Gwydir Catchment Irrigation Profile

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

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

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

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Editorial assistance: Helen Gosper
Cover design: Nicky Parker
Maps: Udai Pradhan

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

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1. EXECUTIVE SUMMARY

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

The Profile details (where possible, by water source and catchment) what is known about:

- the number of licences
- the number of enterprises that irrigate
- 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 Gwydir catchment.

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in the public domain were collected from State and Commonwealth sources, published research and industry reports and unpublished reports.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

This Profile does not attempt to develop or analyse regional and industry-based estimates of WUE. 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 Gwydir catchment

The Gwydir catchment shown in Figure 1 is in northern inland New South Wales (NSW), west of the Great Dividing Range. The catchment has an area of 25,900 km^2, representing 2% of the Murray–Darling Basin (MDB). The Gwydir River is the main watercourse, beginning near Uralla on the Northern Tablelands. The river drains west for 330 km before joining the Barwon River north of Collarenebri. Copeton Dam on the Gwydir River is the main irrigation storage in the catchment, with a capacity of 1,364,000 ML. There are a further six weirs that regulate water along the Gwydir River.

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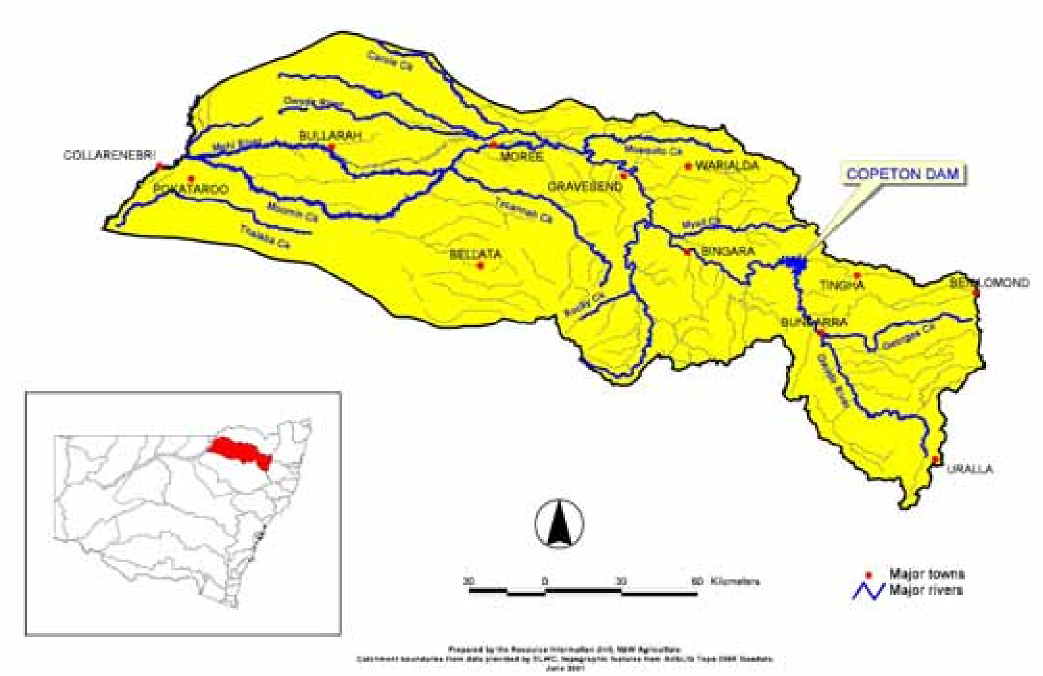
[1] WUE refers to the volume of crop produced (harvested dry matter) per unit of water delivered to the crop. This is usually expressed as tonnes per megalitre (t/ML) (Alexander & Foley 1998).

[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).

The catchment has a summer-dominant rainfall pattern and annual falls decrease from nearly 900 mm in the east to less than 600 mm in the west. Falls are extremely variable, and flooding and drought occurring periodically.

Cotton is the major irrigated commodity in the catchment and irrigation water is mostly sourced from regulated surface supplies. The industry also relies heavily on surplus flows. Cotton is grown on the alluvial plains, while lucerne and pasture are grown in the upper catchment along the small alluvial floodplains close to the Gwydir River and its tributaries.

Figure 1. The Gwydir catchment



Of the total value of agriculture in 1996–97 ($592 million), $245 million could be attributed to irrigation (Table 1). Of that, $221 million was attributable to irrigated cotton.

In 1996–97, ABS figures suggest nearly 60,000 ha were irrigated each year from all sources of water (that is, groundwater, regulated and unregulated supplies, farm dams and reticulated water supplies). However, that figure may be an underestimate, as the data from the Department of Land and Water Conservation (DLWC) estimate the area irrigated from regulated supplies alone to be 73,000 ha.

The area irrigated varies considerably depending on climate and access to water. For example, anywhere between 12,000 ha and 80,000 ha are planted to cotton each season.

Table 1. Summary of irrigation data for the Gwydir catchment for 1996–97 by water source

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)[a]	Value of irrigation ($ million)
All sources of water	57,564	nd *450,000 (estimate)*	663	92	1.6 (cotton)	245
Regulated	72,680	404,900	193	nd *82 (1993–94)*	1.6 (cotton)	nd
Unregulated	7,150	nd *10,000 (avg. 1989–90 - 1994–95)*	280	nd *105 (1993–94)*	nd	nd
Groundwater	nd *15,152 (1993–94)*	nd *35,747 (avg.)*	190	173	nd	nd
Farm dams	nd *806 (1993–94)*	nd	na	nd *12 (1993–94)*	nd	nd
Reticulated	nd *0 (1993–94)*	nd	na	nd *0 (1993–94)*	nd	nd
NSW total (all sources of water)	1,150,000	7,700,000	24,000	7,846	1.8 (cotton)	2,496

nd= no data, na = not applicable a. 1 bale of cotton equals approximately 225 kg. 1 ha equals 2.47 acres.

The total volume extracted from all water sources by irrigated agriculture cannot be stated with any accuracy but was estimated to be around 450,000 ML in 1996–97. This volume would vary considerably with climate each year. For example, between 1988–89 and 1993–94, the volume of water used from all sources on cotton alone was estimated to be between 74,400 ML and 413,000 ML.

There are 663 irrigation licences and 92 enterprises irrigating crops in the catchment (Table 1). Of these, 65 are thought to be irrigating cotton. Cotton yields have ranged from 0.7 t/ha to 1.8 t/ha (1988–89 to 1994–95). Data on yields of irrigated crops other than cotton were scarce. Cotton and cereal crops in the lower catchment are generally

watered using surface methods. In the upper catchment, where lucerne and pasture crops dominate, pressure systems are used.

Table 1 summarises irrigation data in the Gwydir catchment in 1996–97, the most recent season with the greatest amount of data. Where there were no data, estimates from other years have been used to complete the picture.

1.2 Irrigation data issues

There were a number of data issues raised in the *Gwydir Catchment Irrigation Profile*. Generally, these relate to the scarcity of data, the lack of data at useful scales and the reliability of available data.

1.2.1 Scarcity of data

Information as fundamental as the volume of water applied to crops is needed to inform the water-sharing debate, to help monitor the impact of policy implementation and to assist the sustainable development of the irrigation industry.

In the past, data have been collected for different purposes to those currently needed. Data are now required for natural resource planning and for the planning and management of irrigation industry (for example, Water Management Plans and Catchment Blueprints).

Of critical importance is information on crop water use and crop area. These data are needed to underpin government programs that have been initiated in all Australian states to improve WUE in irrigated agriculture. This Profile demonstrated difficulty in estimating the volume of water used on crops over the last decade. To summarise, there was:

- a lack of information on volumes applied to crops from groundwater and unregulated streams. Some information was collected on crop areas irrigated from regulated supplies between 1989–90 to 1993–94
- a lack of information on the volume of water used on crops extracted from regulated supplies after the 1993–94 season.

Great care is needed when determining crop application rates based on information presented in this Profile. An accurate assessment requires detailed information about a property water supply and where it used that water. Enterprises may supplement their major water supply (for example, the regulated system) with another source (groundwater). Application rates based on the major water supply only could easily be underestimated.

1.2.2 Lack of data at useful scales

Point-scale data collected by the ABS and ABARE (for example, irrigation value and yield) are confidential and have been reported at SLA, catchment or Agro-Ecological Region scales (AER). These scales limit usefulness to data users who often need information at much finer scales, such as river reach or subcatchment. Finer scale data are extremely useful in, for example, modelling the economic impact of changes to water sharing rules on irrigators or to understanding the variation in the irrigation industry across geographic and climatic zones.

1.2.3 Reliability of irrigation data

Reliability of irrigation data varied:

- according to water source. For example, data about regulated rivers were more reliable than data about unregulated, groundwater and farm dam sources.
- with collection strategy. For example, the ABS collects information from enterprises with an Estimated Value of Agricultural Operations (EVAO)[3] of $5000 or greater. The DLWC collects information from individual licences. The ABS used definitions of regulated and unregulated water sources for the 1993-94 survey that were different to those used by the DLWC. Consequently, irrigation area and enterprise number tended to be overestimated for regulated water supplies and underestimated for unregulated water supplies.

1.3 Conclusion

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

- Data need to be collected at scales that are coarse enough to protect point-scale confidentiality (for example, enterprise level) but fine enough to allow users to aggregate information to useful scales (river reach, subcatchments).
- Protocols for provision of data to users are needed. For example, information providers need to attach reliability ratings to data. This will help users make better decisions about the usefulness of the data and prevent inappropriate manipulation.
- Two-way flow of information between agencies and irrigators needs to be fostered. Collections of irrigation data need to flow back to irrigators in forms that might

[3] The smallest unit collected by ABS is the SLA and the population to be surveyed is determined from the EVAO. The EVAO is estimated from a procedure that takes into account the value of the area of crops sown and the numbers 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.

help them make better water management decisions. This could in turn, over time, improve the reliability of information that is collected from irrigators.

Any approach that deals with information at this fine-scale would need to comply with the provisions in the Privacy Act.

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

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 WUE and IE. From this study, Irrigation Profiles, or situation statements of irrigation, were developed for each of the major catchments and regions in NSW.

This Profile focuses on the Gwydir catchment (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.

This Profile does not attempt to calculate or analyse regional and industry-based assessments of WUE. This will be carried out in a subsequent report.

2.1 Background

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

1980s	The Water Resources Commission (WRC 1980) undertook an assessment of irrigation in NSW.
1980–89	A comprehensive report on crop areas irrigated, yields of irrigated crops and the values of individual irrigated commodities was developed for NSW (DWC 1990).
1986	The WRC (1986) undertook a study to assess WUE in NSW. Data on irrigation were reported catchment by catchment. The study highlighted a lack of data on crop areas irrigated, water used, yields of irrigated crops and financial returns.
1986–current	The Australian Bureau of Statistics (ABS) has been collecting information on irrigation for various years since 1986 (ABS 1998).
1988–92	Sloane (1993) provided an overview of the number of farms and area irrigated for four broad agricultural regions in NSW.
1950s–current	The NSW Department of Land and Water Conservation (DLWC) has collected information over the last 50 years on the area irrigated and water used by sections of the irrigation industry across NSW.
1996–97	More recently, the Australian Bureau of Agricultural Resource Economics (ABARE 2000) completed a survey of broadarea and dairy farms in each of the major catchments in NSW.

However, despite the volume of statistics collected 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, 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 that are being used to irrigate crops and the value of irrigated agriculture.

The importance of up-to-date, 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 across 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.

With the introduction of the new *Water Management Act 2000*, NSW has been developing water sharing plans. These plans require accurate and reliable data on the irrigation industry during their development and implementation phase. Water sharing plans are operational for 10 years with a review in year 5. Monitoring the impact of these plans on the environment and other water users (for example, irrigators) will be undertaken. In other words, irrigation data will need to be collected as part of the implementation phase. In the Gwydir catchment, plans have been prepared for:

- the regulated system
- Rocky Creek, Cobbadah, Upper Horton and Lower Horton (unregulated system)
- the Lower Gwydir groundwater source

As part of the NSW Government's Structural Adjustment Program, an Irrigated Agriculture Water Use Efficiency Incentive Scheme operates to assist irrigators adjust to the NSW Water Reforms. The scheme is jointly managed by NSW Agriculture and the Rural Assistance Authority. In order to measure change as a result of this scheme, irrigation data are needed.

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

3. METHODS

3.1 Summary of data collection

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

1. the ABS Irrigation Statistics Catalogue, AgStats (ABS 1998).

The ABS collected information by Statistical Local Area (SLA) up until 1996–97 (Table 2) and these units can be aggregated into the Gwydir catchment (Figure 2). Only SLAs that covered major areas of irrigation were used in this Profile. For a definition of an SLA see Appendix 14.1.

A summary of the data collected by the ABS over a 13-year period is provided in Table 2 and Appendix 14.2. In this Profile, only data collected between 1993–94 and 1996–97 were used. The reasons for this choice are as follows:

- Prior to 1993–94, data were collected with different EVAOs (Table 2) making comparisons between years difficult. The EVAO, or Estimated Value of Agricultural Operations, is the criteria for determining the population to be surveyed.[4]
- Between 1997–98 and 1999–2000, the ABS collected information by using an EVAO of $22,500 and by AER (Table 2). These regions span catchments and cannot be used to build catchment snapshots of irrigation. From 2000–01, the ABS will be returning to collecting information by SLAs.

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[4] The smallest unit collected by ABS is the SLA and the population to be surveyed is determined from the EVAO. The EVAO is estimated from a procedure that takes into account the value of the area of crops sown and the numbers 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.

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

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

A difficulty with summing SLA data to give catchment totals is that these collection units may cross into other catchments. In this Profile, the Moree Plains SLA spanned important areas of large-scale irrigation in the Gwydir, Far West and Border catchments. Inclusion of the whole SLA may lead to gross over-estimation of area irrigated and number of enterprises irrigating. For the Profile, a licence-based concordance was used to proportion the data where necessary (Table 3). So, for example, Moree Plains had 67.7% of surface licences in the Gwydir catchment. Consequently, 67.7% of the data from this SLA was included in the Profile (Table 3).

For other SLAs, namely Guyra, Uralla and Yallaroi, 100% of the data were included. This was despite the fact that only a proportion of the total number of surface licences in each SLA were located within the Gwydir catchment. The amount of irrigation in these SLAs is relatively small compared to that which occurs in the Moree Plains SLA and the impact on the catchment as a whole small.

For Inverell – Pt A, Dumaresq, Barraba, Narrabri and Walgett, these SLAs were discounted completely on the basis that the percentage of licences was less than 50%. In the case of Barraba, the area irrigated is relatively small and exclusion will have little effect on overall catchment figures.

Figure 2. Relationship between the Gwydir catchment boundary and ABS SLAs

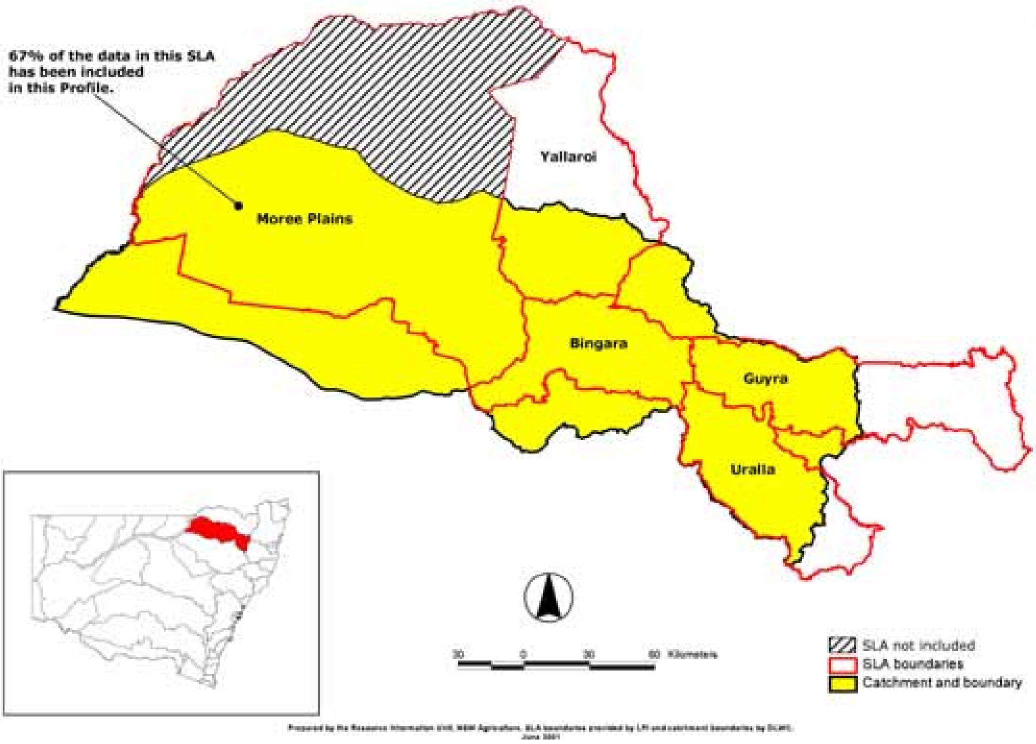


Table 3. Total number of surface licences in each SLA distributed by ratio between the Gwydir and surrounding catchment

SLAs in the *Gwydir Catchment Irrigation Profile*	Gwydir catchment	Border catchment	Namoi catchment	Far West catchment	Macquarie catchment	Clarence catchment	Macleay catchment	Included in the Profile
Bingara	100							✓
Guyra	61.15					30.94	7.91	✓
Moree Plains	67.70	26.07		5.46				✓
Uralla	92.52		1.36				6.12	✓
Yallaroi	76.92	23.08						✓
Inverell – Pt A	9.72	90.28						✖
Dumaresq	2.68					1.34	95.98	✖
Barraba	40.13		59.87					✖
Narrabri	5.25		94.75					✖
Walgett	5.32		29.52	53.06	9.03			✖

2. the 1996–97 ABARE Irrigated Farm Survey results obtained from the ABARE Survey of Primary Industry, Resources and Energy (ASPIRE) database (ABARE 2000). The Barwon Region, which is the amalgamation of the Border, Gwydir and Namoi catchments, was the reporting unit for the ABARE survey. These data cannot be disaggregated into, for example, the Gwydir catchments or its subcatchments.

3. a DLWC database of crop area and water use, designed for use by NSW Agriculture (DLWC 1998b). Unlike ABS and ABARE information, these data can be aggregated to any scale, such as stream reach, subcatchment and catchment.

4. various spreadsheets, for example DLWC (1998a), provided by the Water Analysis and Audit Branch, Sustainable Water Management, DLWC, Parramatta (this branch is now located in Bridge Street, Sydney).

5. Data were also obtained from relevant research and industry reports.

An Irrigation Profile or situation statement of irrigated industries operating within the Gwydir catchment was developed from this information. The Profile was further developed in collaboration with NSW Agriculture staff in regional offices. As these staff uncovered regional data (for example, unpublished reports), this information was incorporated.

3.2 Rating data reliability

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

1. **Class A –** data based on reliable recorded and surveyed information. Little or no extrapolation or interpolation required
2. **Class B –** data based on approximate analysis and limited surveys. Some measured data and some interpolation/extrapolation required to derive the data-set
3. **Class C** – little measured data. Data based on reconnaissance survey
4. **Class D** – data derived without investigation. Figures estimated from other data in nearby catchments or extrapolated/interpolated from any available data

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

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

So, for example, 'the number of enterprises irrigating in the Gwydir catchment in 1996-97 was 92 (ABS 1998, ②)'.

3.3 Structure of the Profile

This Profile summarises the availability and reliability of data for five water sources. The presentation of information by water source was necessary as data availability and reliability varied markedly depending on the water source to which it was related. A description of these sources is provided below.

Regulated rivers are those rivers that have been declared by the Minister, by order published in the Gazette, to be a regulated river (NSW *Water Management Act 2000).* A river is:

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

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

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

but does not include anything declared by the regulations not to be a river. Regulated rivers have their flows controlled by major government-owned rural dams.

These capture water that is then released to users downstream when ordered (DLWC 1999b) or released for flood mitigation.

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

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

Farm dam water is water from dams that exists on first, second or third order watercourses as shown on topographic maps or that has been captured from overland run-off (DLWC 1999d). This definition excludes On-farm Storages used to store water from regulated river supplies or that capture field run-off.

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

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

1. number of licences
2. number of enterprises irrigating
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

4. GWYDIR CATCHMENT OVERVIEW

4.1 Catchment description

The Gwydir catchment, in inland northern NSW (Figure 1), covers approximately 25,900 km^2, representing 2% of the MDB. The catchment is bounded in the south-east by the Nandewar Ranges, in the east by the Great Dividing Range and in the north by Mastermans Range.

The Gwydir River begins near Uralla on the Northern Tablelands and flows 330 km west, terminating just north of Collarenebri. Here, the Gwydir River joins the Barwon River.

The catchment contains three main landscapes – the tablelands, the slopes and the western alluvial plains. The Gwydir River changes dramatically as it flows from east to west through these landscapes.

Tablelands – The tablelands in the east comprise the undulating country upstream of Copeton Dam, with elevations of greater than 600 m. Elevation exceeds 1,000 m at the easternmost boundary. The Gwydir River exhibits the characteristics of an upland stream near its origin and a middle-order river west of Uralla. Once the Gwydir River reaches the western edge of the eastern tablelands at Copeton Dam, it again becomes like an upland stream with bedrock and boulder-dominated substrata and V-shaped banks.

Slopes – Just west of Copeton Dam, the Gwydir River drops in elevation rapidly (within 30 km) from 600 m to 280 m. This drop demarcates the eastern tablelands from the north-west slopes (Lea et al. 1977). Near the property 'Keera', 10 km downstream of the dam, the river again acquires middle-order attributes with widening banks and some floodplain areas. Erosive processes are dominant in the upper reaches and continue until just west of Gravesend (DWR 1993).

Western alluvial plains – In the lower reaches of the catchment, where the Gwydir joins the Barwon River, elevations are approximately 200 m. Just east of Moree, the landscape becomes flat and blacksoil plains extend west to the junction of the Gwydir and Barwon rivers.

After Gravesend the Gwydir River is more like a lowland river and depositional processes increase silt levels (McCosker & Duggin 1992). Near Moree, the first and largest effluent of the river, the Mehi River, begins. West of Moree, the waterway spreads into a series of channels that could be described as an inland delta (WCIC 1973). Numerous wetlands and anabranches cut through blacksoil plains and spread the discharges of the Gwydir River. Before regulation it was only in major flood events that water from the Gwydir River reached the Barwon River (McCosker & Duggin 1992).

The Horton River, one of the major contributors to the Gwydir River, rises in the Nandewar Ranges west of Barraba, NSW. Like the Gwydir River, the Horton River also experiences a sharp decrease in elevation. This stream falls quickly from the Nandewar Ranges at around 1400 m to the more gentle slopes of the Horton Valley. A change in elevation of nearly 900 m occurs after the Horton River has travelled only 30 km. The

Horton River has a short upland section and a major waterfall west of Barraba. The waterway becomes a middle-order river and continues to exhibit these features until its confluence with the Gwydir River near Gravesend.

4.1.1 Soils

Soils vary throughout the catchment, reflecting complex topographic and geological characteristics. In the tablelands and slopes area, the steep landscape and poor fertility of soils adjacent to waterways seriously hamper irrigation development. On the slopes below Copeton Dam down to Biniguy, and along the Horton River, irrigation is restricted to alluvial soils on very narrow floodplains. Basalt-derived soils provide reasonable soil structure and fertility for irrigated crops but the availability of good irrigation sites is limited.

West of Biniguy, self-mulching grey clays fan out into the plains of the Lower Gwydir catchment. This fan is around 5 km wide at Biniguy and extends to around 75 km wide at Boomi (DWR 1993). It is in this area that most irrigation occurs. These soils are well suited to both dryland and irrigated agriculture (Gwydir Catchment Taskforce 1997) and comprise undulating low hills and level plains of grey cracking clays (Murphy & Eldridge 1992).

Grey cracking clays need regular application of nitrogen and phosphorus fertilisers, and sulfur deficiencies have been detected in some locations. Soil compaction has often been identified as a major land degradation problem linked with intensive agriculture. However, these cracking clays, if properly managed and allowed to dry out, have the ability to break up compaction layers through their inherent cracking characteristics. Wheat is often rotated with cotton to achieve this necessary drying and cracking (Cull 1990).

4.1.2 Climate

Climatic characteristics vary significantly between the tablelands and the riverine plains. In the tablelands, average summer temperatures range from 9.8^{0}C to 24.6^{0}C and winter from -0.6^{0}C to 12^{0}C. For the lower section of the catchment, average summer temperatures are between 18°C and 36°C and winter temperatures from 4°C to 18°C.

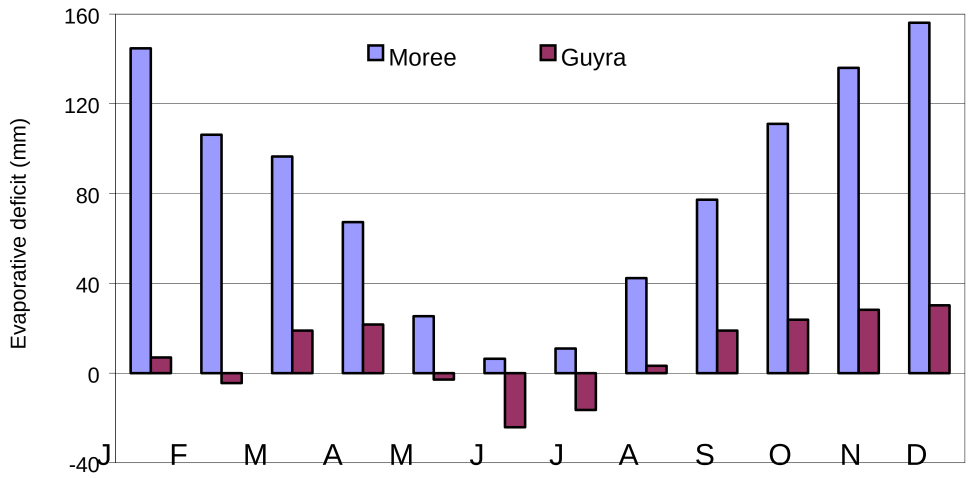
Rainfall declines from east to west in association with changes in elevation and the prevailing direction of incoming weather patterns. Median rainfalls in the upper catchment (elevations over 900 m) can reach 874 mm per year. In the lower catchment, Moree (elevation 200 m) has a median rainfall of 557 mm per year.

The Gwydir catchment receives about 60% of its mean annual rainfall from October to March. January and February are usually the wettest months (Appendix 14.3). A further 14% of mean annual rainfall is received in June and July.

Almost all the run-off for the Gwydir catchment is generated in the tablelands, slopes and the Nandewar Ranges. The 12,600 km^2 of sloping landscapes above Pallamallawa transform 6% of mean annual catchment rainfall into run-off (DWR 1993). Rainfall is extremely variable and has ranged from as low as 201 mm (1902) to 1108 mm (1894) at Moree (DWR 1993). Flooding in the catchment can occur in both summer and winter as a result of storms or prolonged rain periods. However, summer flooding is generally more severe than winter flooding.

As with rainfall, there is a marked difference in the evaporative deficit[5] between the eastern tablelands and the plains. The evaporative deficit – which is the difference between reference evapotranspiration and rainfall – gives some indication of when irrigation water is needed by crops. In the tablelands (Guyra), irrigation water is needed between September and December and then again in March and April. On the river flats (Moree), irrigation water is generally needed all year round but especially from August to April (Figure 3).

Figure 3. Evaporative deficit at Moree and Guyra



4.2 Population centres

Major towns within the Gwydir catchment include Uralla, Guyra, Bingara, Warialda, Moree and Collarenebri. Moree is the largest town with a population of approximately 10,000 (ABS 1997)①. Bundarra, Delungra, Gravesend, Biniguy, Pallamallawa and Terry Hie Hie are smaller centres within the catchment.

4.3 Agriculture

The major agricultural products in the catchment are cotton, wheat, sorghum, cattle and calves and wool.

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[5] Evaporative deficit is the reference evapotranspiration less rainfall. Reference evapotranspiration was determined using the FAO 56 methodology (Allen et al. 1998). Reference evapotranspiration is the amount of evaporation and transpiration from a grass reference crop (Allen *et al.* 1998). Climatic data were obtained from the Bureau of Meteorology (2000).

From the tablelands to Bingara, sheep and cattle grazing is the major rural enterprise. The application of superphosphate to pastures grown on low fertility granite-derived soils has been popular (NSW Agriculture and Fisheries 1991).

From Bingara to Biniguy, sheep and cattle grazing on native pastures are the dominant land uses. Flooding land adjacent to the river is more common in this area and a thin strip of alluvial river floodplains has been used for cropping. Between Biniguy and Moree, cropping close to the river becomes more intensive. Cereals, oilseeds, cotton and nuts are produced in this region. Mixed farming occurs along the Horton River. Basalt-derived soils dominate and cattle grazing is common. Cereal and forage crops are grown along the stream and on adjoining slopes.

Cotton is grown on land west of Moree and is the dominant enterprise in this area. Grazing still occurs in this part of the catchment, particularly on land adjacent to the Lower Gwydir and Gingham wetlands. Cereal and oilseed cropping also occur.

5. IRRIGATION FROM ALL SOURCES OF WATER

5.1 Description of irrigation

Most irrigation in the Gwydir catchment occurs on the fertile floodplains west of Moree, with the largest irrigated enterprise being cotton. The Gwydir catchment is one of the largest cotton-producing areas in Australia (Hearn and Cameron Agriculture 1997) and according to the Environmental Protection Authority (EPA 1997a) between 50,000 ha and 90,000 ha of cotton are regularly planted. Some authors (Hearn and Cameron Agriculture 1997) suggest that cotton areas can fall to 12,000 ha.

Other crops such as wheat are grown in rotation with cotton.

Between Biniguy to Moree, cereals, oil seeds and some irrigated cotton are produced. A large irrigated pecan nut plantation is located near Pallamallawa. Initial development of this nut farm occurred between 1968 and 1973 and the operation has a high security water entitlement of around 13,000 ML/year.

Due to the undulating landscape of the tablelands region, irrigation was not considered feasible (Stannard 1970). Very little irrigation occurs between the tableland and Biniguy as a result.

Irrigation farms in the Barwon region, of which the Gwydir catchment is a part, are larger than most in NSW. In 1996–97, the average area irrigated for broadarea and dairy farms in NSW was 189 ha — in the Barwon region it was 258 ha (ABARE 2000). These farms are large because the cotton industry is dominant in the catchment.

Table 4 summarises the most reliable information on irrigation in the Gwydir catchment for all sources of water. The matrix demonstrates where there are gaps in knowledge, for example, the number of enterprises irrigating and the total water used from all sources of water.

Table 4. Summary of irrigation data - all sources of water

Year (Oct–Sep)	No. of enterprises irrigating[a]	Total irrigation. area (ha)	Area of cotton irrigated (ha)	Total water used by irrigation ag. (ML)	Water used by cotton (ML)	Yield of cotton (t/ha)[6]	Value of irrigation ($m)[f]	Value of irrigation cotton ($m)[f]
1988–89	-	69,822[b]	52,885[d]	-	262,360[d]	1.8[d]	-	-
1989–90	-	62,226[b]	62,027[d]	-	272,065[d]	1.3[d]	-	-
1990–91	-	80,905[b]	63,610[d]	-	413,037[d]	1.7[d]	-	-
1991–92	-	-	76,173[d]	-	308,708[d]	1.7[d]	195	184
1992–93	-	-	48,203[d]	-	107,180[d]	1.2[d]	129	119
1993–94	143	47,218[a] 42,100[c]	29,347[a] 51,974[d]	-	74,385[d]	0.7[d]	83	70
1994–95	-	-	11,677[d]	-	-	1[d]	74	63
1995–96	65	33,106[a]		-	-		149	133
1996–97	92	57,564[a]	54,268[a]	-	-	1.6[e] 1.7[a]	245	221
1997–98	-	-		-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to Section:	5.3	5.4	5.4	5.4	5.4	5.6	5.7	5.7

[a] *(ABS 1998)②*

[b] *(DWR 1993)②*

[c] *(DLWC 1998b) ② and (ABS 1998)②. See Appendix 14.4. Overall reliability rating ③.*

[d] *(Hearn and Cameron Agriculture 1997)③*

[e] *(ABARE 2000) [a] ③*

[f] *(Donovan 2000) ③*

5.2 Number of licences (all sources)

There are an estimated 663 licences with the purpose of irrigation in the Gwydir catchment② [7]. This figure was estimated by summing the following data:

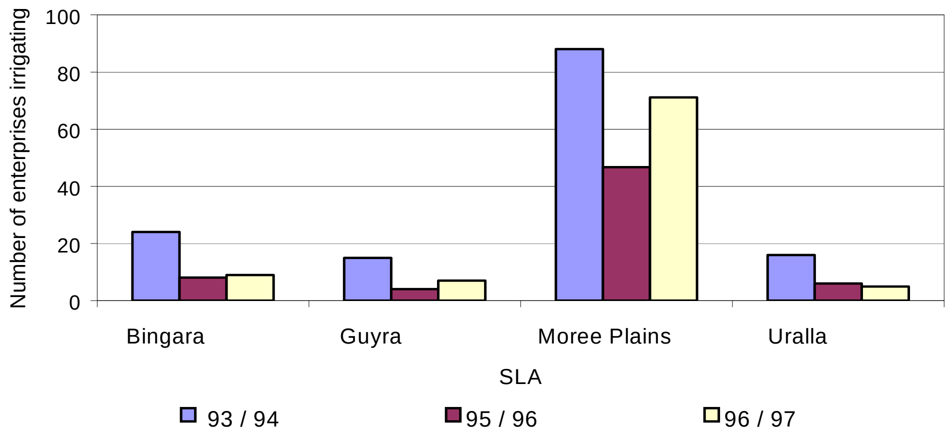
- 193 regulated licences for irrigation (DLWC 1999a) ①;
- 280 unregulated licences for irrigation (DLWC 1999a) ①; and,
- 190 groundwater licences for all purposes ① (Kalaitzis 1997). The number of groundwater licences for irrigation has been assumed to be the same ②.

5.3 Number of enterprises that irrigate (all sources)

There were 92 enterprises irrigating in the Gwydir catchment in 1996–97, and 77% of these were in the Moree Plains SLA (Appendix 14.5) ②. Irrigated agriculture is mostly concentrated on the riverine plains west of Moree. Between 1993–94 and 1995–96 the total number of enterprises irrigating fell from 143 to 65 and then rose again to 92 (1996–97) ② (Figure 4).

The number of enterprises irrigating cotton (represented by the category 'other crops') and cereals decreased between 1993-94 and 1996-97 (Appendix 14.6).

Figure 4. Number of enterprises irrigating in the Gwydir catchment



Source: (ABS 1998)②

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[6] 1 bale of cotton equals approximately 225 kg. 1 ha equals 2.47 acres.

[7] The reliability rating drops from ① to ② due the assumption that the number of groundwater licences for irrigation is the same as the number of licences for all purposes.

[9] Data from the (ABARE 2000) survey show that the Barwon Region (of which the Gwydir catchment is a part), used approximately 551, 000 ML in 1996/97 ③. These figures are for dairy and broadarea enterprises only. Data on the amount of water used by fruit, vegetables and horticultural crops were not collected.

5.4 Area irrigated and water used (all sources)

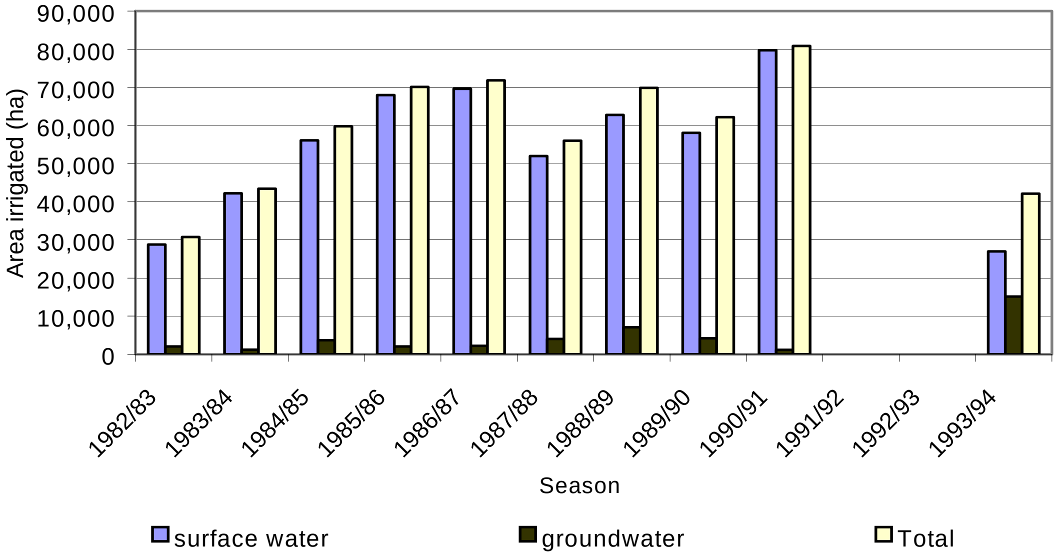
Area irrigated – It was estimated that in 1993–94, the amount of land irrigated was:

- 47,218 ha (ABS 1998)②;
- 42,100 ha (DLWC 1998b) ② and (ABS 1998)② (overall reliability rating ③); or,
- between 95,000 and 110,000 ha (Gwydir Catchment Taskforce 1997) (reliability rating unknown).

The first two figures compare reasonably well. However, the third figure is considerably larger, the reasons for which are not known.

During droughts, dependence on groundwater in the catchment increases. For example, in the 1993–94 drought the area irrigated from groundwater supplies increased from 1,157 ha (1990–91) to 15,152 ha (1993–94) while areas irrigated using surface supplies decreased (Appendix 14.4, Figure 5).

Figure 5. Area irrigated in the Gwydir catchment during the 1980s and early 1990s



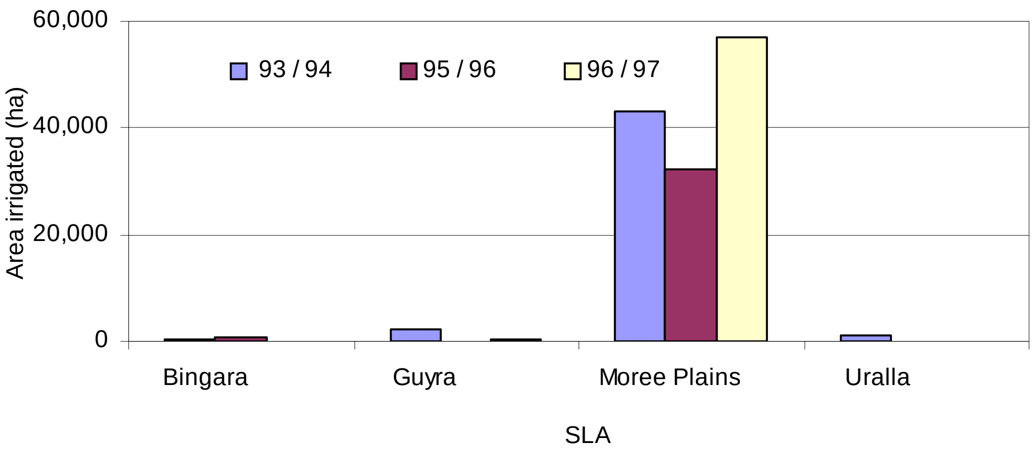
S ource: (DWR 1993)② (DLWC 1998b)② and ④ and (ABS 1998)②. Overall rating ③. See Appendix 14.4 for more details on referencing.

Irrigated area is mostly concentrated in the Moree Plains SLA (Figure 6) with very small amounts in the remaining SLAs.

As noted earlier, cotton is grown mainly along the river west of Moree (Figure 7), and is the major irrigated crop in the catchment. The figures shown in Table 4 suggest that between 12,000 ha and 76,000 ha of cotton are grown each year. Differences between irrigated area estimates from different references (see the 1993–94 season in Table 4) are not well understood. Cotton irrigated areas increased between 1993-94 and

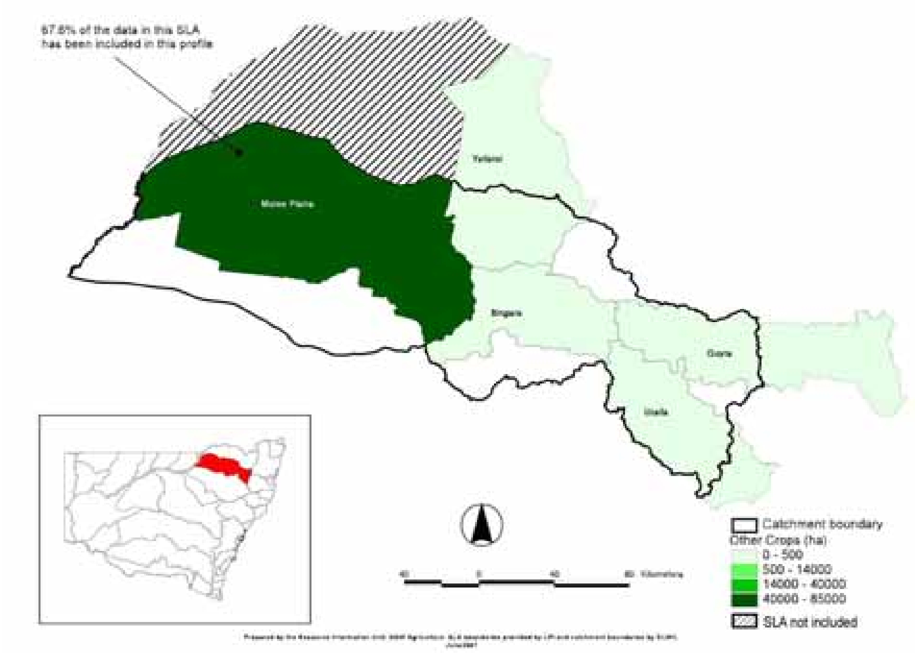
1996-97. Of note is the trend to larger areas being irrigated by smaller numbers of enterprises (Appendix 14.6).

Figure 6. Area irrigated (ha) in the Gwydir catchment between 1993–94 and 1996–97



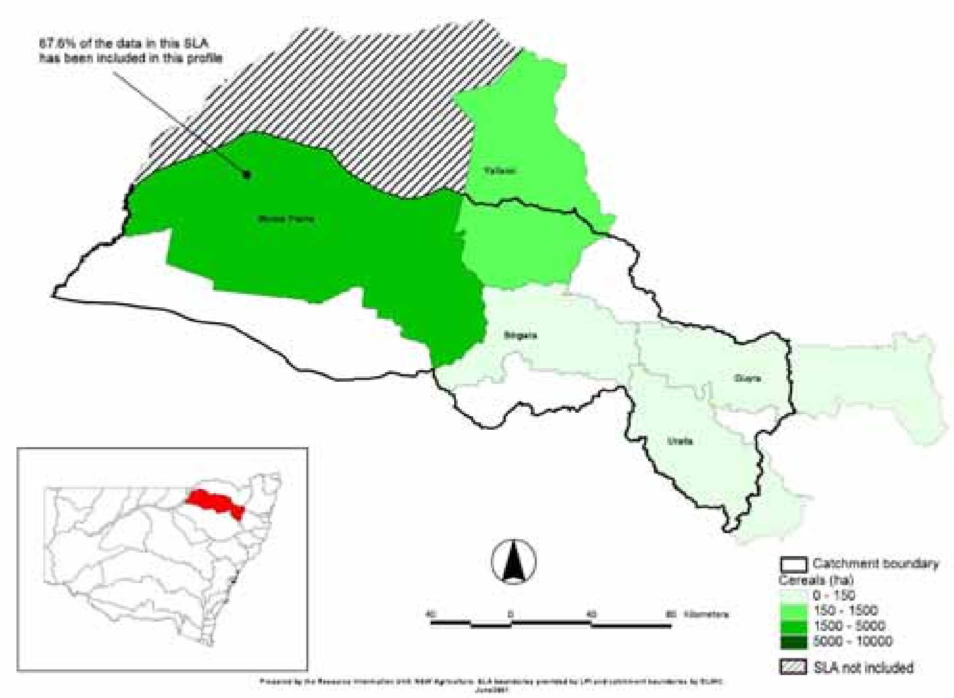
Source: (ABS 1998) ②.

Figure 7. Area of ‘other crops’ irrigated in the Gwydir catchment



Source: (ABS 1998) ②. Note: ‘Other crops’ refers mainly to cotton and includes small areas of oilseeds, tobacco and legumes. Unlike cotton, vegetables, pasture and cereals declined in irrigated area between 1993–94 and 1996–97. Irrigated cereals decreased from 5,126 ha (1993–94) to 2,279 ha (1996–97) (ABS 1998)②. Cereals were located mainly in the Moree Plains SLA (Figure 8).

Figure 8. Area of cereals irrigated in the Gwydir catchment



Source: (ABS 1998) ②

Water used – It has been estimated that 450,000 ML of water were used in the Gwydir catchment in 1996-97 ④[9]. It was not possible to give a more reliable figure as the estimate was determined by summing data from years (Table 1) with different climatic conditions with reliability ratings ranging from ① to ④. As shown in Table 1, the volume extracted from the regulated system by irrigators was known for the 1996–97 season and was based on metered information. However, water use data were collected for years other than 1996–97 (in the case of unregulated and groundwater supplies) or were not collected at all (farm dams and reticulated supplies). This decreased the reliability rating of the overall figure accordingly.

There was very little information on the amount of water used on individual crops irrigated from all sources of water. Again, data were available for the regulated and unregulated system for a short period (1989–90 to 1993–94). However, information regarding other sources (groundwater supplies, farm dams and reticulated water) was scant. Hearn and Cameron Agriculture (1997) attempted to estimate the amount of water used on cotton from all sources. They suggest that a mean of 239,623 ML was used between 1988–89 and 1994–95 and that cotton application rates ranged from 1.4 to 6.5 ML/ha. (Note: industry opinion suggests that these figures appear low (K Arnott, pers. comm.). For most other crops, theoretical (Table 5) or estimated irrigation requirements (Appendix 14.7) must suffice.

Table 5. Irrigation requirement of crops in the Gwydir catchment

Crop class[a]	Tablelands[b] (ML/ha)	Alluvial plains[c] (ML/ha)
Turf	11.5	
Orchards	9	
Nuts	9	
Citrus	8.5	
Vegetables	8	
Perennial pasture (dairy)	7.5	
Cotton	7.5	9
Lucerne	6.5	7
Summer oilseeds	6	8
Summer cereal	6	8.5
Perennial pasture (non dairy)	6	
Pulses	5.5	8
Vines	4.5	
Annual pasture	4.5	
Winter oilseeds	4	
Winter cereal	3	4

Source: (DLWC 2000c) ③. Figures include an assumed irrigation efficiency of 70%.

[a] Crop class refers to the grouping of like crops (for example, wheat and oats) within a generic crop class (such as cereals). Crops that exhibit similar physiological characteristics are likely to have similar water requirements.

[b] Data from climatic zone 3 (DLWC 2000c).

[c] Data from climatic zone 4 (DLWC 2000c).

5.5 Irrigation methods (all sources)

Surface methods predominate in the Gwydir catchment. The most recent ABARE (1998) survey shows that 91% of irrigated crops in NSW were watered using surface methods. This proportion is only slightly greater in the Barwon region, to which the Gwydir catchment belongs (Appendix 14.8) ③. Cotton is typically irrigated using furrow methods with some irrigation through drip and centre pivot.

5.6 Yields of irrigated crops (all sources)

Information on yields of crops irrigated from all water sources was generally poor, with the exception of cotton. Most data were obtained through personal communication with NSW Agriculture staff (Appendix 14.7) or from published material. This information has been summarised in Table 6.

Table 6. Irrigation yields in the Gwydir catchment

Crop	Average yield (t/ha)	References and reliability rating
Barley	4.2	Coulton (1979), pers. comm. G Shaw and J Kneipp ④
	2.8	ABARE (2000) [10] ③
Grain sorghum	2.9	ABARE (2000) [10] ③
	6.3	Coulton (1979), pers. comm. G Shaw and J Kneipp ④
Oats	3	pers. comm. J Spenceley ④
	0.8	ABARE (2000) [10] ③
Wheat	5	pers. comm. J Spenceley ④
	4.5	Coulton (1979), pers. comm. G Shaw and J Kneipp ④
	2.9	ABARE (2000) [10] ③
Soybeans	3	pers. comm. J Spenceley ④
	2.5	Coulton (1979), pers. comm. G Shaw and J Kneipp ④
Oilseeds	1.3	ABARE (2000) [10] ③
Grain legume	0.7	ABARE (2000) [10] ③
Lucerne [b]	6.4	ABARE (2000) [10] ③
Hay & silage production	7.5	ABARE (2000) [10] ③

[10] 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. Yields are for the Barwon region were determined by dividing tonnes by hectares . This Profile provides the RSEs of the data used to calculate irrigation yields: **crop** RSE tonnes, RSE hectares. **Barley** 28, 26, **Grain sorghum** 40, 42 **Oats** 52, 35 **Wheat** 21, 22 **Oilseeds** 46, 49 **Grain legumes** 40, 34 **Lucerne** 28, 23 **Hay & Silage** 28, 22 **Cotton** 17, 16.

Crop	Average yield (t/ha)	References and reliability rating
Cotton	2 (1.13–3.25)	pers. comm. J Spenceley ④
	1.75	Coulton (1979), pers. comm. G Shaw and J Kneipp ④
	1.6	ABARE (2000) [10] ③
	1.3	Hearn and Cameron Agriculture (1997) ③

Where comparisons could be made, ABARE figures tend to be lower than figures from other references (Table 6).

Average cotton yields in the Gwydir catchment were estimated to be 1.3 t/ha (range: 0.7–1.8 t/ha) (Hearn and Cameron Agriculture 1997). Yields will vary from season to season in line with water availability and factors such as pests, diseases, nutrition and cotton prices. ABARE (2000) estimates a cotton yield of 1.6 t/ha for the Barwon region in 1996–97 while Boyce (1997) estimates that, with continually improving varieties, yields of 2.5 t/ha[11] are realistic.

Information on horticultural and vegetable yields was unavailable.

5.7 Value of irrigated production (all sources)

The value of all agriculture (irrigated and dryland) in 1996–97 was estimated to be $592 million[12] (Donovan 2000) ②[13]. The value of irrigation in the same year was $245 million③[14].

Donovan (2000) used ABS information to synthetically derive data on irrigation values. Donovan derived individual irrigated commodity values for Australia by estimating the percentage of the total commodity value that could be attributed to irrigation. The percentage was determined from numerous agency reports and wide consultation with industry bodies (DWC 1990). The individual commodity percentages

[11] Numbers converted from bales to tonnes based on conversion rate of 1 bale of cotton being 225 kg.

[12] The value of agriculture (dryland and irrigated) fluctuated from $380 million (1987–88) to over $600 million (1990–91) (Powell 1996)②.

[13] Figures on total value from agriculture (irrigated and dryland) receive a reliability rating of ②. These data are from the ABS and have not been manipulated.

[14] It should be noted that Donovan (2000) used the ABS SLAs of Bingara, Moree Plains and Uralla to determine the irrigated value of the Gwydir catchment. This Profile has used Bingara, Moree Plains, Uralla and Guyra. Guyra has very little irrigated activity and its inclusion or exclusion has little impact on the total irrigated value.

were applied to the total NSW commodity value data from the ABS for each SLA over the period between 1991 and 1997 (Donovan 2000) ②. The estimated irrigated commodity values were then summed to provide synthetic 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 because grapes are usually irrigated with high security water and this helps to ensure yields and areas remain reasonably static. Cereal areas and yields can, by comparison, vary markedly with climate and water availability. The overall reliability rating for these data is ③.

Agriculture's dependence on irrigation has fluctuated from 29% to 50% (Figure 9). Cotton had the highest value of all irrigated crops in the Gwydir catchment and ranged from $63 million (1994–95) to $221 million (1996–97) ③ (Appendix 14.9) (Table 7). Approximately 80% of the total value of cotton was attributed to irrigation (Figure 9). In 1996–97, irrigated cotton had the largest total value for the Gwydir catchment followed closely by dryland cereal production (Donovan 2000) (Table 7).

Grain cereal crops were the next most valuable irrigated crop and ranged in value from $1.7 million (1994–95)[15] to $11.8 million (1996–97) (Appendix 14.9) ③.

Irrigated fruit and nuts (excluding grapes) were the next most valuable irrigated category, increasing from $0.5 million (1991–92) to $2.6 million (1996–97) (See Appendix 14.9) ③. Dependence on irrigation by the fruit and nut industry dropped over this period from 91% to 64% (Figure 9).

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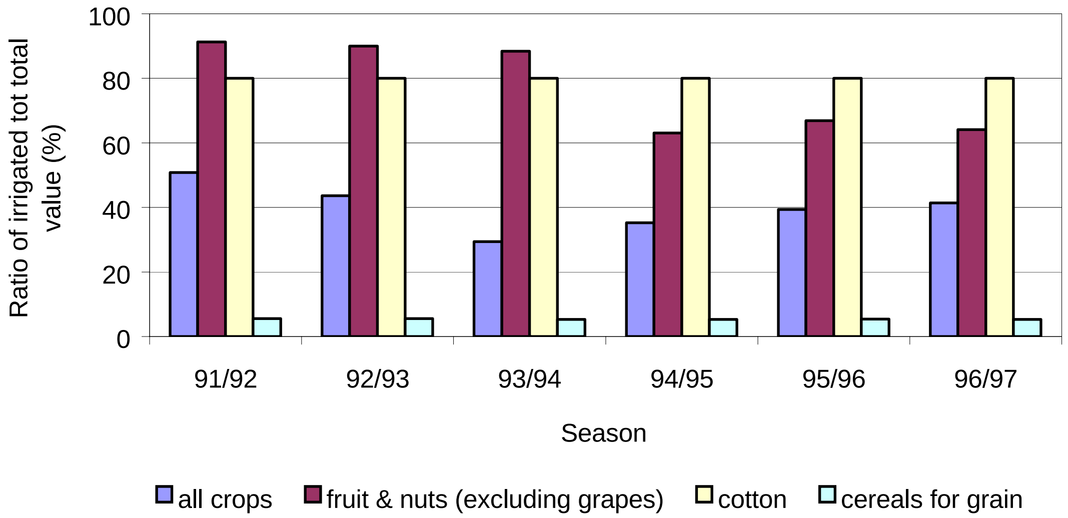
[15] Between the 1979–80 and 1991–92 seasons, a median of 4,179 ha of irrigated wheat was grown (DWR 1993). At a gross margin of $523/ha (Scott 1998) the median area equates to $2.2 million in income. This figure is close to that provided by (Donovan 2000).

Figure 9. Value attributed to irrigation in the Gwydir catchment as a percentage of the total value



Source: (Donovan 2000) ③

Table 7. Value ($) of agricultural production in the Gwydir catchment in 1996–97

Crop	Irrigated agriculture ($mill.)	Dryland agriculture ($mill.)	Total agriculture ($mill.)	Irrigated value as proportion of total value (%)
Cotton	220.8	55.2	276	80
Other crops	5.5	7.6	13.1	41.8
Cereals for grain	11.8	212.4	224.2	5.3
Fruit (excl. grapes)	2.6	1.4	4.0	64.1
Livestock products	2.5	29.5	32.0	7.8
Total livestock slaughtering	1.3	39.6	40.9	3.3
Pasture and grasses	0.5	0.4	0.8	54.7
Crops for hay	0.1	0.4	0.5	24.0
Vegetables	0.046	0.00003	0.046	99.9
TOTAL	**245.1**	**346.5**	**591.6**	**41.4**

Source: (Donovan 2000) ③.

6. IRRIGATION FROM REGULATED RIVERS

6.1 Description of the regulated water supply

The Gwydir, Gil Gil and Mehi Rivers are the only regulated watercourses in the catchment. Since the construction of Copeton Dam and river regulation, the mean daily discharges have increased in January and decreased in June (Table 8). Flows during winter are lower and more predictable. Summer flows are more variable and depend heavily on Copeton Dam water levels (Bennett 1996).

Table 8. Changes in mean daily stream discharges in the Gwydir River at Pallamallawa since the construction of Copeton Dam

	Flow (ML/day)			
	Pre-Copeton Dam (1952–72)		Post-Copeton Dam (1973–95)	
Month	Min	Max	Min	Max
January	31	3,849	310	15,082
June	38	17,272	97	6,169

Source: (Bennett 1996) (reliability unknown). These figures should be used as a guide only given that a reliability rating cannot be assigned.

Regulation involves the management of releases from Copeton Dam (capacity 1,364,000 ML) and six weirs or regulators (Table 9) (DWR 1993). Copeton Dam was constructed in two stages – stage one began in 1971 and stage two in 1973 (Cross 1995).

Streamflows in the Gwydir River were naturally variable before regulation. Prior to the construction of Copeton Dam, flows at Pallamallawa varied from about 1% to 500% of the annual average flow of 804,000 ML (Beale 1970). The Gwydir River at Pallamallawa ceased to flow for 5% of the time between 1890 and 1973 (DWR 1993).

The highest median daily flows for the 20 years recorded prior to Copeton Dam were from July to November. This situation has now changed and the maximum daily discharges usually occur in January and February. This coincides with high water demands during these months from the irrigation industry on the Gwydir River west of Moree (A Robertson, pers. comm.). During peak irrigation periods, about 7,000 ML/day are released from the dam. At other times in the irrigation seasons this figure can decrease to between 3,000 and 4,000 ML/day (pers. comm. P Christmas).

Table 9. Major structures for river regulation in the Gwydir catchment

Structure	Installation date	Location	Purpose
Tareel Roi Weir	1972	Gwydir River	To form a weir pool for diversions from the Gwydir River into the Mehi River
Boolooroo Weir	1979	Gwydir River	To control waters entering the Carole and Gil Gil creek systems
Carole Creek Regulator	1937	Carole Creek	Flow control
Combadello Weir	1977	Mehi River	To form a weir pool for diversions from the Mehi River into the Moomin Creek
Gundare Regulator	1979	Mehi River	To form a weir pool for diversions from the Mehi River into the Mallowa Creek
Mallowa Creek Regulator	1977	Mallowa Creek	Flow control

***Source**: (DWR 1993)*

Copeton Dam was built to allow for the expansion of irrigation in the Gwydir catchment. The catchment is now one of the largest cotton-growing areas in Australia (Hearn and Cameron Agriculture 1997). The project also supplies water to the town of Inverell and was funded by contributions from government and the irrigation industry.

Copeton Dam was initially expected to provide a reliable supply of water to around 50,000 ha of cropping. However, this was an overestimate (Pigram 1986). The nominal annual volumetric allocation introduced in the 1980s was over 530,000 ML but there was less than 50% reliability of receiving this supply (EPA 1997b). Area-based licences that existed along the regulated river were converted to volumetric licences in 1981 at a rate of 6 ML/ha, based on a reliability of 45% (TCM undated). It has been estimated that long-term reliability is between 50 and 55% (DWR 1993).

The Gwydir catchment has a continuous accounting system that was implemented in 1998. This system allows licensees with individual general security accounts to be credited with up to 150% of their allocation. Any unused allocation can be carried over to the next season. Licensees may receive a new allocation increment of up to a maximum limit of 150% depending on resource conditions. In any season, each licensee is limited to a maximum on-allocation usage of 100%.

Table 10 summarises what information is available on irrigation from regulated water supplies in the Gwydir catchment.

Table 10. Summary of irrigation data - regulated water supplies

Year (Oct – Sept)	Number of enterprises irrigating [a]	Total irrigation area (ha)	Area of cotton irrigation (ha)[c]	Total water used by irrigation agriculture (ML)	Water used by cotton [c]	Yield Of cotton (t/ha)	Value of irrigation ($m)	Value of cotton ($m)
1988–90	-	55,744 [b]	-	-	-	1.8 [e]	-	-
1989–90	-	53,886 [b] 34,891[c]	32,762	276,997[c]	139,444	1.3 [e]	-	-
1990–91	-	77,282 [b] 75,801 [c]	71,622	392,800 [b] 425,708 [c]	208,802	1.7 [e]	-	-
1991–92	-	65,212 [b] 53,578 [c]	51,460	260,700 [b] 312,117 [c]	167,705	1.7 [e]	-	-
1992–93	-	32,398 [b] 32,148 [c]	30,716	142,800 [b] 113,069 [c]	87,358	1.2 [e]	-	-
1993–94	82	28,112[a] 20,580 [b] 21,208 [c]	19,514	47,900 [b] 81,051 [c]	60,556	0.7 [e]	-	-
1994–95	-	8,961 [b]	-	63,800 [b]	-	1 [e]	-	-
1995–96	-	44,576 [b]	-	222,900 [b]	-		-	-
1996–97	-	72,680 [b]	-	404,900 [b]	-	1.6 [f]	-	-
1997–98	-	83,515 [b]	-	523,800 [b]	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	85,000[g]	-	434,000[d]	-	-	-	-
2000–01	-	89,000 [g]		-	-	-	-	-
Refer to Section:	0	6.5	6.5	6.5	6.5	6.7	6.8	6.8

[a] *(ABS 1998)* [b] *(DLWC 1998a) total area irrigated②, total water used ①.*

[c] *(DLWC 1998b) total area irrigated ②, total water used ①, crop areas ②, crop water use②*

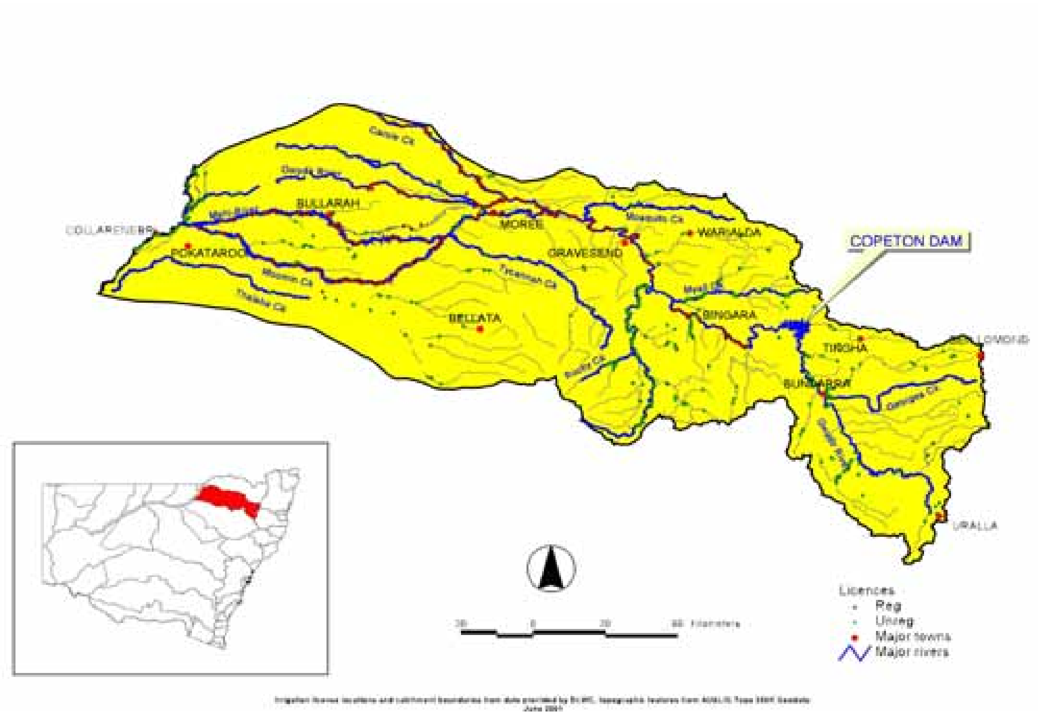
[d] *(pers. comm. D. Barma) from LAS ①* [e] *(Hearn and Cameron Agriculture 1997) ③*

[f] *(ABARE 2000) ③* [g] *DLWC (2001)*

6.2 Number of irrigation licences (regulated)

A total of 222 regulated licences have been issued for the Gwydir River and effluents below Copeton Dam (DLWC 1999a)[16]①. Of these, 193 have been issued for the purpose of irrigation (location shown, Figure 10) and about 99% of these are fully active. Of the irrigation licences, 187 are general security licences, and four are high security licences used by horticultural enterprises (DLWC 1999a)①.

Figure 10. Location of surface licences for the purpose of irrigation in the Gwydir catchment



Source: (DLWC 2000d), ①

6.3 Volumetric entitlement (regulated)

The total entitled water for irrigation from the regulated river system was 524,144 ML (DLWC 1999a)①. This entitlement is used for general irrigation purposes (broadarea cropping) and high security purposes (pecan and citrus) (Table 11).

[16] An issued licence is one that has been paid for.

Table 11. Entitlement by purpose in the Gwydir catchment

Purpose	Entitlement (ML/year)	% of total entitlement
Irrigation	510,401	92.13
Environmental Contingency Allocation (ECA)	25,000[a]	4.51
Pecan nuts	13,715	2.48
Stock	1,645	0.30
Experimental & research purposes	1,060	0.19
Domestic	802	0.14
Town water supply	760	0.03
Recreation (low security)	171	0.03
Industrial	150	0.02
Sand & gravel	117	0.02
Recreation (high security)	42	0.01
Citrus plantings	28	0.01
TOTAL	**554,007**	**100**

Source: (DLWC 1999a)①. [a] This figure is multiplied by the percentage of available general security allocation each year, for example an announced allocation of 20% = ECA of 5,000 ML.

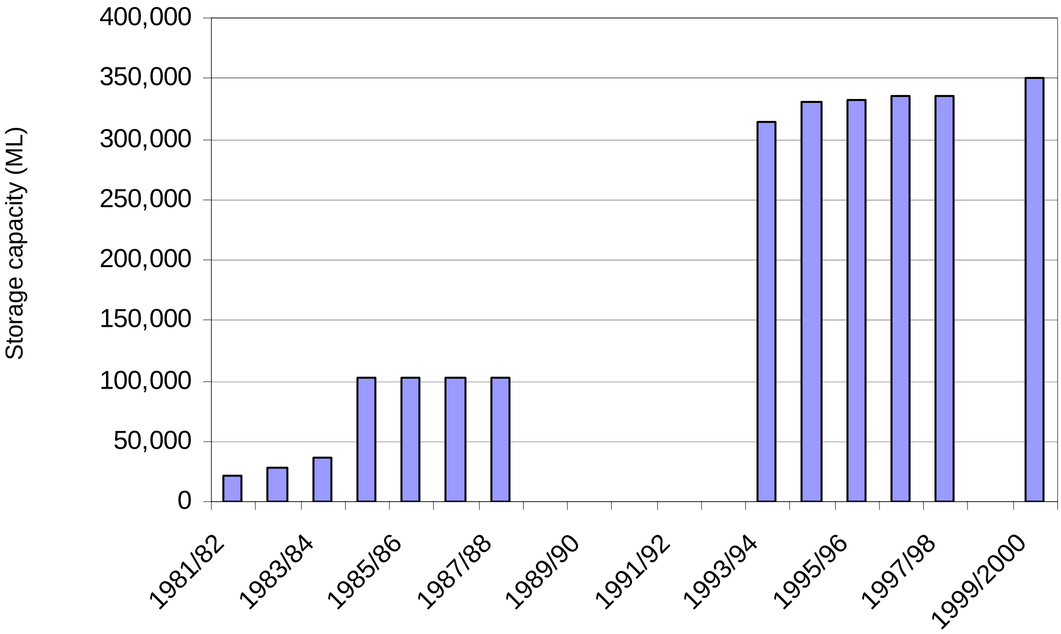
Off-allocation flows are those that the DLWC considers be surplus to all consumptive needs and are used by irrigators to supplement on-allocation volumes. That is, when high flows occur within a regulated stream, the DLWC may announce the availability of off-allocation water (now called Supplementary Water). Much of the off-allocation flows available to irrigators are sourced from the unregulated Horton River. Irrigation in the Gwydir catchment is heavily dependent on surplus flows (K Arnott, pers. comm.). The average use of off-allocation, now ‘supplementary’, water has been 116,000 ML and maximum use has been 162,000 ML (R Hart, pers. comm.).

Large on-farm storages have been built on many farms to take advantage of off-and on-allocation water from the Gwydir River and its effluents (McCosker & Duggin 1992).

These on-farm storages have separate licensing arrangements to farm dams and are exempt from the farm dams policy (see Section 9). They are used to store river water or tailwater from irrigation fields.

On-farm storages increased in capacity from 200,000 ML (1990–91) (McCosker & Duggin 1992) to 350,000 ML (2000–01; D Barma, pers. comm.) (Figure 11). The volume of water held in these storages varies considerably from year to year, reflecting access to river water. For example, the amount of water pumped into storage facilities ranged from 8,511 ML in 1993–94 to a high of 195,956 ML in 1990–91 (DLWC 1998b)② (Appendix 14.10).

Figure 11. On-farm storage capacity in the Gwydir catchment



Source: (DLWC 1998a)②, D Barma, pers. comm. from LAS ①

The amount of off-allocation water used by irrigators has also increased in line with increased on-farm storage capacity (Table 12).

Table 12. Off-allocation and on-farm storage capacity in the Gwydir catchment

	On-farm storage capacity (ML)	Off-allocation availability (ML)
1991–92	200,000 [a]	25% of all water used by irrigators [a]
1993–94	314,108 [c]	73,000 [a]
1994–95	331,080 [c]	81,000 [b]
1999–00	350,328 [c]	87,000[c]

[a] *McCosker & Duggin 1992* [b] *(Gwydir Catchment Taskforce 1997)*

[c] *D Barma, pers. comm., from the Licence Administration System (LAS) ①*

During 1998–99, new rules governing off-allocation availability meant that access to off-allocation water was limited to 50% of any one flow event and that the volume of streamflow needed to exceed consumptive requirements by at least 1,000 ML (DLWC 1998c). The Water Sharing Plan for the Gwydir regulated river water source sets out the rules for sharing of supplementary water. Refer to Clause 48 of the plan for further information.

6.4 Number of enterprises that irrigate (regulated)

The number of enterprises irrigating from regulated supplies in 1993–94 was estimated to be 82 (ABS 1998)②. However, this figure is likely to be an overestimate due to the questionnaire ABS used to collect the data. The questionnaire did not clearly differentiate between unregulated and regulated systems (Appendix 14.11). The ABS definition includes extraction from a river or stream controlled by a water board or water resources commission dam or weir. As a result, some SLAs (such as Guyra) have recorded usage from regulated streams where there are no regulating structures present.

The number of enterprises irrigating could also be determined from DLWC licence databases. However, this approach has many difficulties and was not attempted for this Profile. Often many irrigators may hold one licence (as for Surface Authorities) or one irrigator may hold many single surface licences. To determine the number of enterprises in the catchment, one must approach each Surface Authority to determine the number of enterprises within the 'licensed' area. One must also amalgamate licences held by a single irrigator. This may be difficult when single licences held by the one enterprise are catalogued under different family names and contact addresses.

6.5 Area irrigated and water used (regulated)

Area irrigated – The area irrigated from regulated supplies has ranged widely from 8,961 ha (1994–95) to 83,515 ha (1997–98) (DLWC 1998b) ② (Table 10). These fluctuations can usually be related to announced allocations from Copeton Dam (Appendix 14.12). For example, the small area irrigated in 1994–95 coincides with the third year of zero allocations from Copeton Dam (DLWC 1995).

Where comparisons could be made between different references, figures were generally close, with the exceptions of 1989–90 and 1991–92 (Table 10). Reasons for this are not known.

Cotton has the largest area irrigated in the Gwydir catchment and shows marked variation that increases and decreases with storage levels. Cotton irrigation areas ranged from 19,514 ha (1993–94) to 71,622 ha (1990–91) (DLWC 1998b) (Appendix 14.10) ②. Announced allocations at the beginning of these seasons were zero and 60% respectively (Appendix 14.12).

Water use – The total amount of water used to irrigate crops varied widely from a minimum of 48,000 ML (1993–94) to 524,000 ML (1997–98) (DLWC 1998a) ① (Table 10Table 10). In 1999–00, 434,000 ML was diverted from the river, comprising 347,000 ML of on-allocation and 87, 000 ML of off-allocation (D Barma, pers. comm., from LAS). ②. Where comparisons could be made, differences in volume between references ranged from 30,000 ML to 50,000 ML (Table 10).

Cotton was the largest extractor of water (Appendix 14.10), with a low of 60,556 ML (1993–94) and a high of 208,802 ML (1990–91) (DLWC 1998b)②.

The catchment also depends heavily on on-farm storages. Large volumes of water ranging from 8,500 ML and 196,000 ML were extracted from the river and pumped into on-farm storages (DLWC 1998b)②, ultimately to be used mostly on cotton.

Pecan nuts were the next largest user after cotton, taking around 10,000 ML/year and irrigating 700 ha. The remaining volume extracted was shared between other crops such as soybeans, wheat and sorghum (DLWC 1998b)② (Appendix 14.10).

Better information on the volume of water used by crop type is scarce.
Data for crops other than cotton have not been collected since 1993–94.

6.6 Irrigation methods (regulated)

Most of the water used from the regulated system in the Gwydir catchment is delivered to crops by surface methods. However, there are no specific datasets on irrigation methods by water source. For further information, see Section 5.5 for methods relating to all sources.

6.7 Yields of irrigated crops (regulated)

The irrigation data provided in Section 5.6 may be referred to here, as most cotton grown in the Gwydir catchment relies on regulated supplies.

6.8 Value of irrigated production (regulated)

There are no data showing the total value of crops irrigated from regulated supplies only. However, for reasons outlined above, refer to Section 5.7.

7. IRRIGATION FROM UNREGULATED RIVERS

7.1 Description of the unregulated water supply

The major unregulated streams within the Gwydir catchment are the upper Gwydir River and the Horton River. Other unregulated subcatchments are shown in Appendix 14.13 [17] and irrigators along these watercourses are confined to small river flats. Access to water is highly variable and stream flows are highest from December to February and lowest during April and May (WRC 1980). Water management changed considerably during the 1990s.

- There was an embargo on further licence applications on unregulated streams across most of NSW (DLWC 1999d).
- In 1999, rivers and streams were classified according to their assessed level of stress and this classification has helped guide management priorities and policies (DLWC 1999c).
- Since 2000, Water Management Committees, comprising agency and community representatives, have been developing water-sharing plans in the Gwydir catchment.
- In 2000, area-based licences were converted to volume-based licences[18]. Details of the volumetric conversion process can be found in DLWC (2000c). Licences on unregulated streams have been converted at variable rates depending on crops and history of use.

Table 13 summarises the most reliable information on irrigation from unregulated water supplies in the Gwydir catchment. It shows the areas where data are in short supply.

7.2 Number of irrigation licences (unregulated)

In 1993, there were 207 licences for irrigation (DWR 1993)①. The number has more recently dropped to 191 licences (DLWC 1999a)①.

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[17] The DLWC undertook a desktop assessment of the environmental and hydrological stress of unregulated subcatchments in the Gwydir catchment and a brief outline of the method and results are provided in Appendix 14.13.

[18] This situation is similar to that which occurred in the regulated river systems across NSW in 1981 where licences were converted to a volumetric allocation at a rate of 6 ML/ha.

Table 13. Summary of irrigation data (unregulated)

Year (Oct–Sept)	No. of enterprises irrigating	Total irrigated area (ha)	Area of cotton irrigated (ha)	Total amount of water used by irrigated agriculture (ML)[b]	Total amount of water used on cotton	Yields of irrigated cotton (t/ha)	Value of irrigation ($m)	Value of cotton ($m)
1988–90	-	-	-	-	-	-	-	-
1989–90	-	1,369 [b]	778[b]	3,537[b]	-	-	-	-
1990–91	-	1,733 [b]	1,250 [b]	8,968 [b]	-	-	-	-
1991–92	-	2,178 [b]	1,250 [b]	8,420 [b]	-	-	-	-
1992–93	-	540 [b]	259 [b]	3,368 [b]	-	-	-	-
1993–94	105[a]	24,615[a] 5,467[c] 5,740 [b]	3,041 [c] 4,651 [b]	2,127 [b]	-	-	-	-
1994–95	-	2,540 [c] 3,023 [b]	738 [c] 1,493[b]	1,466 [b]	-	-	-	-
1995–96	-	6,841 [c]	4,001 [c]	-	-	-	-	-
1996–97	-	7,152 [c]	4,346 [c]	-	-	-	-	-
1997–98	-	6,250 [c]	3,838 [c]	-	-	-	-	-
1998–99	-	6,136 [c]	3,637 [c]	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to section:	0	7.5	7.5	7.5	7.5	7.7	7.8	7.8

[a] *(ABS 1998)②*

[b] *(DLWC 1998b)④*[19]

[c] *(DLWC 2000b)②*

[19] Data were collected by crop return survey. As not all irrigators returned information to the DLWC, the data are indicative only and receive the lowest reliability rating.

7.3 Number of enterprises that irrigate (unregulated)

The number of enterprises irrigating with water from unregulated rivers was 105 in 1993–94 (ABS 1998)② but is likely to be underestimated due to the ABS survey question format. See Section 0 for further details regarding this issue. Most of these enterprises were in either Moree Plains or Bingara SLAs (Appendix 14.14).

As noted in Section 0, it would be possible to determine the number of irrigation enterprises from the DLWC licence databases. Due to the large amount of work involved in undertaking such an exercise, these figures have not been determined.

7.4 Area authorised and volume entitled (unregulated)

The volume entitled to irrigation in the catchment from unregulated streams has not yet been determined. A total of 27,645 ha was authorised to be irrigated (DLWC 1999c)①.

7.5 Area irrigated and water used (unregulated)

Area irrigated – An average of 5,710 ha were irrigated from unregulated streams in the Gwydir catchment between 1993–94 and 1998–99, according to figures from the DLWC (2000b) ②. During this period, irrigated areas remained reasonably static with the exception of 1994–95 when only 2,540 ha were irrigated. Where comparisons could be made between different references, estimates of total area and crop area were reasonably close except for 1993–94 (Table 13). Differences between DLWC and ABS data cannot be explained.

Cotton had the largest area irrigated and according to the DLWC (2000b)② varied from 738 ha in (1994–95) to 4,346 ha (1996–97) (Table 14) ②.

Water use — There is very little information on water used from unregulated streams in the Gwydir catchment. Information was collected from irrigators by crop return cards between 1989–90 and 1994–95. The information attracts a low reliability rating as only a proportion of growers submitted returns each year (DLWC 1998b). These data show that extraction of water ranged from 1,466 ML in 1994–95 and 8,968 ML in 1990–91 (DLWC 1998b)④ (Appendix 14.15).

There were no data on the total amount of water used on different crops. The theoretical conversion rates for unregulated licences have been provided in Table 5.

7.6 Irrigation methods (unregulated)

Data on the methods used to irrigate crops with water from the unregulated rivers in the Gwydir catchment have not been collected. Cotton and cereal crops in the lower catchment are generally watered using surface methods. In the upper catchment, where lucerne and pasture crops dominate, pressure systems are used.

Table 14. Irrigated crop area in the Gwydir catchment (unregulated)

Data	1993–94	1994–95	1995–96	1996–97	1997–98	1998–99
Cotton	3,041	738	4,001	4,346	3,838	3,637
Winter cereal	1,211	736	1,657	1,430	1,326	1,062
Perennial pasture	619	563	532	650	555	568
Other	1	1	6	2	2	256
Lucerne	388	363	323	305	287	234
Pulses	46		186	152	133	152
Summer cereal	8		8	28		110
Annual pasture	72	70	70	83	68	68
Fodder	80	69	53	45	37	45
Trees - orchards					3	2
Vegetables		1			1	2
Trees - other	1	1	1	1	1	1
Summer oilseeds				110		
Turf			4			
Total	**5,467**	**2,540**	**6,841**	**7,152**	**6,250**	**6,136**

Source: (DLWC 2000b) ②. Data were obtained from growers by written survey (DLWC 2000c).

7.7 Yields of irrigated crops (unregulated)

There are no data on yields of crops irrigated specifically from unregulated rivers in the Gwydir catchment (see Section 5.6 for details on crops irrigated from all sources).

7.8 Value of irrigated production (unregulated)

Data are unavailable on the value of irrigation dependent on unregulated systems in the Gwydir catchment.

8. IRRIGATION FROM GROUNDWATER

8.1 Description of groundwater

Irrigation has limited dependence on groundwater in the Gwydir catchment and use varies with seasonal conditions and the use of conjunctive use licences[20].

In the undulating landscapes of the tablelands above Biniguy, groundwater is scarce and is contained in small areas of alluvium. Yields from this area are only enough to satisfy stock and domestic needs (Ross & Little 1993).

In the lower catchment immediately west of Biniguy and overlaying the edge of the Great Artesian Basin, a fan of high yielding alluvium begins. This aquifer extends 40 km west of Moree and is up to 30 km wide. Bores in this region can yield up to 60 L/s, although yields of 12–40 L/s are more common (Ross & Little 1993). Groundwater outside the alluvial fan can be hard to find and of low yield and quality.

Groundwater recharge of 38,000 ML/year has been indicated for the Lower Gwydir catchment (Rob Brownbill, pers. comm.).

Groundwater from the Great Artesian Basin is used only for stock and domestic needs.

The 'One Resource' policy introduced in 1983 allowed landholders to access groundwater during times of drought or low available allocations. For example, when an irrigator could access 6 ML/ha, or 100% surface water allocation, from Copeton Dam, that operator could only access an additional 1.5 ML/ha of groundwater to bring their water availability to 7.5 ML/ha. When there was no water available from Copeton Dam, an irrigator could access 4 ML/ha of groundwater from licensed bores (Pigram 1986).

These access rules changed with the introduction of the *Water Management Act* (2000), which separated the groundwater component of conjunctive licences from dependence on announced allocations from the regulated system. For further details on the access rules, see the Groundwater Sharing Plan for the catchment. The conjunctive component was converted to a 'standalone' groundwater licence at the rate of 1.76 ML/ha of authorised irrigation area (DLWC 2002) and has been enforced under the Act.

Currently the NSW Government is developing a Groundwater Structural Adjustment Program for the Lower Gwydir 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 15 summarises the most reliable data from 1988–89 to 2000–01. The table highlights the lack of irrigation data across most categories.

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[20] Conjunctive use licences – as surface water resources decreases, the volume of water that can be extracted from groundwater systems increases.

Table 15. Summary of irrigation data - groundwater supplies

Year (Oct – Sept)	No. enterprises irrigating	Total irrigated area (ha)	Area of cotton irrigated (ha)	Total water used by irrigated agriculture (ML)	Water used on cotton (ML)	Yield of cotton (t/ha)	Value of irrigation ($m)	Value of cotton ($m)
1988–89	-	7,039[c]	6,738 [c]	-	-	1.8[d]	-	-
1989–90	-	4,170 [c]	4,048 [c]	-	-	1.3 [d]	-	-
1990–91	-	-	-	-	-	1.7 [d]	-	-
1991–92	-	-	-	-	-	1.7 [d]	-	-
1992–93	-	-	-	-	-	1.2 [d]	-	-
1993–94	27[a]	15,152[a]	-	-	-	0.7 [d]	-	-
1994–95	-	-	-	-	-	1 [d]	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	1.6[e]	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	173[b]	-	-	-	-	-	-	-
Refer to Section:	8.3	8.5	8.5	8.5	8.5	8.7	8.8	8.8

[a] *(ABS 1998)* ②

[b] *R. Brownbill, pers. comm.* ①

[c] *(DWR 1993)* ②

[d] *(Hearn and Cameron Agriculture 1997)* ③

[e] *(ABARE 2000)* ③

8.2 Number of irrigation licences (groundwater)

There are 190 bore licences on issue for all purposes in the NSW Gwydir catchment alluvium (Kalaitzis 1997) ① and it can be assumed that most of these are for the purpose of irrigation ②.

8.3 Number of enterprises that irrigate (groundwater)

There are 27 (ABS 1998) ② enterprises irrigating with groundwater supplies in the Gwydir catchment. Most of these enterprises exist in the Moree Plains SLA (Appendix 14.14).

Other sources suggest more enterprises are irrigating than the ABS (1998) estimates. According to R. Brownbill (pers. comm.), 173 properties had access to groundwater supplies in the Gwydir catchment. Of these, around 38 use more than half their allocation of groundwater, a further 40 properties use less than half and around 95 properties are inactive.

8.4 Volume entitled to irrigation (groundwater)

There are 68,046 ML of base allocation for all purposes in the Gwydir catchment including town water supplies for Moree and Pallamallawa. When the town water component is removed, the remaining entitlement is 64,474 ML, most of which will be for irrigation purposes.

8.5 Total area irrigated and water used (groundwater)

Area irrigated – There were 15,152 ha of land irrigated from groundwater supplies in the Gwydir catchment in 1993–94 (ABS 1998)② , most of which was in the Moree Plains SLA (Appendix 14.14). During 1993–94, drought increased the need to supplement surface water with groundwater (Figure 5). Areas irrigated by groundwater reached 15,000 ha. For years prior to 1993–94, between 2,000 and 7,000 ha were irrigated from groundwater supplies (Appendix 14.4).

The available information on crop areas is scant and unreliable. Table 16 gives a rough estimate of areas irrigated between 1982–83 and 1989–90. Groundwater was used mainly to irrigate cotton.

Table 16. Area irrigated (ha) using groundwater between 1982–83 and 1989–90 in the Gwydir catchment

Year	Cereal / wheat (ha)	Cotton (ha)	Lucerne (ha)	Pasture / fodder (ha)	Orchards, vegies (ha)	Other (ha)	Total (ha)
1982–83	101	1,636	41	57	35	163	2,033
1983–84	0	1,122	6	30	15	21	1,194
1984–85	925	2,642	43	44	11	16	3,681
1985–86	492	1,282	41	80	12	187	2,094
1986–87	485	1,509	37	57	15	121	2,224
1987–88	59	3,869	15	20	31	54	4,048
1988–89	140	6,738	15	34	3	109	7,039
1989–90	0	4,048	35	63	23	1	4,170

Source: (DWR 1993) ④ Should be regarded as an indication only.

Water use – The total average volume of water used by irrigation each year from alluvial aquifers in the Gwydir catchment is 35,747 ML with a maximum of around 50,000 ML used during dry times.

In the past, fluctuations in usage would have reflected the activation of the groundwater component of conjunctive use licences during times of scarce surface water [21].

There are no data showing the volume of water used from groundwater systems on crops in the Gwydir catchment.

8.6 Irrigation methods (groundwater)

Data on methods used to irrigate crops from groundwater supplies in the region were unavailable. However, since cotton accounts for around 97% of groundwater-based irrigation, it can be assumed that cotton grown using groundwater would employ surface methods (see Section 5.5 for details on methods used to irrigate from all sources).

[21] (Kalaitzis 1997) expresses concern that in 1995–96, when an announced allocation of 18% of regulated surface water was in force, groundwater use was similar to the 1994–95 period, when zero allocations were in place. As mentioned earlier, groundwater records before 1993–94 are notoriously unreliable but the records from 1993–94 onwards are much more accurate following the onset of metered use.

8.7 Yields of irrigated crops (groundwater)

Data on yields from irrigated crops dependent on groundwater supplies only were unavailable. However, yields based on groundwater irrigation would be very similar to those for all sources of water (see Section 5.6 for details on yields of irrigated crops from all sources or Table 15).

8.8 Total value of irrigation (groundwater)

Data on the value of irrigation dependent on groundwater supplies in Gwydir region were unavailable.

9. IRRIGATION FROM FARM DAMS

9.1 About farm dam water supplies

Irrigation using water from farm dams is limited in the Gwydir catchment (ABS 1998)② and mostly occurs in the SLA of Guyra.

The definition provided in Section 3.3 separates large on-farm storages (mostly located in the cotton-growing area) from the small dams supplying irrigated agriculture in tablelands region. Information on irrigation from on-farm storages is considered in Section 6.

The definition for this water supply follows:

> **Farm dam water** is water from dams that exists on first, second or third order watercourses as shown on topographic maps or that has been captured from overland run-off [DLWC 1999d].

This definition accords well with ABS question format used to collect information about farm dams.

> The area irrigated from a farm dam with its own catchment and not filled by pumping from a river or stream.

As with on-farm storages, surcharge areas used to collect tailwater from cotton farms are also exempt from farm dams policy. Tailwater, which may be laden with chemicals and nutrients, is required to be stored on-farm under the *Protection of Environment Operations Act 1997*.

There have been considerable recent policy changes regarding licensing farm dams. In the past, a dam of up to 7 ML could be built without the need for licensing, providing the water was used for non-commercial purposes. This limit did not allow for size of a property or for climatic variation. In addition, there were no restrictions on the number of dams that could be built on a property. The Farm Dams policy announced in September 1998 provides a harvestable right for all landholders regardless of the purpose the water is used for. The landholder can take a proportion (no more than 10%) of the average yearly regional run-off figure from the property each year without needing to be licensed.

Table 17 summarises available information about irrigation from farm dams in the Gwydir catchment.

Table 17. Summary of irrigation data – farm dams

Year (Oct – Sept)	No. enterprises irrigating[a]	Total irrigated area (ha) [a]	Area of major crop irrigated (ha)	Total water used by irrigated agriculture (ML)	Water used of 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	12	806	-	-	-	-	-	-
1994–95	-	-	-	-	-	-	-	-
1995–96	-	-	-	-	-	-	-	-
1996–97	-	-	-	-	-	-	-	-
1997–98	-	-	-	-	-	-	-	-
1998–99	-	-	-	-	-	-	-	-
1999–00	-	-	-	-	-	-	-	-
2000–01	-	-	-	-	-	-	-	-
Refer to Section:	9.3	9.4	9.4	9.4	9.4	9.6	9.7	9.7

[a]*(ABS 1998)②*

9.2 Number of irrigation licences (farm dams)

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

9.3 Number of enterprises that irrigate (farm dams)

There were 12 enterprises using water from farm dams to irrigate crops in the Gwydir catchment (ABS 1998)② in 1993-94 and most exist in the Uralla SLA (Appendix 14.4).

9.4 Area irrigated and water used (farm dams)

Area irrigated – Water from farm dams was used to irrigate 806 ha in 1993–94 (ABS 1998) ② and most of this land is in the Guyra SLA.

Water use – The water used in total and by crop type is unknown.

9.5 Irrigation methods (farm dams)

No data were available. See Section 5.5 for details on methods used to irrigate crops from all sources of water.

9.6 Irrigated yields (farm dams)

No data were available. See Section 5.6 for details on yields obtained from crops irrigated using all sources of water.

9.7 Value of irrigated production (farm dams)

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

10. IRRIGATION FROM RETICULATED WATER SUPPLIES

10.1 About reticulated water supplies

Irrigation of crops from reticulated water supplies does not occur in the Gwydir catchment.

11. OPPORTUNITIES AND ISSUES

11.1 Opportunities for improving irrigation data

Changes to water legislation in NSW have created an opportunity to better resource the collection of reliable and accurate irrigation data. Accurate and reliable irrigation data are urgently needed to inform the water sharing debate, to help strategically direct resources to improving WUE and to measure change as a result of water reform.

- **Volumetric conversion of area-based licences will lead to better information about use of water from unregulated streams.** As a result of licences being converted from area-based to volume-based, users will no longer be billed on authorised area but on the entitled volume. Water use will eventually be metered and recorded by the DLWC. This will improve knowledge of crop water use and patterns of extraction.

- **Collection of data at scales that are more useful to resource managers.** The opportunity exists to provide agencies and communities with data that can be aggregated to useful scales through use of Geographic Information System (GIS) applications (that is, river reach or subcatchment). The challenge would be to continue to maintain data confidentiality (for example, licence and enterprises information) while maximising data usefulness to resource managers. An example of the development of data collection strategies using GIS methods can be found in the Barwon-Darling region (Brill et al. 2001).

- **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 (in the Gwydir catchment information collection finished in 193–94). 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.

11.2 Other opportunities for irrigated agriculture

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

- **The opportunity exists to expand the high-value olive industry that is already established in the Gwydir catchment.** Olives are suited to the catchment's well-drained soils and the crop can survive without irrigation (although production levels will be affected). There is local infrastructure to support the industry at Inverell. However, access to water may constrain the industry's growth. The olive industry may be able to expand only in subcatchments that are not considered stressed (for example, the upper Gwydir River and Boorolong Creek) and where trading embargoes are more likely to be lifted.

- **Improved irrigation efficiency may liberate water.** As irrigators improve irrigation management, they potentially liberate water that can be either traded or used to develop and expand existing or new industries.

11.3 Issues

11.3.1 Data issues

There are major areas of concern regarding irrigation data, namely scarcity of information, reliability of data and provision of data at useful scales.

- **Information about irrigation is scarce.** Since the implementation of water reforms and the development of water sharing plans, a much greater range of irrigation data are needed than is available (for example, data on crop areas, crop water use, yield, value of production and irrigation methods). The major reason for this paucity is that in the past, agency and community data needs were fewer and therefore fewer data were collected.

- **The ability to calculate crop WUE and IE in the Gwydir catchment is limited.** For example, the last time DLWC collected crop area and water use information for the regulated system was 1993–94. The last time data on crop areas were collected from unregulated rivers was 1994–95 – data on crop volumes have never been collected from this source of water. More recent data are needed to estimate current WUE**.** The demand for data on crop water use and area has increased dramatically across Australia with the implementation of the COAG Water Reforms. In all Australian states, programs have been initiated to improve WUE in irrigated agriculture. These programs need better data to underpin debates regarding industry and catchment levels of WUE.

- **Data collection agencies need to provide data reliability ratings.** The National Land and Water Resources Audit (1999) provides reliability ratings and metadata (data about data). A similar protocol is needed for the provision of data to public by State agencies and private authorities. Without these ratings, users are more likely to manipulate or treat irrigation data inappropriately.

- **Data are scarce at useful scales.** Natural resource managers involved in developing water sharing plans require data at planning scales, that is, 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 are typically collected by, or determined from, either ABARE or the ABS. However, these data-sets have the following shortcomings:

  - ABARE reports data at the Barwon region scale, which is the amalgamation of the Border, Gwydir and Namoi catchments. This presentation is much coarser than that required by, for example, WMC.

  - The ABS has collected data by SLA for a number of years. These data do not align well with catchment and subcatchment boundaries. Consequently, the area irrigated may be underestimated or overestimated depending on each SLA's composition and its relationship with catchment boundaries.

This Profile has attempted to overcome this problem with the use of a licence-based concordance. See Section 3.1 for further details.

- ABS ceased collecting data by SLA in 1996–97 and began collecting information by AER in 1997–98 (Table 2). These AERs often span many catchments and cannot be disaggregated into these smaller units. This reduces the usefulness of data on the number of enterprises irrigating and the value of irrigation. Consequently, there is gap in ABS information between 1997–98 and 1999–2000 in the Gwydir catchment.

- **Collection strategies can limit data usefulness.** The ABS has collected irrigation data at three different EVAOs or survey cut-off points over the past 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. For that reason, this Profile only compares data from 1993–94 to 1996–97.

11.3.2 Other issues for irrigated agriculture

Issues for irrigated agriculture in the Gwydir catchment relate to how on-farm storages affect WUE and the impact of trading embargoes on the ability of new or existing enterprises to expand.

- **On-farm storages may decrease irrigation efficiency.** The Gwydir catchment has a large on-farm storage capacity and off-allocation water is typically stored in these facilities for long periods. Consequently, evaporative losses from these dams may be large and this may decrease overall on-farm irrigation efficiency[22].

- **Expansion of new and existing industries is restricted by an embargo on distributing new irrigation licences.** This may make it more difficult for new industries or developing industries to access water.

[22] On-farm irrigation efficiency is defined as the volume of water supplying the crop's water requirements (that is, crop water requirement less effective rainfall) as a percentage of water delivered to the farm (Alexander and Foley 1998).

12. SUMMARY

This study highlighted difficulties in obtaining information on irrigation in the Gwydir catchment. Data were often scarce, unreliable or provided at inappropriate scales. A more comprehensive and consistent approach to the collection of irrigation statistics is needed. This would help to ensure that data are comparable across different water sources and industries. The following provisions are needed to improve the situation.

- **Better crop data are needed.** In particular, information on crop water use and irrigated area are needed to underpin estimates of WUE. In all Australian states, programs have been initiated to improve WUE in irrigated agriculture. These programs desperately need better irrigation data to inform the debates about WUE.
- **Protocols for provision of data to users are needed.** For example, information providers need to include reliability ratings and metadata to help users make better choices about reliability and usefulness.
- **Two-way flow of information between agencies and irrigators needs to be fostered.** Irrigation data need to flow back to irrigators in forms that might potentially assist them to make better water management decisions. This would in turn, over time, improve the reliability of information.
- **Two-way flow of information between agencies needs to be fostered.** Processes that minimise duplication of effort and maximise efficiency of data collection, storage and efficiency need to be promoted.
- **Irrigation data need to be collected at finer scales.** Data are needed at scales that are coarse enough to ensure confidentiality of individual enterprises but fine enough to allow users to aggregate information to useful scales.

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

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14. APPENDICES

14.1 Definitions of statistical units used by the ABS

Extract from ABS Web Page (ABS 1999).

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

An LGA is an SLA if:

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

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

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

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

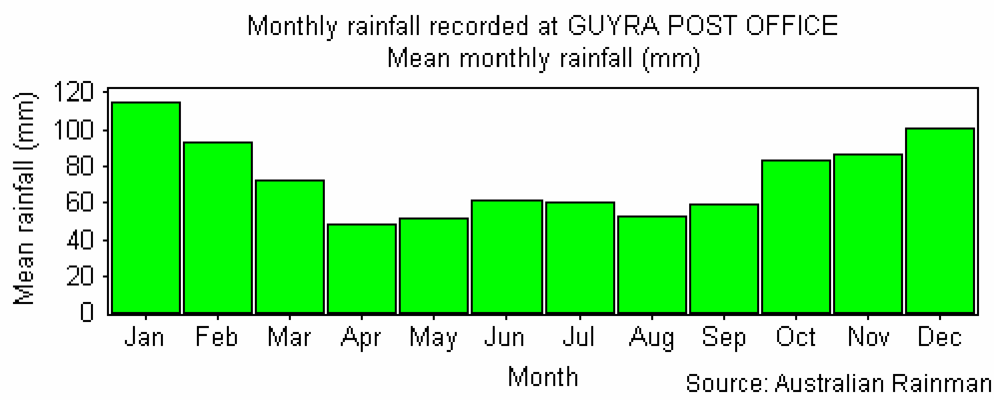
- unincorporated on-shore area(s) and/or off-shore island(s) in an SSD;
- that part of an unincorporated area which is considered of sufficient economic significance as to warrant the formation of a separate SLA;
- Off-Shore Areas & Migratory SLAs, formed for census purposes for all S/Ts [states and territories] except the Australian Capital Territory and Other Territories to encompass off-shore, shipping and migratory CDs (off-shore, shipping and migratory CDs [collection districts] are explained in chapter 2);
- the entire area of the Australian Capital Territory. Each SLA is either a suburb, a locality or the non-urban area of an SSD; and
- the unincorporated part of the Northern Territory. In some SSDs (e.g. Daly, Bathurst-Melville) the entire area is covered by one unincorporated SLA. In other SSDs (e.g.

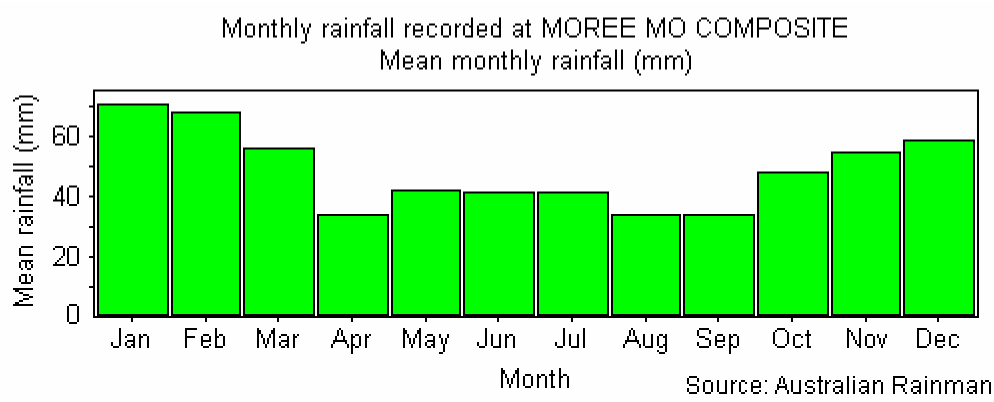
East Arnhem), the unincorporated area is split into several SLAs to distinguish an economically significant town (e.g. Nhulunbuy), island (e.g. Groote Eylandt) or administrative region.

14.2 Summary of ABS data collection

Year	EVAO	Collection Unit	Survey (S) or Census (C)	No. of irrigation enterprises and area irrigated	Crop area by number of enterprises	Source of water by area and by no. of irrigation enterprises	Methods by area by number of enterprises	Adoption of scheduling by area irrigated by no. of enterprises
1986–87	20,000	SLA	C	Yes			Yes	
1987–88								
1988–89								
1989–90	20,000	SLA	C	Yes		Yes	Yes	
1990–91	20,000	SLA	C	Yes	Yes	Yes		
1991–92	22,500	SLA	C	Yes	Yes			
1992–93	22,500	SLA	C	Yes	Yes			
1993–94	5,000	SLA	C	Yes	Yes	Yes		
1994–95	5,000	SLA	C					
1995–96	5,000	SLA	C	Yes				Yes
1996–97	5,000	SLA	C	Yes	Yes			
1997–98	22,500	AER	S	Yes	Yes			
1998–99	22,500	AER	S	Yes	Yes			
1999–00	22,500	AER	S	Yes	Yes	Yes	Yes	
2000–01	5,000	SLA	C	Yes	Yes			Yes
2001–02	5,000	SLA	S					

14.3 Monthly rainfall in the Gwydir catchment





Source: (Clewett et al. 1999)

14.4 Area of land irrigated (all sources of water)

Year	Area irrigated from surface water (ha)	Area irrigated from groundwater (ha)	Total area irrigated (ha) ④[23]
1982–83	28,754	2,033	30,787
1983–84	42,229	1,194	43,423
1984–85	56,099	3,681	59,780
1985–86	67,986	2,094	70,080
1986–87	69,577	2,224	71,801
1987–88	51,994	4,048	56,042
1988–89	62,783	7,039	69,822
1989–90	58,056	4,170	62,226
1990–91	79,748[a]	1,157[b]	80,905
1991–92	Nd	Nd	Nd
1992–93	Nd	Nd	Nd
1993–94	26,948 [a]	15,152 [b]	42,100

Source: All figures apart from those that have been specifically referenced are from DWR (1993) and have a reliability rating of ②.

[a] *DLWC (1998b); ABS (1998). The DLWC (1998b) figures include regulated ② and unregulated statistics ④. Estimates of land irrigated from farm dams in 1990–91 and 1993–94 were taken from ABS (1998) ②.*

[b] *ABS (1998). Nd = No data.*

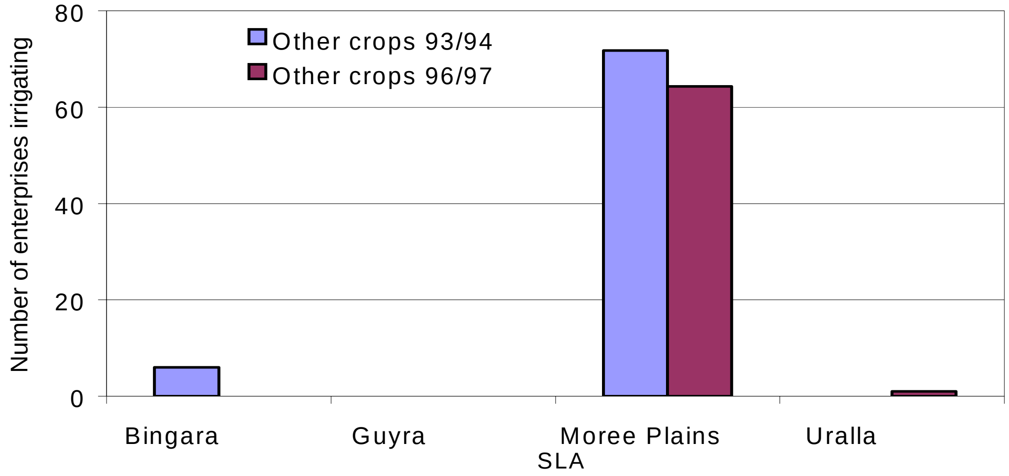
[23] The total figure receives a reliability rating of ④ due to the inclusion of information from unregulated streams.

14.5 Change in the number of enterprises that irrigate and the area irrigated between 1993–94 and 1996–97

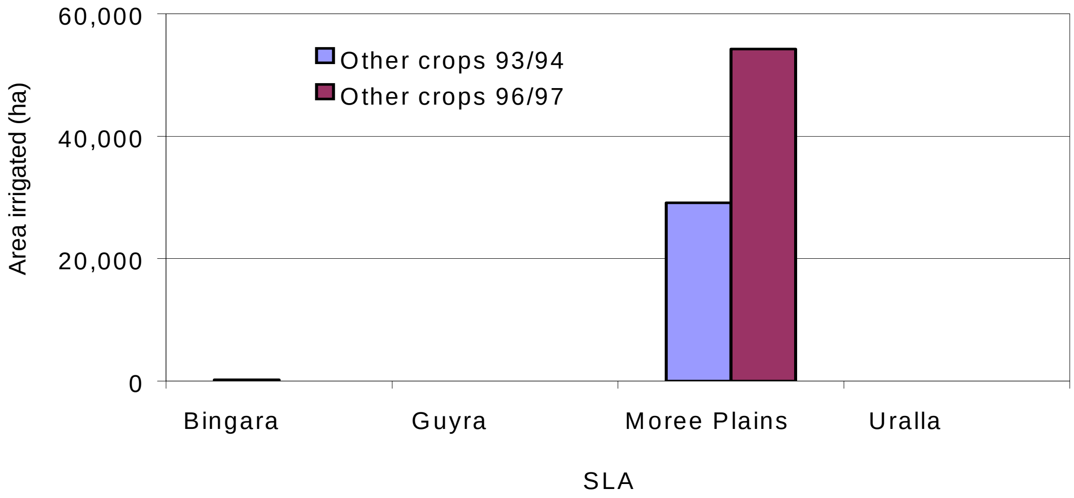
	1993–94		1995–96		1996–97	
SLA	Area irrigated (ha)	Number of enterprises	Area irrigated (ha)	Number of enterprises	Area irrigated (ha)	Number of enterprises
Bingara	536	24	639	8	113	9
Guyra	2,350	15	116	4	282	7
Moree Plains	63,653	130	47602	69	84,205	105
Uralla	1,239	16	125	6	164	5
Total	**67,778**	**185**	**48,482**	**87**	**84,763**	**126**

Source: (ABS 1998) ②

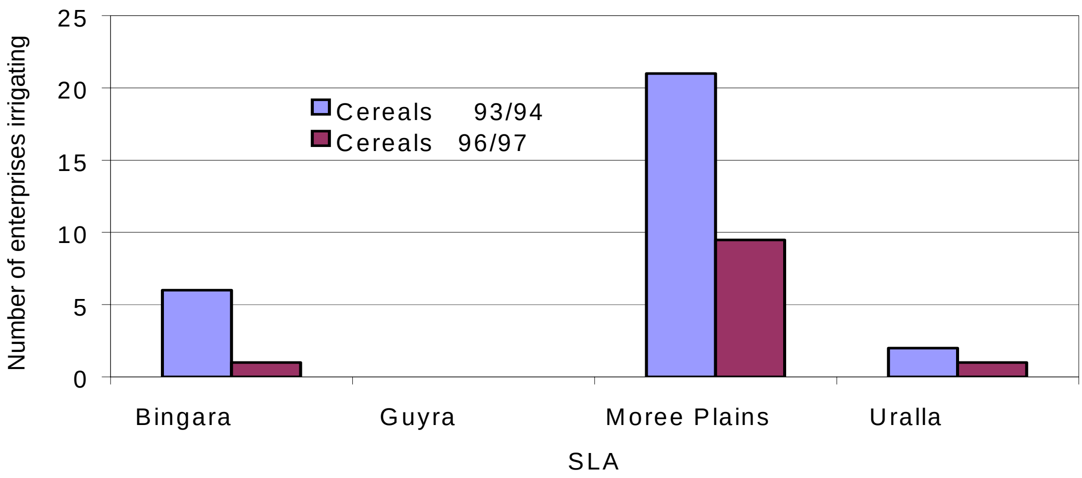
14.6 Crop area irrigated and the number of enterprises



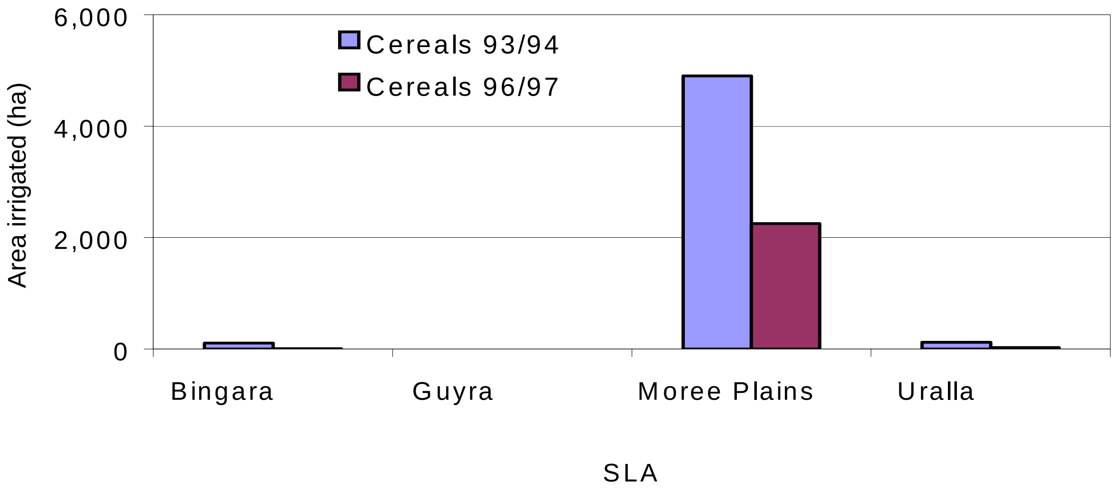
NB: ‘Other crops’ approximates cotton.



NB: ‘Other crops’ approximates cotton.



Source: (ABS 1998) ②



Source: (ABS 1998) ②

14.7 Irrigated crops in the Moree area of the Gwydir catchment

Crop class[a]	**Cereals**	**Cereals**	**Cereals**	**Cereals**	**Cereals**	**Fibres**	**Oilseeds**
Crop	Barley	Grain sorghum	Maize	Oats	Wheat	Cotton	Soybeans
CWR [b] average (ML/ha)						7	
CWR min (ML/ha)						6	
CWR max (ML/ha)						12	
IR [c] average (ML/ha)	1		4	2	1	7	4
IR min (ML/ha)						6	
IR max (ML/ha)						12	
Y [d] avg (t/ha)		5	6	3	5	8	3
Y min (t/ha)						4.5	
Y max (t/ha)						13	
Root depth (m)							0.7
Sowing date [e]		15 Sep	15 Sep	15 Mar	1 Jun	15 Sep	15 Nov
Time of growth total [f]		153	153	214	167	181	120
System [g]						Flood/ furrow	
Efficiency (%)[h]							

Source: pers.comm.J.Spenceley from NSW Agriculture irrigated crop survey (1999) 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. [b]

c Irrigation Requirement - the depth of water required to satisfy crop water requirement, leaching requirement and system inefficiencies (conveyance,

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

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

e Date on which annual crops are typically sown.

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

g System refers to irrigation system used.

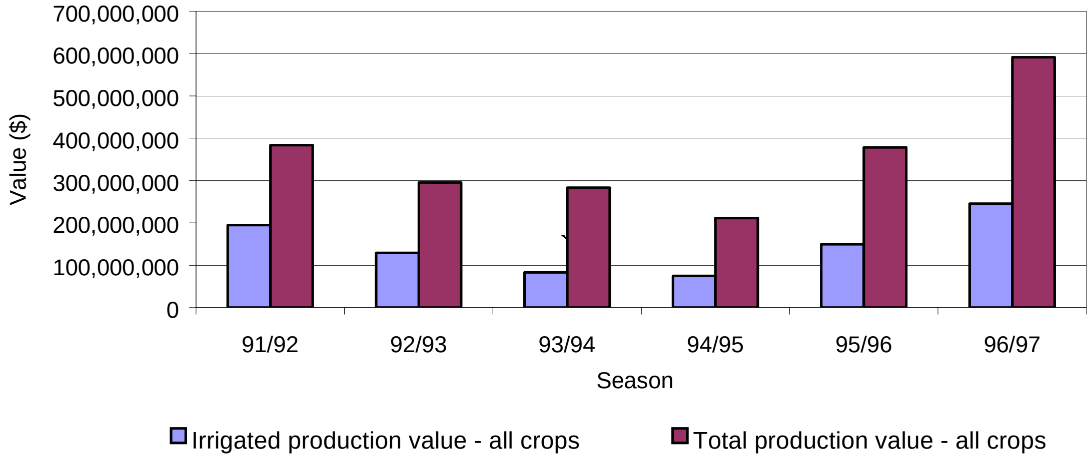
h Effic – Irrigation Efficiency, meaning the ratio between crop water requirement and the irrigation water delivered to the farm. It therefore describes losses due to leaching requirement and conveyance (deep percolation and evaporation), distribution, and application inefficiencies.

14.8 Irrigation methods in the Barwon region – broadarea and dairy enterprises only

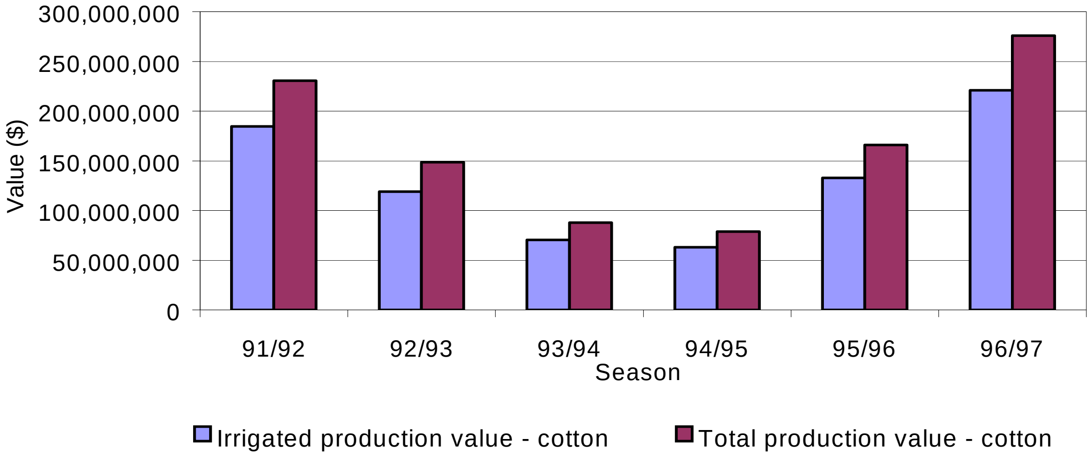
Method	NSW total (% of total area)	Barwon region (% of total area)
Surface	91.3	92.1
Moveable spray	3.5	3.9
Travelling irrigator	4.4	1.9
Trickle/drip/sub-surface	0.2	0.0
Fixed low throw sprinkler	0.02	0.0
Fixed micro sprays	0.3	1.9
Fixed overhead sprinkler	0.2	0.2
Other	0.1	0.0

Source: (ABARE 2000) ③. The Barwon region refers to the aggregation of the Border (NSW portion), Gwydir and Namoi catchments.

14.9 Value of irrigated production for major crops in the Gwydir catchment



Source: (Donovan 2000) ③



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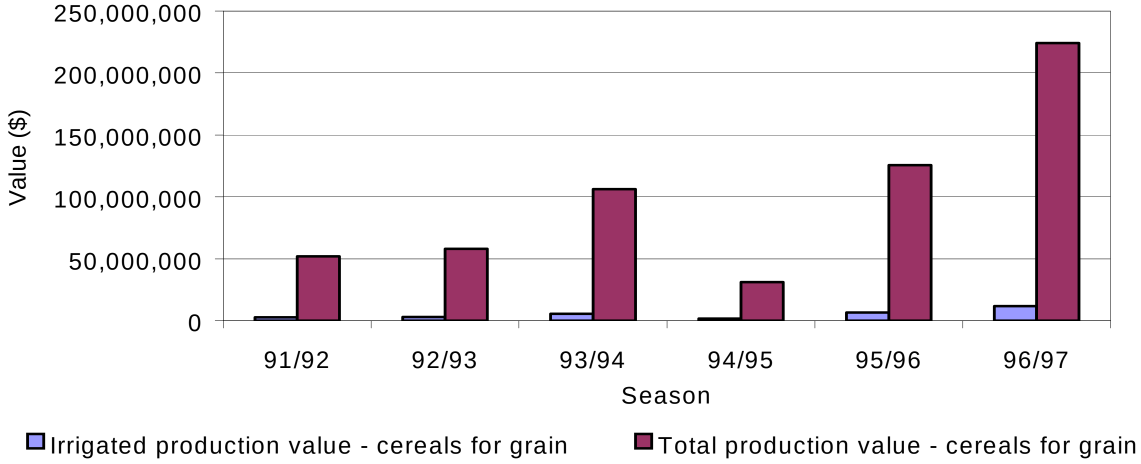
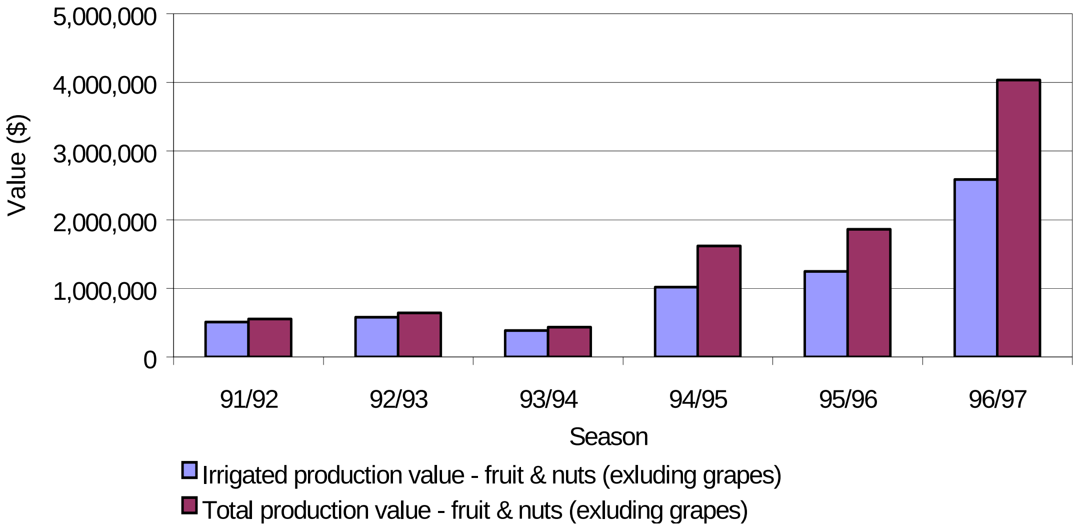


Source: (Donovan 2000) ③



Source: (Donovan 2000) ③

14.10 Area irrigated and water used in the Gwydir catchment (regulated supplies)

Area irrigated (ha)

Crops	**1989–90**	**1990–91**	**1991–92**	**1992–93**	**1993–94**
Cotton	32,762	71,622	51,460	30,716	19,514
Storage		932			
Pecan nuts	700	700	700	715	700
Soybeans	289	1,191	653	90	73
Wheat	536	315	100	140	674
Sorghum	97	317	300	240	58
Summer pasture	212	210	26	84	
Oats	120	160	107	90	170
Mung beans		100			
Lucerne	130	108	93	12	10
Barley			96	35	
Summer cereal	26	100	35		
Sunflower		25	2		
Winter pasture		2		15	
Pre irrigation		10		5	
Citrus	7	7	7		7
Vegetables	12	2		2	2
Total	**34,891**	**75,801**	**53,578**	**32,148**	**21,208**

Source: (DLWC 1998b) ②

Water use by irrigated agriculture (ML)

Crops	1989–90	1990–91	1991–92	1992–93	1993–94
Cotton	139,444	208,802	167,705	87,358	60,556
Storage	124,018	195,956	129,416	11,695	8,511
Pecan nuts	10,105	9,669	9,810	11,492	8,757
Soya beans	966	7,282	2,526	141	80
Sorghum	98	1,348	1,454	1,502	260
Wheat	722	690	267	169	2,420
Oats	143	769	336	380	397
Summer cereal	86	761	236		
Summer pasture	608	101	29	129	1
Lucerne	347	203	151	19	26
Pre irrigation	400	17		1	
Barley			133	40	
Winter pasture		4		130	
Citrus	36	50	49		41
Sunflower		48	5		
Vegetables	24	8		7	2
Sudax				6	
Total[a]	**276,997**	**425,708**	**312,117**	**113,069**	**81,051**

Source: (DLWC 1998b) ②. [a] Total water use receives a reliability rating of ① as these data were calculated from metered data.

14.11 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)

14.12 Gwydir allocation announcement history

Year	Date Announced	Allocation Announced	Overdraw Next Season	Comments
1980–81 [a]	18/03/1981	33%	0%	No restriction prior to this date (temp).
1981–82 [a]	1/07/1981	33%	0%	Carrying 33% over from previous year.
	21/08/1981	55%	0%	Volumetric Scheme started this season.
	7/11/1981	80%	0%	
	8/11/1981	65%	0%	
1982–83 [a]	16/07/1982	15%	0%	
1983–84 [a]	5/07/1983	35%	0%	
	10/08/1983	50%	0%	
	14/09/1983	85%	0%	
	11/10/1983	100%	0%	
1984–85 [a]	9/07/1984	100%	0%	
1985–86 [a]	22/07/1985	100%	0%	
1986–87 [a]	12/08/1986	85%	0%	
1987–88 [a]	11/09/1987	12%	0%	Water year now October - September.
	11/12/1987	17%	0%	
	5/01/1988	20%	0%	
	1/02/1988	23%	0%	
1988–89 [a]	23/09/1988	33%	0%	
	13/10/1988	35%	0%	Carry over permitted.
1989–90 [a]	16/08/1989	20%	0%	
	12/01/1990	22%	0%	Carry over permitted.
1990–91 [a]	20/08/1990	60%	0%	
	29/11/1990	80%	0%	Carry over permitted.
1991–92 [a]	18/09/1991	35%	0%	Max alloc., min. reserve, 25% C-Over.
1992–93 [b]	14/10/1992	0%	0%	
	23/12/1992	5%	0%	Pumped over a 2-week period early Jan.

Year	Date Announced	Allocation Announced	Overdraw Next Season	Comments
1993–94 [b]	1/10/1993	0%	0%	
1994–95 [b]	30/09/1994	0%	0%	
1995–96 [b]	1/10/1995	0%	0%	
	1/12/1995	10%	0%	
	22/12/1995	18%	0%	
1996–97 [b]	11/12/1996	75%	0%	
1997–98 [c]	24/10/1997	82%		Unused water can be carried over into next season. Shared
				Access will be available from any unregulated flow events.
1998–99 [c]	11/11/1998	150%	0%	All irrigators were credited with 150% allocation for 98–99 season, under a new allocation management system called Continuous Accounting (CA). CA will allow to carryover unused allocation and then receive new allocation up to a combined limit of 150%, but will be limited to a max individual on-allocation usage of 100% during a season.

Source: (DLWC 2000a)① Announced by [a]Minister [b] Manager [c] Director

14.13 Stressed stream classification in the Gwydir catchment

An environmental stress rating or each of the freshwater subcatchments within the Gwydir 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 sulfate soils
- water quality (indicative purposes only – not used in decision tree)

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

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

Streamflow estimation was made using information available through DLWC's flow gauging network and a range of hydrologic predictive techniques to extend estimates into rivers without local gauging sites. Estimates of the peak monthly water extractions have been made using the surface water returns lodged by licence holders. However, not all survey cards are returned to DLWC and the volumes were adjusted for the proportion of licence holders who have chosen not to lodge a return. A hydrologic index (indicating hydrologic stress) was derived for each subcatchment for current use and full water use development by proportioning estimated water extraction to the estimated streamflow. Each subcatchment was then classified as being of low (0 to 30% extraction of flow), medium (40 to 60% extraction) or high (70 to 100% extraction) hydrologic stress.

The data that were used to generate hydrological and environment stress ratings and therefore management options were not always reliable. For example, the hydrological stress rating was determined using crop return card information and is a source that is known to be unreliable. Despite underlying difficulties and concerns with the data, the assessment provides the most comprehensive overview of the land and water resources of subcatchments in the Gwydir catchment.

The matrix showing stress categories and the ratings given to individual subcatchments in the Gwydir catchment are provided in Table 18 and Table 19 respectively.

Table 18. Stress matrix

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

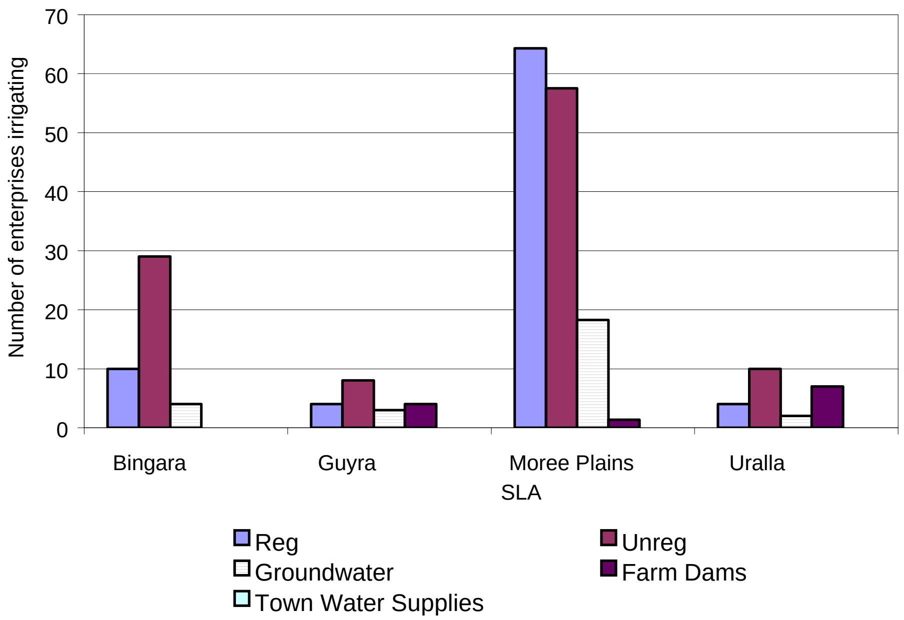
Source: (DLWC 1999c)

Table 19. Stress ratings for subcatchments in the Gwydir catchment

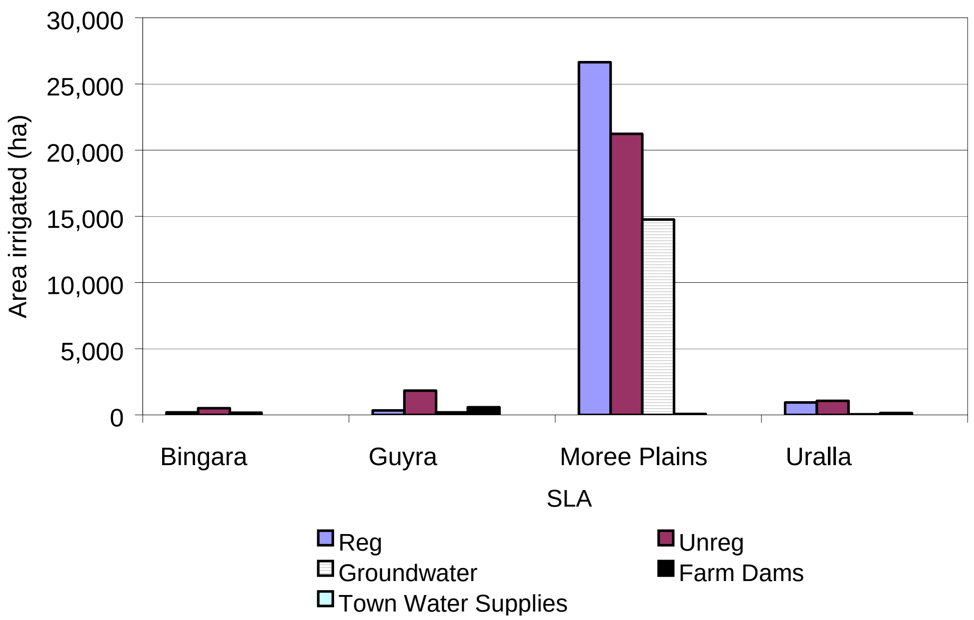
Subcatchment name	Environmental stress	Hydrologic stress	Management class	Future risk
Roumalla Creek	medium	high	S3	S3
Bakers Creek	medium	low	U3	U3
Laura	medium	high	S3	S3
Upper Horton	high	high	S1	S1
Cobbodah Creek	medium	medium	S4	S3
Keera	medium	low	U3	S4
Rocky Creek	high	low	S5	S1
Moredun Creek	medium	high	S3	S3
Copeton Dam	medium	low	U3	U3
Boggy Creek	high	unres	unres	unres
Halls Creek	medium	low	U3	S4
Thalabah Creek	high	unres	unres	unres
Mackenzies Flat	medium	low	U3	S4
Upper Tycannah	medium	low	U3	U3
Lower Horton	high	low	S5	S1
Gurley Creek	high	low	S5	S5
Milli Creek	medium	unres	unres	unres
Myall Creek	high	high	S1	S1
Slaughterhouse	medium	low	U3	S4
Warialda Creek	high	high	S1	S1
Lower Tycannah	medium	unres	unres	unres
Mehi River	high	unres	unres	unres
Moree	medium	unres	unres	unres
Mosquito	high	low	S5	S5
Gwydir	high	unres	unres	unres
Gingham W'course	low	unres	unres	unres
Carole Creek	high	unres	unres	unres
Rocky River	medium	high	S3	S3
Upper Gwydir River	low	low	U4	U1
Boorolong Creek	low	low	U4	U2
Georges Creek	medium	low	U3	S4
Barwon River	low	unres	unres	unres

Source: (DLWC 2000b) ②. Unres = unresolved

14.14 The number of enterprises irrigating and area irrigated from different sources



Source: (ABS 1998) ②



Source: (ABS 1998) ②

14.15 Area irrigated and water used in the Gwydir catchment (unregulated)

	Crops	1989–90	1990–91	1991–92	1992–93
Area irrigated (ha)	Cotton	778	1,250	1,250	259
	Lucerne	192	181	207	173
	Summer pasture	128	103	420	55
	Other	8		12	22
	Summer cereal		45		16
	Winter cereal	243	80	178	12
	Winter pasture	20	35	110	3
	Citrus		40		
	Vegetables			2	
Total area irrigated (ha)		1,369	1,733	2,178	540
Total water used (ML)		3,537	8,968	8,420	3,368

Source: (DLWC 1998b). NOTE: This information is based on raw and incomplete data (July to June water year).

	Crops	1993-94	1994-95
Area irrigated	Cotton	4,651	1,493
	Winter pasture	342	496
	Sunflower		401
	Winter cereal		300
	Lucerne	293	199
	Maize		68
	Soybeans		47
	Winter grains		16
	Other crops		1
	Other vegetables		1
	Vines		1
	Adzuki beans	3	
	Oats	8	
	Orchard	4	
	Sorghum	40	
	Summer grains	10	
	Summer pasture	388	
Total area irrigated (ha)		5,740	3,023
Total water usage (ML)		2,127	1,466

Source: (DLWC 1998b). NOTE: This information is based on raw and incomplete data (July to June water year).