–94		1995–96		1996–97	
Region	**Area (ha)**	**Number of enterprises**	**Area (ha)**	**Number of enterprises**	**Area (ha)**	**Number of enterprises**
Glen Innes	4	2			4	2
Inverell Pt A	2,724	65	2,987	40	2,221	48
Inverell Pt B	3,154	13	96	4	399	8
Moree Plains	16,613	34	12,424	18	21,977	27
Severn	3,249	20	78	7	351	7
Tenterfield	2,074	77	442	26	726	44
Yalleroi	2,905	17	1,221	12	1,480	15
Total	**30,723**	**228**	**17,248**	**107**	**27,159**	**151**

Source: (ABS 1998) ②

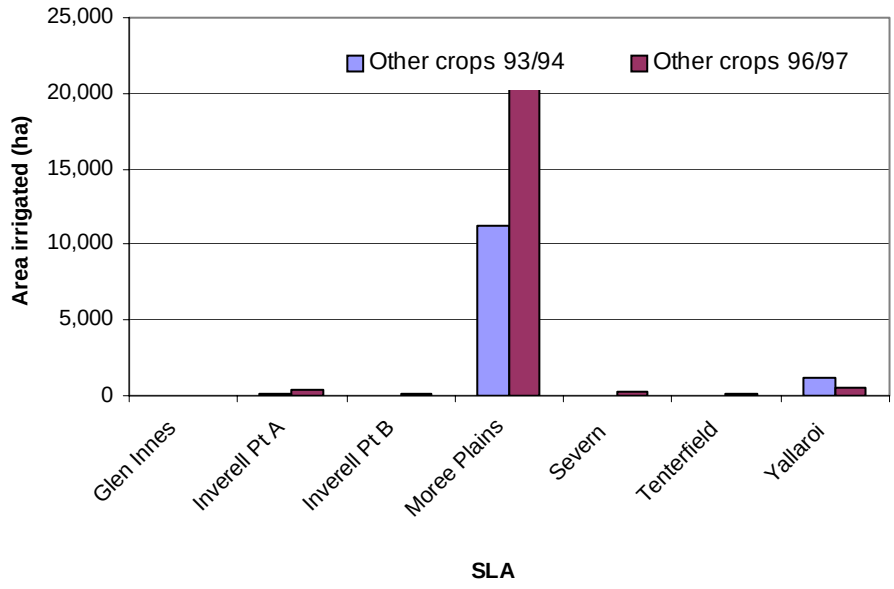



25,000
20,000
15,000
10,000
5,000
0
Area irrigated (ha)
1993/94
1995/96
1996/97
Glen Innes
Inverell Pt A
Inverell Pt B
Moree Plains SLA
Severn
Tenterfield
Yallaroi

14.4 Crop areas irrigated and number of enterprises irrigating in the Border Rivers (NSW) catchment in 1993–94 and 1996–97

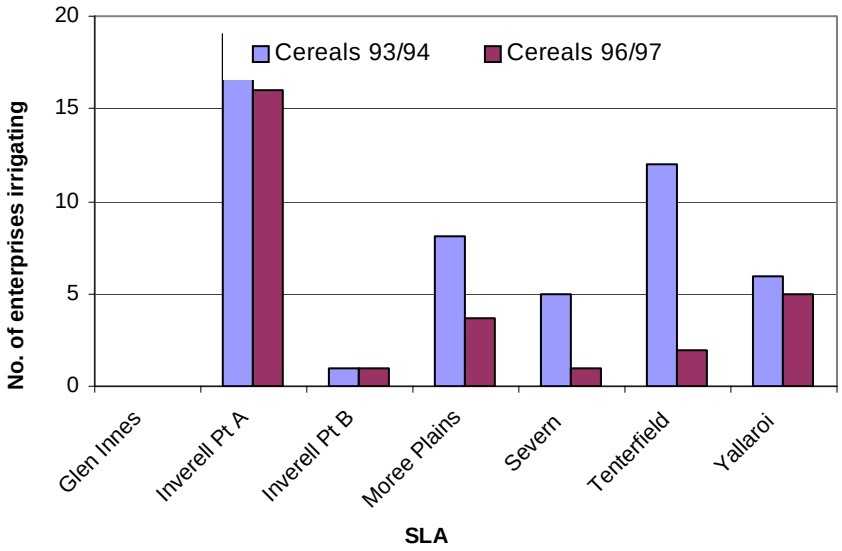


Source: (ABS 1998) ②.

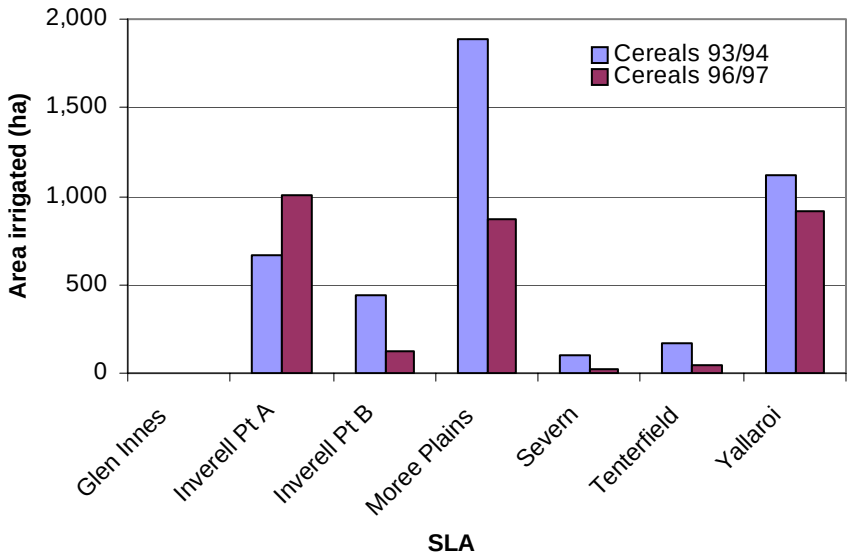


Source: (ABS 1998) ②

Cereals

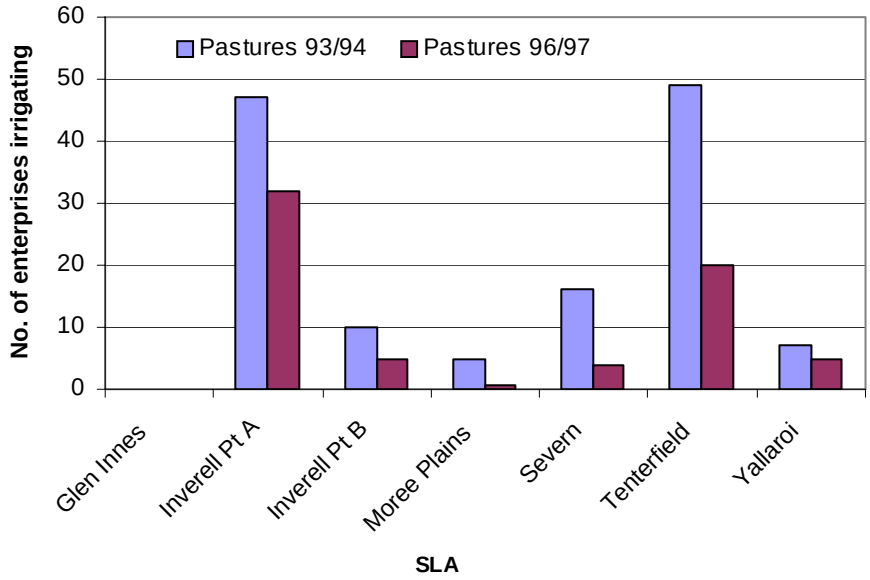


Source: (ABS 1998) ②

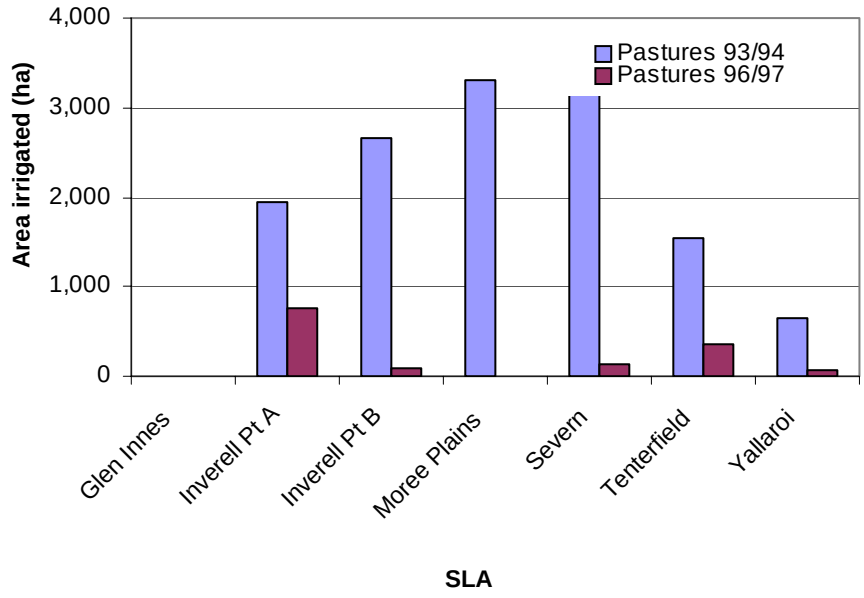


Source: (ABS 1998) ②

Pasture



Source: (ABS 1998) ②



Source: (ABS 1998) ②

14.5 Irrigated crop information for the Barwon Region

Location	Crop class[a]	Crop	CWR[b] av. (ML/ha)	CWR min	CWR max (ML/ha)	IR[c] av. (ML/ha)	IR min (ML/ha)	IR Max (ML/ha)	Y[d] Ave (t/ha)	Y Min (t/ha)	Y Max (t/ha)	Root Depth (m)	Sowing Date[e]	Time of growth Total[f]	System[g]
Glen Innes*	Berry fruits	Blueberries	–												drip
Glen Innes	Berry fruits	Gooseberries	–												drip
Glen Innes	Berry fruits	Logan-berries	–												drip
Glen Innes	Berry fruits	Rasp-berries	–												drip
Glen Innes	Berry fruits	Straw-berries	–												drip
Glen Innes	Cereals	Barley	–			2.0			6.0	4.0	8.0		15-Apr	210	surface
Glen Innes	Cereals	Grain sorghum	–			4.0			7.5	6.0	10.0		1-Dec	130	surface
Glen Innes	Cereals	Maize				5.0			10.0	7.3	12.0		15-Nov	135	surface
Glen Innes	Cereals	Oats				2.0			5.0	4.0	8.0			195	surface
Glen Innes	Cereals	Triticale				2.0			4.0	3.0	7.0		1-May	175	surface
Glen Innes	Cereals	Wheat				2.0			7.0	6.0	9.0		15-Apr	210	surface
Moree†	Cereals	Barley				1.0									
Moree	Cereals	Grain sorghum							5.0				15-Sep	153	
Moree	Cereals	Maize				4.0			6.0				15-Sep	153	
Moree	Cereals	Oats				2.0			3.0				15-Mar	214	
Moree	Cereals	Wheat				1.0			5.0				1-Jun	167	

Location	Crop class[a]	Crop	CWR[b] av. (ML/ha)	CWR min	CWR max (ML/ha)	IR[c] av. (ML/ha)	IR min (ML/ha)	IR Max (ML/ha)	Y[d] Ave (t/ha)	Y Min (t/ha)	Y Max (t/ha)	Root Depth (m)	Sowing Date[e]	Time of growth Total[f]	System[g]
Moree	Fibres	Cotton	7.0	6.0	12.0	7.0	6.0	12.0	8.0	4.5	13.0		15-Sep	181	flood/ furrow
Glen Innes	Grapes	Wine grapes													drip
Glen Innes	Miscel	Herbs													sprinkler and drip
Glen Innes	Oil seeds	Soybeans				4.0			3.6	2.5	5.0		1-Dec	130	sprinkler and drip
Moree	Oil seeds	Soybeans				4.0			3.0			0.7	15-Nov	120	
Glen Innes	Pasture	Other				2.5	0.0	6.0	10.0	6.0	12.0			365	sprinkler
Glen Innes	Pasture	Perennial				2.0	0.0	6.0	8.0	4.0	12.0			365	sprinkler
Glen Innes	Pome fruit	Apples													sprinkler and drip
Glen Innes	Pome fruit	Pears													sprinkler and drip
Glen Innes	Stone fruit	Apricots													sprinkler and drip
Glen Innes	Stone fruit	Cherries													sprinkler and drip
Glen Innes	Stone fruit	Nectarine													sprinkler and drip
Glen Innes	Stone fruit	Peaches													sprinkler and drip
Glen Innes	Stone fruit	Plums													sprinkler and drip
Glen Innes (JS)	Stone fruit	Orchards (High Chill)											1-Sep	240	
Glen Innes (JS)	Stone fruit	Orchards (High Chill)											1-Sep	240	

Location	Crop class[a]	Crop	CWR[b] av. (ML/ha)	CWR min	CWR max (ML/ha)	IR[c] av. (ML/ha)	IR min (ML/ha)	IR Max (ML/ha)	Y[d] Ave (t/ha)	Y Min (t/ha)	Y Max (t/ha)	Root Depth (m)	Sowing Date [e]	Time of growth Total[f]	System[g]
Glen Innes (SW)	Vegetables	Potatoes				3.5							10-Aug	144	centre pivot
Glen Innes (SW)	Vegetables	Potatoes				7.5							15-Feb	181	centre pivot
Glen Innes	Vegetables	Broccoli													sprinkler
Glen Innes	Vegetables	Cabbage													sprinkler
Glen Innes	Vegetables	Capsicum													drip
Glen Innes	Vegetables	Carrots													sprinkler
Glen Innes	Vegetables	Cauli-flower													sprinkler
Glen Innes	Vegetables	Egg plant													drip
Glen Innes	Vegetables	Garlic													sprinkler
Glen Innes	Vegetables	Leeks													sprinkler
Glen Innes	Vegetables	Parsnips													sprinkler
Glen Innes	Vegetables	Peas Green													sprinkler
Glen Innes	Vegetables	Potatoes													drip
Glen Innes (SW)	Vegetables	Potatoes											15-Nov	138	centre pivot
Glen Innes	Vegetables	Pumpkins													sprinkler

Location	Crop class[a]	Crop	CWR[b] av. (ML/ha)	CWR min	CWR max (ML/ha)	IR[c] av. (ML/ha)	IR min (ML/ha)	IR Max (ML/ha)	Y[d] Ave (t/ha)	Y Min (t/ha)	Y Max (t/ha)	Root Depth (m)	Sowing Date [e]	Time of growth Total[f]	System[g]
Glen Innes	Vegetables	Sweet corn													drip
Glen Innes	Vegetables	Tomatoes - field													drip

④. [a] Crop class refers to a category under which similar crops can be grouped. [b] CWR (Crop Water Requirement) - 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 Ave, 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. [h] Effic (Irrigation efficiency) - the ratio between crop water requirement and the irrigation water delivered *to the farm*. It therefore describes losses due to leaching requirement and conveyance (deep percolation and evaporation), distribution, and application inefficiencies.

* Glen Innes data, pers. comm. from District Agronomist Jeff Lowien, with additional information from District Horticulturists John Slack and Stephen Wade † Moree data, pers. comm.. from Extension Agronomist Jennie Spenceley

14.6 Irrigation methods in the Barwon region, broadarea and dairy enterprises only

Region	State total (% of total area)	Barwon Region (inc. NSW Border, Gwydir & Namoi catchments) (% of total area)
Surface	91.3	92.1
Moveable spray	3.5	3.9
Travelling irrigator	4.4	1.9
Trickle/drip/sub-surface	0.2	0.0
Fixed low throw sprinkler	0.02	0.0
Fixed micro sprays	0.3	1.9
Fixed overhead Sprinkler	0.2	0.2
Other	0.1	0.0

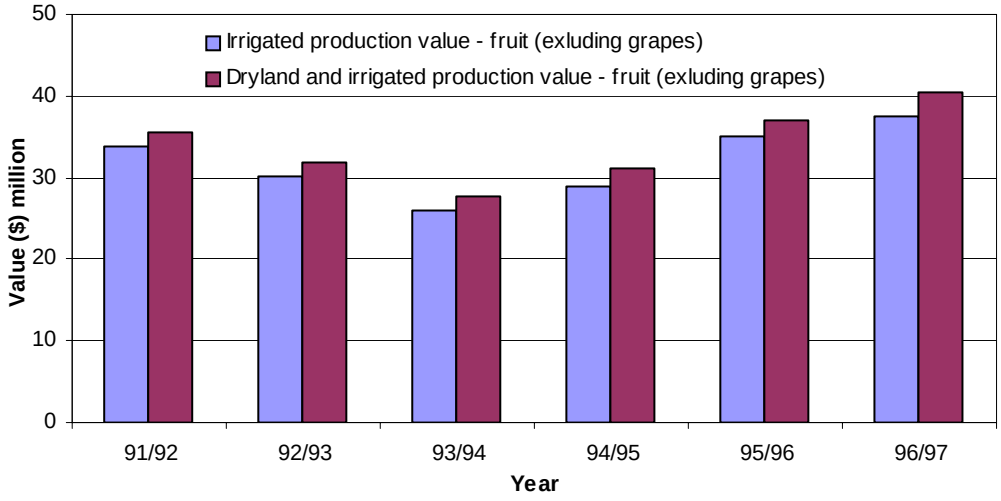
Source: (ABARE 2000) ③

14.7 Value of irrigated agriculture production for major crops in the Border Rivers catchment (NSW and Qld)

Cotton

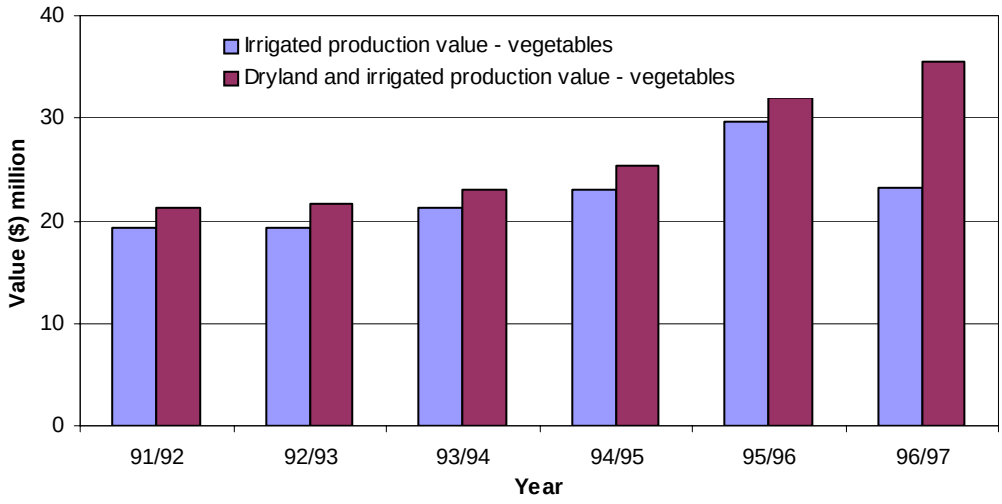
Source:(Donovan 2000) ③

Fruit and nuts (excluding grapes)



Source: (Donovan 2000) ③

Vegetables



Source: (Donovan 2000) ③

14.8 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)

14.9 Allocation announcement history, Pindari Dam, Border Rivers (NSW) catchment

Year	Date announced	Allocation	Overdraw	Carryover	Announced by	Comments
1981–82[a]	18/09/1981	50%	0%		Minister	
	30/12/1981	75%	0%		Minister	
1982–83	26/08/1982	30%	0%		Minister	
	23/12/1982	40%	0%		Minister	
1983–84	11/08/1983	30%	0%		Minister	
	9/11/1983	60%	0%		Minister	
1984–85	8/10/1984	50%	0%		Minister	
	1/2/1985	60%	0%		Minister	
1985–86	4/09/1985	30%	0%		Minister	
1986–87	12/09/1986	15%	0%		Minister	
	10/11/1986	100%	0%		Minister	For ‘A’ Allocation. Change in system.
	10/11/1986	18%	0%		Minister	For ‘B’ Allocation.
1987–88	9/09/1987	100%	0%		Minister	For ‘A’ Allocation.
	9/09/1987	16%	0%		Minister	For ‘B’ Allocation.
	18/01/1988	20%	0%		Minister	For ‘B’ Allocation.
1988–89	13/10/1988	100%	0%		Minister	For ‘A’ Allocation.
	13/10/1988	40%	0%		Minister	For ‘B’ Allocation.
	19/01/1989	40%	3%		Minister	
1989–90	5/10/1989	100%	0%		Minister	For ‘A’ Allocation.
	5/10/1989	27%	0%		Minister	For ‘B’ Allocation.
1990–91	24/10/1990	100%	0%		Minister	For ‘A’ Allocation.
	24/10/1990	35%	0%		Minister	For ‘B’ Allocation.
	4/01/1991	40%	0%		Minister	For ‘B’ Allocation.
1991–92	26/09/1991	100%	0%		Manager	For ‘A’ Alloc. 90/91 C-Over till Dec.
	26/09/1991	11%	0%		Manager	For ‘B’ Allocation.

Year	Date announced	Allocation	Overdraw	Carryover	Announced by	Comments
	24/12/1991	15%	0%		Manager	For 'B' Allocation.
1992–93	2/10/1992	100%	0%		Manager	For 'A' Allocation.
	2/10/1992	5%	0%		Manager	For 'B' Allocation.
	23/12/1992	15%	0%		Manager	For 'B' Allocation.
	3/02/1993	20%	0%		Manager	For 'B' Allocation.
	17/02/1993	22%	0%		Manager	For 'B' Allocation.
1993–94	2/11/1993	100%	0%		Manager	For 'A' Allocation.
	2/11/1993	0%	0%		Manager	For 'B' Allocation.
	15/12/1993	4%	0%		Manager	For 'B' Allocation.
	7/01/1994	7%	0%		Manager	For 'B' Allocation.
1994–95	30/09/1994	0%	0%		Manager	For 'A' Allocation.
	30/09/1994	0%	0%		Manager	For 'B' Allocation.
	3/04/1995	0%	100%		Manager	For 'A' Allocation.
1995–96	29/09/1995	100%	0%		Manager	For 'A' Allocation.
	29/09/1995	0%	0%		Manager	For 'B' Allocation.
	1/12/1995	5%	0%		Manager	For 'B' Allocation.
1996–97	16/12/1996	100% 'A'	0%		Manager	For 'A' Allocation.
	16/12/1996	65% 'B'	0%		Manager	For 'B' Allocation.
1997–98	15/10/1997	100% 'A'			Director	For 'A' Allocation.
	15/10/1997	55% 'B'		20%	Director	For 'B' Allocation.
1998–99	11/11/1998	100% 'A'			Director	For 'A' Allocation.
	11/11/1998	35% 'B'		40%	Director	For 'B' Allocation.

Source: (DLWC 2000a) a The official Volumetric Allocation Scheme (20W) was introduced on 1/9/81. A '60ML A/B Priority Scheme' was introduced on 10/11/1986. This involves an 'A' component being the first 60ML of entitlement with the remainder of the entitlement making up the 'B' component.

14.10 Area irrigated and water used from regulated supplies, selected years

	Area irrigated (ha)						
Crop	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	Average
Cotton	34,870	27,758	25,108	28,594	20,473	10,251	24,509
Lucerne	797	1143	686	728	510	584	741
Summer pasture	506	840	967	621	563	500	666
Storage	0	1650	0	0	0	0	275
Oats	96	294	352	243	121	377	247
Summer cereal	80	0	285	367	162	0	149
Barley	40	120	165	240	0	249	136
Sorghum	150	330	125	100	50	0	126
Tobacco	62	127	51	115	46	12	69
Vegetables	41	146	22	22	30	87	58
pre irrigation	0	0	250	10	10	73	57
Winter pasture	78	50	75	2	0	78	47
Soya beans	115	120	10	0	0	0	41
Winter cereal	20	20	0	0	0	81	20
Wheat	0	0	0	0	0	65	11
Nuts	0	30	20	0	0	0	8
Sunflower	40	0	0	0	0	0	7
Millet	12	0	0	0	0	4	3
Nursery	0	0	0	0	0	11	2
Total	**36,907**	**32,628**	**28,116**	**31,042**	**21,965**	**12,372**	**27,172**

Source: (DLWC 1998a)②

	Water use by irrigation (ML)						
Crop	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	Average
Cotton	83,977	49,576	115,941	121,982	47,455	28,204	74,523
Storage	65,497	85,473	48,059	3337	56,047	21,414	46,638
Lucerne	3,856	5,795	5,046	6518	4,905	2,594	4,786
Summer pasture	1,926	4,568	3,598	3132	2,714	947	2,814
Sorghum	758	663	771	989	58	80	553
Oats	80	422	980	571	269	732	509
Tobacco	352	512	421	748	531	5	428
Summer cereal	119	0	946	1,000	475	0	423
Barley	70	142	554	142	0	316	204
Vegetables	105	462	87	205	176	74	185
Soya beans	219	480	49	0	0	0	125
Pre irrigation	0	0	529	19	17	36	100
Winter pasture	169	52	150	4	0	124	83
Nuts	0	62	76	0	0	0	23
Sunflower	137	0	0	0	0	0	23
Wheat	0	0	0	0	0	107	18
Nursery	0	0	0	0	0	100	17
Winter cereal	71	10	0	0	0	0	14
Millet	22	0	0	0	0	2	4
Total[a]	**157,358**	**148,216**	**177,207**	**138,647**	**112,647**	**54,734**	**131,468**

Source: (DLWC 1998a) ②. [a]Total figure has a reliability rating of ①

	Area irrigated (ha)						
Season	Cotton	Lucerne	Pasture	Cereals	Soy Beans	Vegetables	TOTAL
1986/87	11,700	150	150	2,500			14,500
1987/88	20,000	180	220	580	130		21,110
1988/89	23,000	220	340	500	200		24,260
1989/90	25,535	190	400	750			26,875
1990/91	26,000	200	450	1,400	100		28,150
1991/92	23,200	380	500	1,500			25,580
1992/93	24,600	394	830	2,500			28,324
1993/94	19,088	400	1,010	2,300	350	8	23,156
1994/95	9,840	300	1,000	480		50	11,670
1995/96	12,134	350	1,100	1,030		36	14,650
1996/97	31,555	500	1,000	450	600	58	34,163
1997/98	34,247	500	850	680	580	10	36,867
Averages	21,742	314	654	1,223	327	32	24,109

Source: (DLWC 1999a) ②

14.11 Stressed stream classification in the Border Rivers (NSW) catchment

An environmental stress rating for each of the freshwater subcatchments within the Border Rivers (NSW) catchment 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 sulphate 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 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 NSW Border Rivers catchment.

The matrix showing stress categories and the ratings given to individual subcatchments in the NSW Border Rivers catchment are provided in Table 21 and Table 22 respectively.

Table 21. Stress matrix for the determination of subcatchment stress ratings

	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 occur 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 22. Stress ratings for subcatchments in the Border Rivers (NSW) catchment

NAME	Environmental stress	Hydrological stress	Management class	Future risk
Croppa Creek	high	unres	unres	unres
Gil Gil Creek	high	unres	unres	unres
Gundablui	medium	unres	unres	unres
Whalan Creek	high	unres	unres	unres
Ottleys Creek	high	low	S5	S1
Stony Creek	medium	unres	unres	unres
Dumaresq	medium	unres	unres	unres
Campbells Creek	medium	unres	unres	unres
Yetman	medium	low	U3	S3
Camp Creek	high	unres	unres	unres
Gulf Creek	medium	unres	unres	U1
Bonshaw	medium	low	U3	S3
Kings Plain	high	low	S5	S2
Inverell	high	high	S1	S1
Glen Innes	high	high	S1	S1
Beardy Creek	medium	high	S3	S3
Mole River	medium	medium	S4	S3
Reedy Creek	medium	low	U3	U3
Rock of Gibraltar	medium	low	U3	S4
Tenterfield	medium	high	S3	S1
Tenterfield Creek	medium	low	U3	S3

Source: (DLWC 2000b)

14.12 Average area (ha) irrigated by crop type in the Border Rivers (NSW) catchment from unregulated rivers

Data	93–94	94–95	95–96	96–97	97–98	98–99
Lucerne	1,261	1,349	1,202	1,003	991	911
Perennial pasture	339	323	430	458	336	343
Summer cereal	280	334	338	495	562	349
Vegetables	222	235	343	277	247	209
Winter cereal	161	177	169	261	365	499
Fodder	125	177	168	137	134	129
Cotton	100	272	322	422	624	624
Other	74	66	19	23	19	80
Annual pasture	52	30	46	67	86	88
Trees - Orchards	43	43	45	56	61	59
Summer oilseeds	12	2	32	34		
Nurseries	3	3	3	3	3	3
Citrus		1	2	3	4	
Olives						1
Pulses		20	13	80	133	120
Trees - other				2	2	3
Turf		20	10	10	10	23
Vines - table grapes				2	2	2
Vines - wine grapes			8	11	40	40
Grand total	**2,671**	**3,051**	**3,148**	**3,343**	**3,618**	**3,483**

Source: (DLWC 2000b) ②. The average area irrigated for each crop type was determined using six years of data between 1993/94 and 1998/99. Data were obtained from growers by written survey.

14.13 Area and water use from unregulated streams in the Border Rivers (NSW) catchment

	Crops	1989–90	1990–91	1991–92	1992–93
Area irrigated (ha)	Lucerne	270	333	319	302
	Winter Cereal	45	34	89	159
	Winter Pasture	290	123	173	127
	Summer Cereal	40	11	40	98
	Summer Pasture	148	129	134	76
	Other	114	86	151	76
	Vegetables	35	45	62	65
	Cotton	0	112	112	0
	Citrus	0	0	0	0
	Vines	5	0	0	0
	Wheat	40	0	0	0
Total Area (ha)		**986**	**873**	**1080**	**902**
Water Usage (ML)		**2761**	**2549**	**3218**	**4899**

	Crops	1993/94	1994/95
Area irrigated (ha)	Lucerne	489	554
	Soybeans	0	423
	Cotton	405	408
	Winter Pasture	292	289
	Sunflower	0	259
	Summer Pasture	140	142
	Sweet Corn	0	72
	Other Vegetables	51	69
	Orchard	17	31
	Other Crops	35	28
	Winter Grains	0	11
	Triticale	0	1
	Grapes	15	0
	Potatoes	1	0
	Sorghum	212	0
	Summer Grains	4	0
	Tomatoes	1	0
	Wheat	22	0
Total Area (ha)		**1682**	**2287**
Water Usage (ML)		**2020**	**2761**

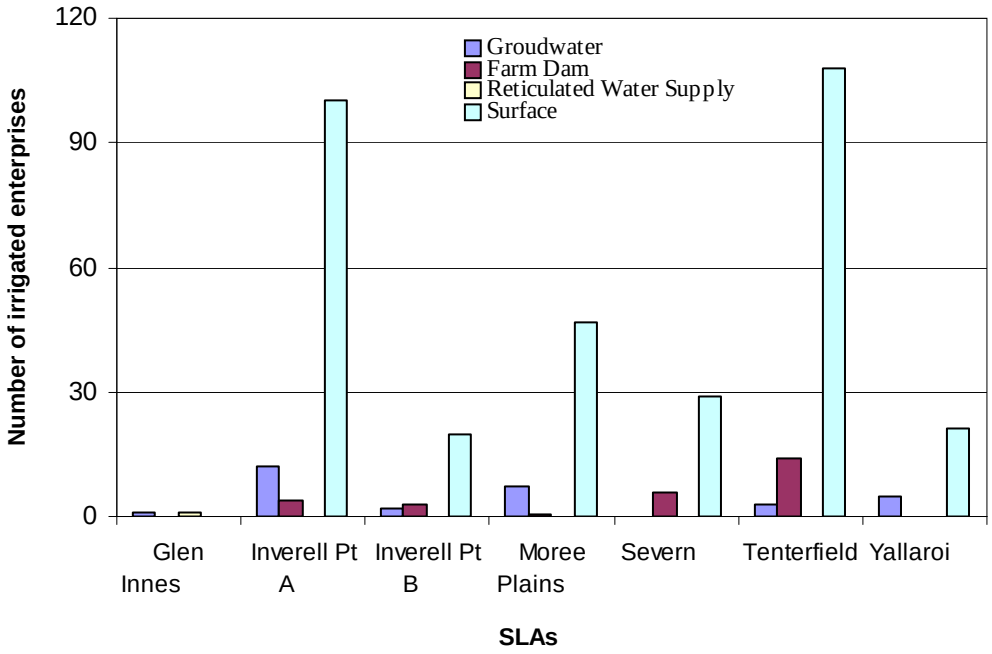
Source: (DLWC 1998a)③

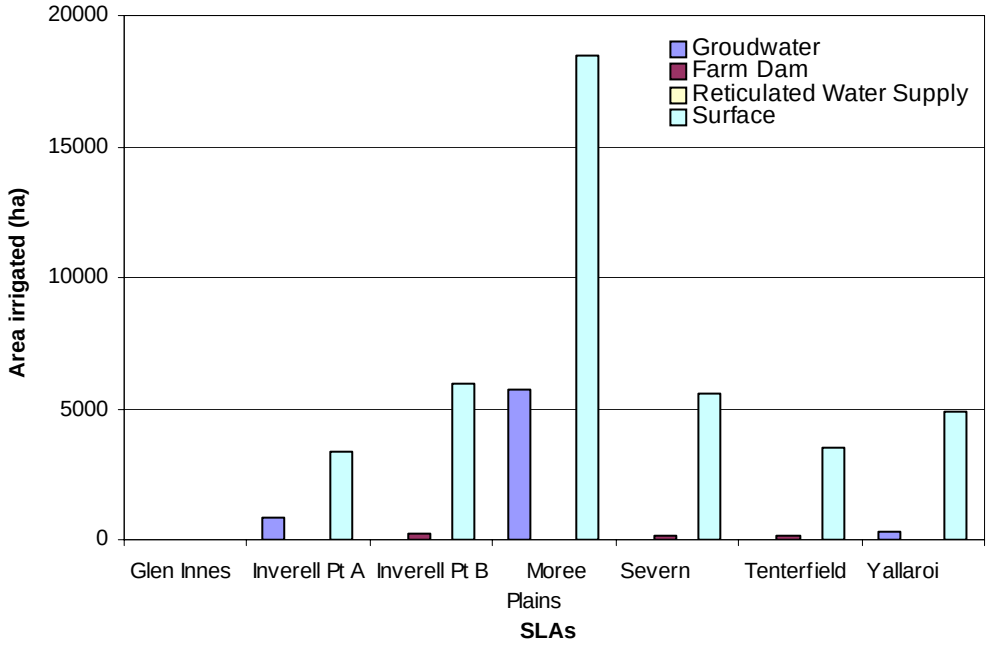
14.14 Usage from alluvial aquifers in the Border Rivers (NSW) catchment

Area of aquifer (km^2)	37,900
Volume in storage (× 1,000 ML)	349,715
Annual usage in 1980 (× 1,000 ML)	Urban: 0 Irrigation: 2.1 Other: 12.5 **Total: 14.6**

Source: (WRC 1980). Note these 1980 figures. These figures are very old and are unlikely to represent current water use figures.

14.15 Area irrigated and number of irrigation enterprises by water source and by SLA in the Border Rivers (NSW) catchment 1993–94





Source: (ABS 1998) ②