REGIONAL IRRIGATED LAND AND WATER USE MAPPING IN THE GOULBURN MURRAY IRRIGATION DISTRICT

2019/20

FARM IRRIGATION SURVEY TECHNICAL REPORT - SEPTEMBER 2021

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY
Goulburn-Murray WATER
North Central CMA
Murray DAIRY
Dairy Australia Your Levy at Work
HMC PropertyGroup
VICTORIA State Government

This Technical Report can be found at www.gbcma.vic.gov.au

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- Department of Environment, Land, Water and Planning (DELWP)
- Agriculture Victoria
- Goulburn-Murray Water (GMW)
- North Central Catchment Management Authority (NCCMA)
- Murray Dairy
- HMC Property Group

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1. Introduction

The GMID is a major irrigation district comprising 15,000 properties over 9,950 square kilometres (Figure 1). The main enterprises are cropping, dairy, mixed grazing and horticulture. There are major food processors with the region supporting a population of 170,000 people and the gross value of agricultural production around $2.1 billion per year (ABS, 2019).

The Regional Irrigated Land and Water Use Mapping (RILWUM) in the Goulburn Murray Irrigation District (GMID) project collects information on irrigated land and water use, as a tool to support decision makers. This project builds on the work undertaken in the Shepparton Irrigation Region and more recently the GMID, for over two decades e.g. 2018/19 (GB CMA, 2020 *unpub*), 2015/16 (GB CMA, 2017), 2009/10 (HMC, 2010), 2004/05 (GMW, 2006) and pre-2000. The 2019/20 project is being undertaken through existing partnerships between the Goulburn Broken Catchment Management Authority (GB CMA), Goulburn-Murray Water (GMW), Agriculture Victoria (AgVic), Department of Environment, Land, Water and Planning (DELWP), HMC Valuations, Murray Dairy, and the North Central CMA (NCCMA), in collaboration with the Irrigated Cropping Council, and Fruit Growers Victoria.

There are two key parts to the RILWUM project, including spatial mapping which is undertaken to determine seasonal water use by Water Use Licences and industry. This mapping is undertaken by GMW Customer Service Officers in each irrigation district. The data from this spatial assessment is provided in an accompanying report (GB CMA, 2021a).

Farm Irrigation Survey (FIS) data is the other key part to the RILWUM project and complements the spatial mapping process, by surveying a random selection of irrigators, to understand property level irrigator decision making and the cumulative impact of this at a regional level. The approximate location of the surveys within the project area is shown in Figure 1.

Land and water use spatial mapping and FIS data, will enable continued assessment of shifting water demands and land use change and help to:

- Build understanding of how the GMID is changing and adapting to reduced water availability;
- Inform water, agriculture and planning policy at the local, regional, state and national level;
- Provide essential input for economic modelling and analysis;
- Guide regional economic development investment;
- Inform the broader community and help landowners looking to expand, redevelop or contemplating exit options, make informed decisions;
- Support GMW's strategic planning for infrastructure rationalisation and renewal and efforts to reduce operating and capital costs for long-term viability; and
- Contribute to Water for Victoria Actions 4.1 (Support regional development and change), 4.3 (Help irrigation districts adapt), 4.4 (Reduce barriers to change and support communities in irrigation districts) and 4.7 (Manage irrigation development) (DELWP, 2016).

For the purposes of this report, the project area is referred to collectively as the GMID, which includes the Goulburn Murray Irrigation District (including Woorinen Irrigation District), Nyah Irrigation District and Tresco Irrigation District.

1.1. Farm Irrigation Survey Outcomes

The purpose of the Farm Irrigation Surveys as part of the Regional Irrigated Land and Water Use Mapping project was to:

- Obtain a representative sample of irrigators in the GMID, stratified from each of the key land use activities in the region against Water Use Licence number, to complement the spatial mapping;

- Draw comparisons between the 2019/20 survey and previous survey datasets e.g. 2015/16 and 2004/5; and,
- Communicate key messages to inform national, regional and state water, planning and agriculture policy and programs.

Outcomes were achieved by capturing the following data:

- Land use;
- Farm context;
- Irrigation infrastructure and water use;
- On-farm irrigation practices and barriers;
- Allocation trade and water management;
- Land use change and transition behaviours; and
- Farm management practices (e.g. natural resource management).

2. Methodology

The method of data collection in 2019/20 for the Farm Irrigation Surveys consisted of the following:

2.1. Population and Sampling Frame

The interviews were based on the 2019/20 irrigation season (period of 15 August 2019 to May 2020).

There were two sub-sets of population for this project:

- Target population - the target population for this project is GMID irrigators (identified by Water Use Licence) across the range of land uses (defined by industry); and,
- Survey population - the survey population for this project will be randomly selected irrigators in the GMID involved in the mailed-out questionnaire.

A sampling frame (defined by the complete list of non-overlapping sampling units), for this survey was developed from GMW Water Use Licence numbers. This consisted of 14,401 Water Use Licence numbers from within the GMID. For reporting purposes, we refer to Water Use Licences as the collective, which also includes mimimal Water Use Registrations.

Stratified sampling (the process of dividing the population (GMID irrigators) into mutually exclusive sub-populations e.g. Dairy, Cropping, Horticulture (orchard) and Grazing) based on 400 irrigation properties across the GMID were selected from an estimated parent sampling frame of 14,401 Water Use Licences.

The sample selection unit was the irrigated land parcel/s related to the Water Use Licence numbers for the sampling purpose, while the reporting unit was the farmer. For each farm unit selected, the farmer was identified, and the Goulburn-Murray Water client frame was used to identify the ownership of other farm units.

All the farm units belonging to a farm enterprise were used as a reporting unit and questions were asked at the enterprise level. For example, if a landholder owned more than one Water Use Licence, then the survey questions related to all of the area (farm) covered by the multiple WULs.

The approximate location of the 134 irrigators who responded to the survey is shown in Figure 1.

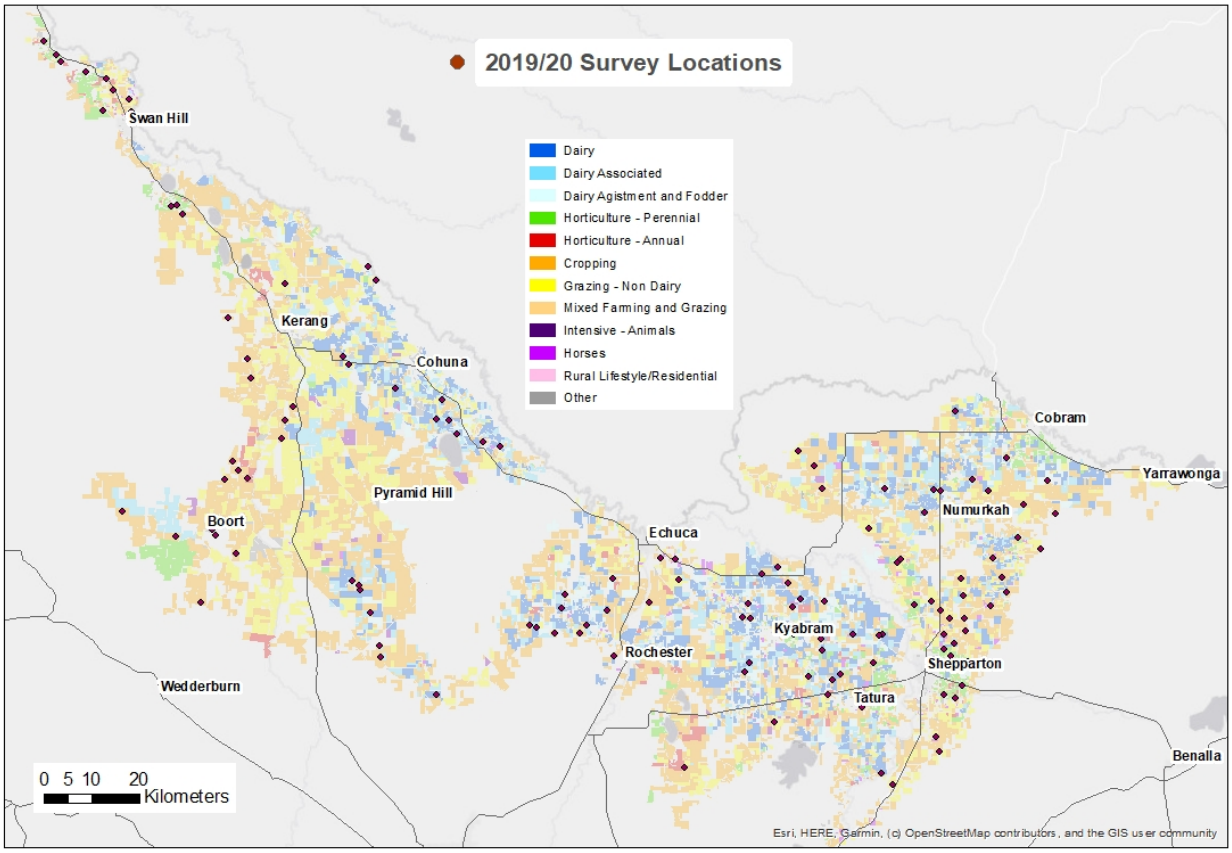

Figure 1: Approximate location of the 134 irrigators (respondents) (as per applicable Water Use Licence)

2.2. Sample Size

Sample size is affected by level of variation in the population; desired precision of the results; confidence level at which that precision is calculated; population size; sampling methods used; and, the resources available.

The sample size of 400 was desired. Of the 400 surveys distributed, 134 (Table 1) responded, which is a response rate of 31.5%. A key determinant of sample size is the need to look separately at different sub-groups and make sure that there are sufficient numbers in each (de Vaus, 2002) based on the proportion of Water Use Licences in the GMID by industry type (e.g. dairy 25%, see Table 1). In this survey, four industry sub-groups, namely dairy, cropping, horticulture and livestock production were identified. All the sub-groups have less than 55 cases, thus requiring care when inferring to their population.

Table 1: Sample size with land use stratification

Industry	Sample size based on Water Use Licence No.	Response No.
Dairy	100 (25.0)	29 (21.6)
Cropping	100 (25.0)	54 (40.3)
Horticulture	52 (13.0)	12 (9.0)
Grazing	148 (37.0)	39 (29.1)
Total	400 (100)	134(100)

Figures in parenthesis () indicate percentages

2.3. Errors in Statistical Data

There are two main types of error: sampling error and non-sampling error. Sampling errors relate to the manner of obtaining the sample. It is mostly quantifiable. Factors that affect it include sample size, sampling design and population variability. Non-sampling errors are other errors in the estimate which can occur at any stage. These include processing errors, response errors, non-response errors and incorrect response. However, error is difficult to quantify. It is important that all types of errors should be minimised so that the results are realistic, and the survey is successful.

2.4. Period of Study

This study focused on responses from irrigators for the irrigation season of August 2019 to May 2020, with the questionnaire mailed out and collected during November 2020 to January 2021. Phone calls were made by Agriculture Victoria (Biosecurity and Agriculture Branch) in Echuca, Tatura and Kerang, Murray Dairy (Tatura) and Goulburn Broken CMA staff, during January 2021 to follow up on non-response.

2.5. Questionnaire Design

The standardised questionnaire (Appendix 2) was prepared based on questions asked during the 2015/16 Irrigation Farm Survey to enable comparisons. In the 2019/20 study additional questions were added, and others asked in different ways based on feedback from the previous surveys. This attempt to standardise the questionnaire will enable comparisons between results, with acknowledgement of different contexts (e.g. seasonal conditions) in which the surveys were undertaken.

The 2019/20 questionnaire was divided into the following sections, including:

- Land use;
- Farm context;
- Irrigation infrastructure and water use;
- On-farm irrigation practices and barriers;
- Allocation trade and water management;
- Land use change and transition behaviours; and
- Farm management practices (e.g. natural resource management).

2.6. Data Collection and Analysis

Data was collected through mail-out questionnaires sent by the Goulburn Broken Catchment Management Authority on behalf of the Technical Working Group (Appendix 1). It was highlighted in the cover page of the questionnaire that the information collected would remain confidential with no identifying information provided external to the collecting authorities and that details obtained from the survey would be made available as aggregated information.

Prior to data analysis the data was processed and cleaned by an evaluation specialist. This involved:

- Entering data from the interview sheets (paper form) into an Excel spreadsheet and checking data for errors; and,
- Data was coded numerically where appropriate and any missing data identified.

The cleaned data set was then analysed. Analysis of data for this report was undertaken using Microsoft Excel and IBM SPSS Package.

The statistical analysis applied in the report included frequency, mean and median. Analysis of Variance (ANOVA), T-test and Scheffe test were used to compare mean differences between variables. Chi-square test and co-relation analysis were also used to examine associations and relationships between

variables. The investigation of relationships is an important step in the explanation of how two variables relate to each other, which contributes to the building of theories about the nature of their interaction. It does not tell the cause and effect of a relationship (e.g. variable A causes variable B) but it can show whether variable A and variable B are related.

This survey was planned, conducted, and analysed in a manner that provided a reliable estimate of the population parameter. 'Standard error' was used to define sampling error which provided the difference between the estimate obtained from a sample and the value that would be obtained if the whole survey population were enumerated. Australian Bureau of Statistics (2013) emphasise the importance of considering sampling error when publishing survey results, as it gives an indication of the accuracy of the estimate and therefore reflects the importance that can be placed on interpretations.

2.6.1. Standard error of mean

For the mean value, 95% confidence intervals were calculated using Standard Error formula. Using the formula there is 95% confidence that, if multiple similar samples were taken, the true value of the mean would fall between$\pm\ 1.96\ \times \sigma/\sqrt{n}$, where σ is the standard deviation and n being sample size and $\sigma/\sqrt{n}$ is the standard error of the mean.

2.6.2. Standard error of proportion

The standard error of the proportion or percentage can make a close estimate using the formula:

$$= 1.96\ \times \sqrt{p(100-p)}/\sqrt{n}$$

Where, 'p' is the observed percentage and 'n' is the sample size.

A 95% confidence interval for a percentage is defined by a range of about two standard deviations either side of the observed percentage. This interval estimate will be a little larger than a more sophisticated estimate that takes account of the stratified sample structure.

Throughout this report, confidence intervals are shown as part of the results. A confidence interval is a measure of how confident we can be in the results. More accurately it tells us about the boundaries between which the value of a given variable would be 95% likely to fall if we repeated the survey multiple times with a similar sample. In general, confidence is higher if there is a large sample size and little deviation in scores. Confidence is lower if there is a small sample size and high deviation.

In this report, figures with bars indicate the percentage or mean value. The black line indicates error bar with upper and lower bounds of 95% confidence interval. Confidence intervals can be used to help identify if a difference is likely to be significant or not. If the confidence intervals of two values don't overlap, it is highly likely that there is a statistically significant difference between them.

2.6.3. Comparisons with prior data

Prior to 1993, irrigator interviews were conducted annually. Since 1993, the interviews were undertaken approximately four-yearly by GMW in partnership with Catchment Management Authorities to gain an understanding of its customer base. The last interviews conducted by GMW were in 2004/05 (GMW, 2006). Following this, a survey was conducted in 2015/16 and 2019/20. Where possible, a comparative analysis between the 2004/05, 2015/16 and 2019/20 irrigation season was undertaken as part of this report.

2.7. Limitations

All surveys have limitations. The following important limitations should be noted when reading this report and drawing conclusions from it.

Missing data: Not all irrigators (respondents) answered every question they were asked in the survey(s). The number of irrigators to questions (n) is noted where this is less than the total number of irrigators (i.e. n=134).

Results are a snapshot in time: The results are influenced by the issues of the day. The data was collected from November 2020 to January 2021, based on the 2019/20 irrigation season.

Non-sampling errors: Non-sampling errors occur in any data collection. Sources of non-sampling error include non-response, errors in reporting by irrigators or recording of answers by interviewers and errors in coding and processing the data.

Non-sampling errors are difficult to quantify in any data collection. However, every effort has been made to reduce non-sampling error by careful design of questionnaires, proper data collection, data entry and extensive editing and quality control procedures at all stages of data processing.

Non-response error: Non-response is an issue in this survey because of the use of mailed-out questionnaire for collecting data. The response rate for this survey was 31.5%. Non-response may cause bias in the results as non-respondents (irrigators) may have different characteristics to respondents (irrigators).

In this survey, efforts were made to minimise non-responses. Both prior and post survey strategies were undertaken to reduce non-response rates (Sivo *et al.,* 2006). Effort was made in survey design (e.g. limit the number of questions) to increase attractiveness and response rate. All irrigators were sent a cover letter explaining the survey purposes and use, and assurance of confidentiality. A postage paid envelope was attached with the questionnaire to make it easy for the irrigators complete and return it. Public awareness activities including discussions with key organisations and interest groups, media releases and social media articles, were undertaken to engage the community. In addition, those irrigators who had not returned the questionnaires were contacted by telephone by local contacts (Agriculture Victoria, Murray Dairy and the Goulburn Broken CMA) and helped.

Several ad hoc post-survey strategies were used to examine non-response error. Analysis of key variables like 'years of farming' and 'preparation of professionally prepared Whole Farm Plans' was compared between this study and a similar study conducted in 2015/16. The underlying assumption being that these variables will have the same or a similar distribution between these studies. Comparisons of results between early and late returned responses was also examined. The underlying assumption being that late responses are similar to non-responses (Sivo *et al.,* 2006). Comparing the variances between early and late responses results for key variables like 'use of carryover water' and 'the use of allocation trade' found the results were similar in both cases. Nevertheless, care must be exercised in drawing conclusions about sub-groups of a population when the number of units captured by the sample in the sub-groups is very small.

Conclusions drawn from larger sample sizes are more accurate than conclusions drawn from smaller samples. The accuracy of data in this report is shown by examining the standard error and/or the confidence intervals for the estimates.

3. Farm Irrigation Survey Results

3.1. Overview

The following section presents the findings of the farm irrigation survey with a representative sample of irrigators (134 responses), stratified from each of the key land use activities in the GMID.

Self-completion mail-out questionnaires were designed to collect information about farm irrigation enterprises within the GMID and improve understanding of irrigators views of land and water issues. Where possible, the results of the 2019/20 irrigator responses is compared with 2015/16, 2009/10 and 2004/05 results.

The spread of respondents (referred to as irrigators) by Irrigation Area is shown in Table 2. The Irrigation Area is associated with the Water Use Licence number selected and is not representative of associated enterprises (e.g. where multiple WULs). The spread of irrigators by land use (e.g. dairy, cropping and horticulture) were provided previously (Table 1) as it is the basis for stratification of the population to determine our sample.

Table 2: Spread of respondents (irrigators) by Irrigation Area

Irrigation Area	No. Irrigators	%
Murray Valley	17	12.7
Shepparton	30	22.4
Central Goulburn	26	19.4
Rochester	19	14.2
Loddon Valley	18	13.4
Torrumbarry	24	17.9
Total	**134**	**100.0**

3.2. Farm size, land cover and irrigation systems

3.2.1. Farm size

The median size of the properties for different industry groups were shown below in Table 3. Since there were large variations in the mean area of the properties reported by the irrigators, the median was considered to represent average land size more accurately. The median operational size of Dairy (210ha) and Cropping (188ha) properties were bigger than that of Horticulture (orchard) (44ha) and Grazing (60ha), however a larger percentage of the median total area of Horticulture (orchard) (84%) was used for irrigation compared to approximately 66% for Dairy, Cropping and Grazing.

Table 3: Median irrigated and total areas (ha)

Industry[1]	No. Irrigators	Median irrigated area ha	Median total area ha
Dairy	n=27	140	210
Cropping	n=50	125	188
Horticulture (orchard)	n=10	37	44
Grazing	n= 34	40	60
All irrigators	**n=121**	**87**	**119**

1. *Respondents (irrigators) provided multiple responses (and some did not respond)*

3.2.2. Land cover

For the 2019/20 irrigation season, nearly two-thirds of irrigators (59%) reported growing annual pasture, followed by winter grain/fodder (48%) and perennial pasture (32%). Table 4 provides the tabulated data on land use. It should be noted that irrigators from each sub-group provided multiple responses for land cover. The figures are comparable to the 2015/16 irrigation season except for winter grain/fodder and annual pasture which were both substantially higher in the 2019/20 season.

Dairy reported growing annual pasture (93%), followed by perennial pasture (52%), winter grain/fodder (48%) and Lucerne (30%). Growing annual pasture was also high for Grazing (66%) and Cropping (46%). Winter grain/fodder crops were popular for Cropping (78%).

Table 4: Proportion of irrigators growing major crops/pasture on their property (%)

Industry[1]	Perennial pasture	Annual pasture	Lucerne	Winter grain/fodder	Summer grain/fodder
Dairy	51.7	93.1	31.0	48.3	13.8
Cropping	20.4*	46.3	40.7	77.8	9.4
Horticulture	-	-	-	-	-
Grazing	45.7	65.7	20.0	14.3	0.0
All irrigators (2019/20) (n=134)	**32.8**	**58.6**	**29.7**	**48.1**	**7.1**
All irrigators (2015/16)	**34.4**	**53.9**	**27.9**	**32.0**	**9.6**

1. Respondents (irrigators) provided multiple responses

** A percentage of Cropping irrigators reported growing some perennial pasture such as Ryegrass from secondary land use of Grazing.*

3.2.3. Irrigation systems

This section provides information on the types of irrigation systems operated by irrigators (Table 5). More than one irrigation system can be used on properties. Gravity irrigation channel remains a popular irrigation method with 86% of irrigators operating this system, compared to 77% in 2015/16. Twenty-eight percent of irrigators use pipe and riser systems, which more than doubled (from 12% to 28%) since 2015/16. Seven percent of irrigators have pressurised systems, mainly centre pivots, and linear move sprinkler systems, which increased since 2015/16 (from 3% to 7%). Micro-drips and sub-surface irrigation systems were highest for Horticulture (orchard) (91%), followed by pipe and riser (27%) and fixed sprinkler systems (10%).

Table 5: Proportion of irrigators using different irrigation methods on their properties (%)

Industry[1]	Gravity channel irrigation	Pipe and riser	Centre pivot and linear move	Fixed sprinkler systems	Micro drip and sub- surface irrigation
Dairy	96.4	42.9	7.1	3.6	0.0
Cropping	94.3	28.3	11.3	3.8	3.8
Horticulture (orchard)	0.0	27.3	0.0	10.0	90.9
Grazing	92.3	17.9	2.6	2.6	2.6
All irrigators (2019/20)	**86.3**	**28.5**	**6.9**	**3.8**	**9.9**
All irrigators (2015/16)	**76.8**	**12.0**	**2.9**	**2.3**	**3.9**

1. Respondents (irrigators) provided multiple responses

3.3. Farm context and farm operations

3.3.1. Years of farming

In 2019/20 irrigators had been farming an average of 35 years, ranging from 31 to 37 years across all industry groups (Figure 2). This was similar to 2015/16 with no statistical difference.

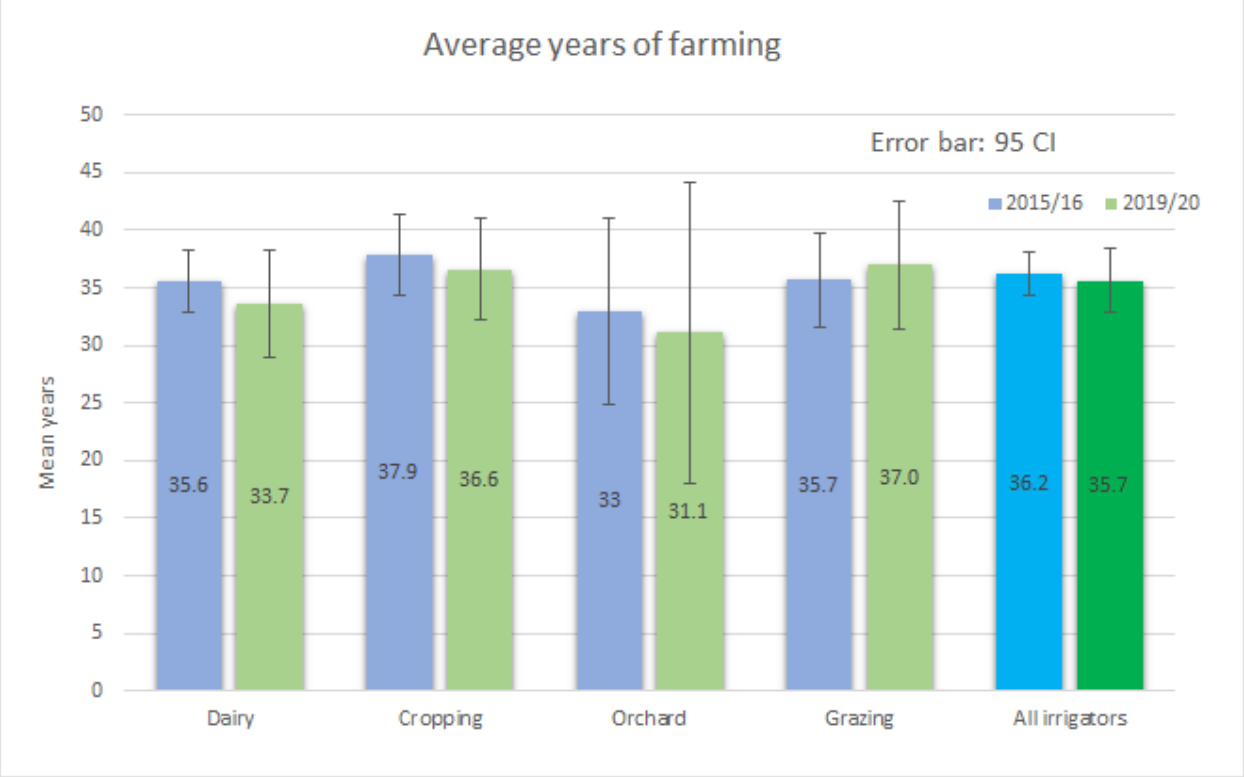

Figure 2: Average years of farming in the GMID

3.3.2. Ownership of properties

Eighty-three percent of irrigators owned their properties, which was a reduction since 2015/16 (96.5%) (Table 6). However, there was an increase in responses for those who own, but also lease, manage, or share farm additional properties, which was an increase across all categories since 2015/16. For example, in 2015/16 1.5% of irrigators reporting owning and leasing land, compared to 5% in 2019/20. This suggests an increase in the diversity of business models of agricultural enterprises.

Table 6: Ownership of properties (%)

Ownership	2019/20 %	2015/16 %
Own (n=111)	83.5	96.5
Own and lease (n=7)	5.3	1.5
Own and managed (n=6)	4.5	1.5
Own and share farmed (n=7)	5.3	0.5
Own, lease and share farmed (n=2)	1.4	-
All irrigators (n=133)	**100**	**100**

3.3.3. Future irrigation intentions

Table 7 shows irrigators responses when asked to respond to the statement – '*I think this property will be irrigated in 5 years' time'*. Three-quarters (75%) of irrigators agreed that their properties would still be irrigated in the next five years and 9% disagreed, with 16% undecided. The results were compared with 2015/16 (GB CMA 2017) and 2004/05 data (GMW 2006) which showed a decrease in irrigators selecting "agree" and an increase in irrigators selecting "disagree" and "undecided", indicating a gradual decline in confidence about the future of agriculture enterprises (Table 7).

Table 7: Response to a statement – 'I think this property will be irrigated in 5 years' time' (%)

Industry	Disagree	Undecided	Agree
Dairy	3.4	13.8	82.8
Cropping	16.0	18.0	66.0
Horticulture (orchard)	0.0	9.1	90.9
Grazing	7.9	15.8	76.3
All irrigators 2019/20	**9.4**	**15.6**	**75.0**
All irrigators 2015/16	**7.0**	**14.6**	**78.4**
2004/05 data	**2.2**	**10.3**	**87.5**

3.3.4. Succession planning

When asked about succession planning, 54% of irrigators in 2019/20 intend to pass on their properties on to another person in the family (Figure 3). This result is comparable to 2015/16 at 50% and 2004/05 at 51%.

Figure 3: Interviewees' response to whether they would pass the property to another family member (%)

An analysis was undertaken to determine if there was an association between 'expectations for family succession' and 'industry group' (e.g. dairy), which found no association between these factors (Table 8).

Table 8: Chi-square test result showing no association between 'expectation for family succession' and 'industry group'

Statistical test	Test	Test value	Degrees of freedom	Statistical significance[1]
There is no association between *'expectation for family succession'* and *'industry group/land use' (e.g. dairy)*	$\chi 2$ (n=119)	9.42	6	0.15

[1] to be considered statistically significant this value must be <0.01

Succession planning can be a complex decision-making process. Data was analysed to determine the association between succession planning and years of farming and found those planning on passing property to family members had a higher average period of farming (41 years) than those who have no intention of passing their properties to family members (30 years) (Table 9). Therefore, the decision to pass property to family, was significantly associated with average farming years.

Table 9: Average age of farming versus succession planning

Industry	Median	Mean
Planning to pass on property to family members (n=63)	40.0	40.6
Not planning to pass on property family members (n=40)	29.5	29.7
Total (n=103)	**40.0**	**36.4**

- *ANOVA test result: F (1,103) = 14.42, p <0.000 (significant)*

3.4. Irrigation modernisation

A series of questions on modernisation of irrigation infrastructure (supply point and on-farm) were asked of irrigators. Following completion of the Goulburn-Murray Water Connections Project, the questions asked in 2019/20 differed slightly from 2015/16, to align with current information requirements. Datasets have been compared where relevant.

3.4.1. Modernisation of supply point to irrigated land and on-farm irrigation practices/upgrades

In 2019/20, 93% of irrigators had modernised supply points, compared to 68% in 2015/16 connected to the Goulburn-Murray Water main channel (backbone) system. The variation in modernised supply points among different industries in 2019/20 is shown in Figure 4, with Dairy (96%) and Cropping (96%) having the highest percentage of irrigators with modernised supply points, followed closely by Horticulture (orchard) (91%) and Grazing (86%).

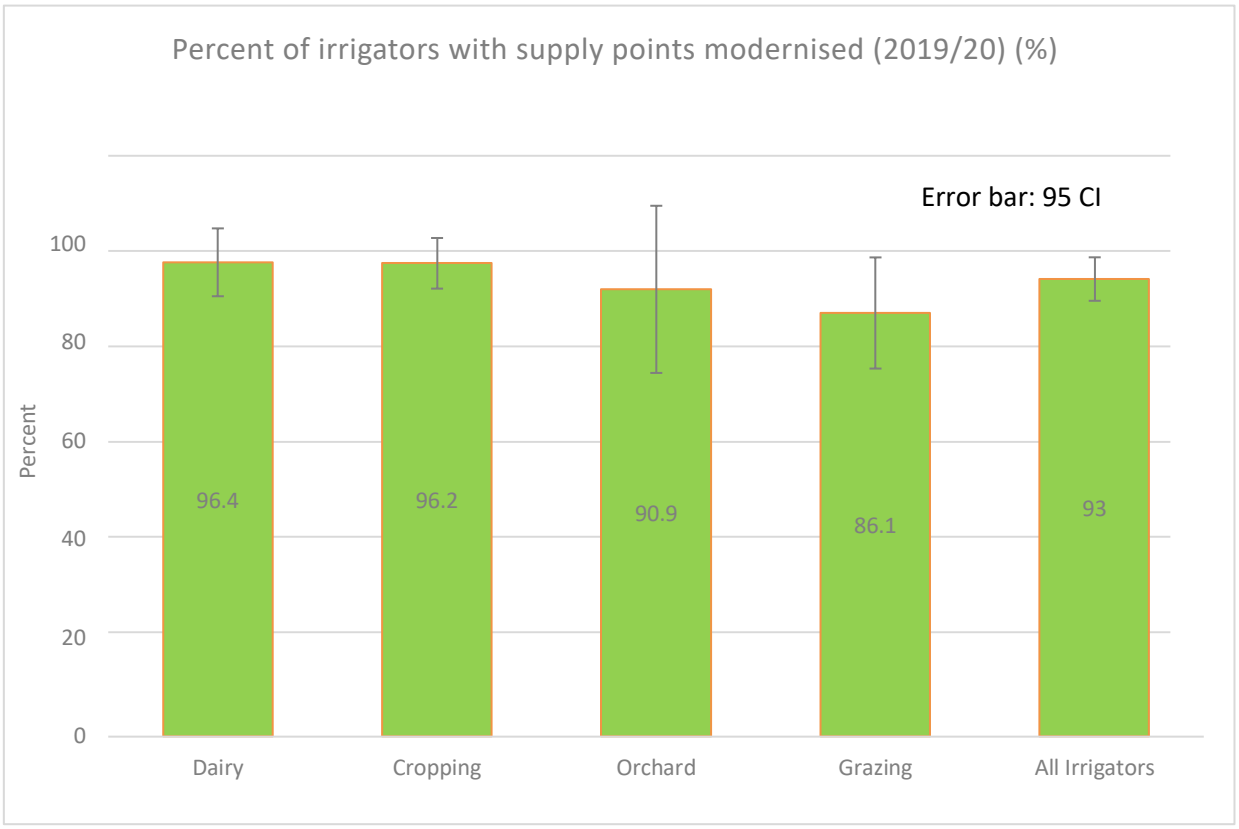

Figure 4: Irrigators with supply points modernised (2019/20) (%)

3.4.2. Improved irrigation management

Irrigators who had modernised their supply point/s (Figure 4 above) were asked if their irrigation management had improved following modernisation of their supply point/s. As shown in Figure 5 (below), in 2019/20 62% of irrigators indicated their irrigation management had improved, with the highest positive response from Dairy (78%) and the lowest from Grazing (50%). This question was asked slightly differently during 2015/16 survey, where irrigators were asked if they had increased production following modernisation and 64% reported they had.

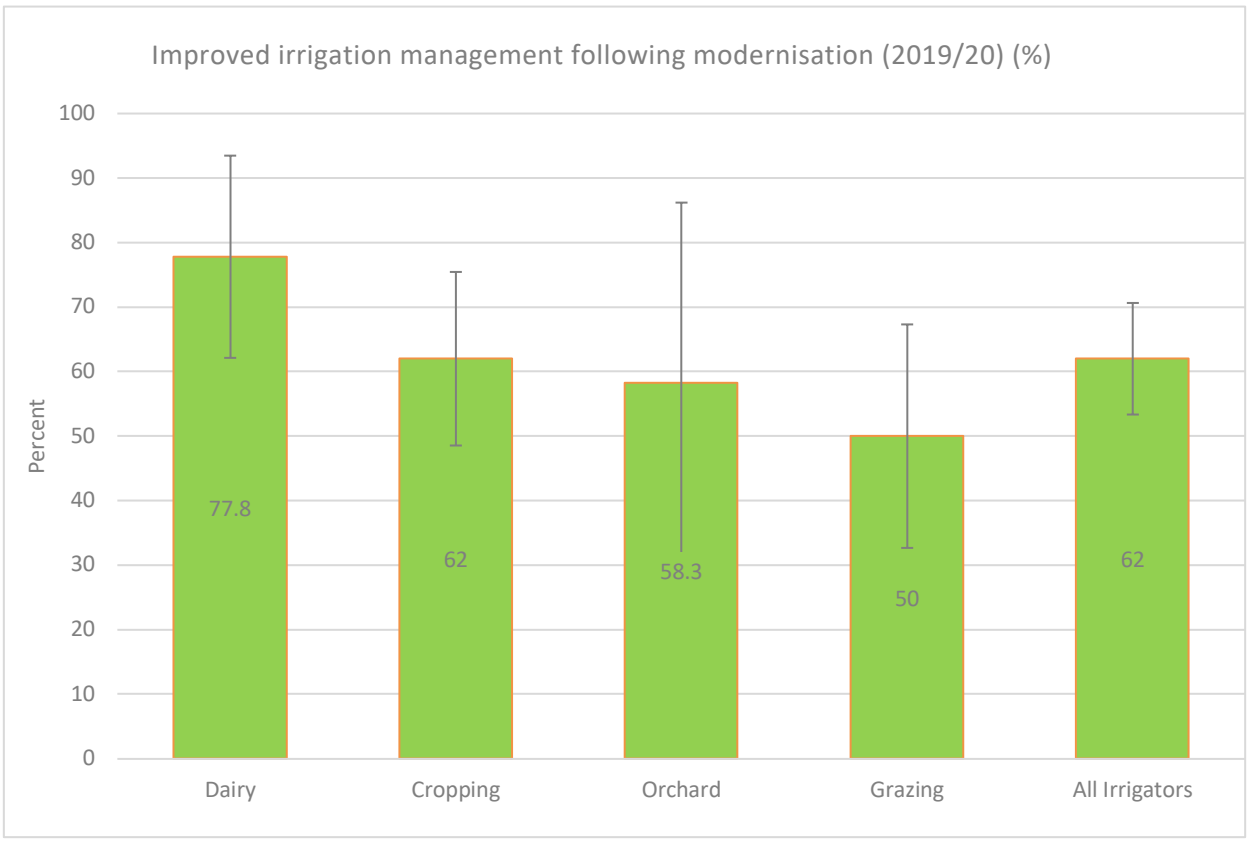

Figure 5: Irrigators that answered 'Yes' to having Improved irrigation management after modernization of irrigation supply point/s (%)

3.4.3. On-farm irrigation system upgrades

Irrigators were asked if and when they upgraded their on-farm irrigation infrastructure. In 2019/20 80% of irrigators had upgraded their on-farm irrigation systems, which was considerably higher than in 2015/16, where only 50% had done so (Figure 6). Dairy (92%) and Cropping (88%) had the highest percentage of irrigators who had improved their on-farm irrigation systems; with Cropping having the greatest increase since 2015/16 (from 40% to 88%).

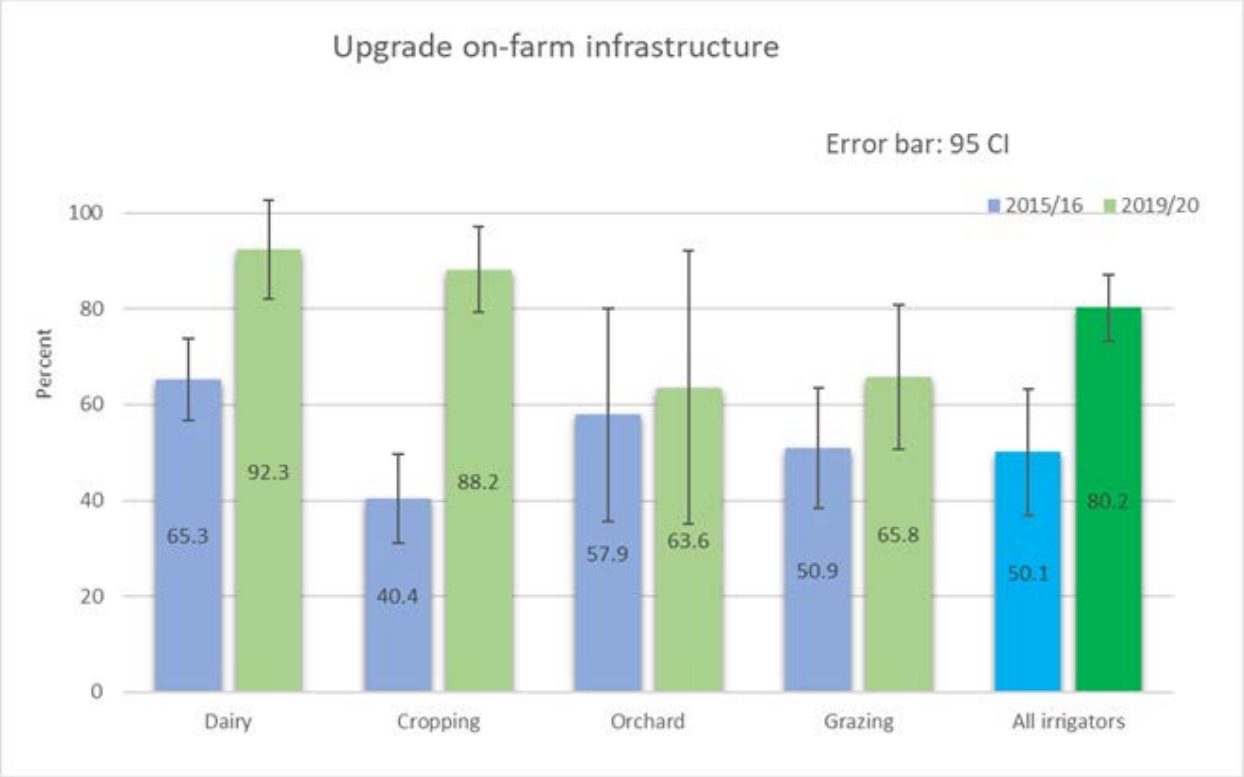

Figure 6: Upgrades to on-farm infrastructure (%)

Irrigation infrastructure upgrades included laser grading (62%), water reuse systems (39%), new irrigation systems (22%) (e.g. pipe and risers, centre pivot and linear moves and upgrade of channels and outlets), installation of automation (18%), and irrigation scheduling (16%) (e.g. soil moisture monitoring and irrigation scheduling probes) (Figure 7).

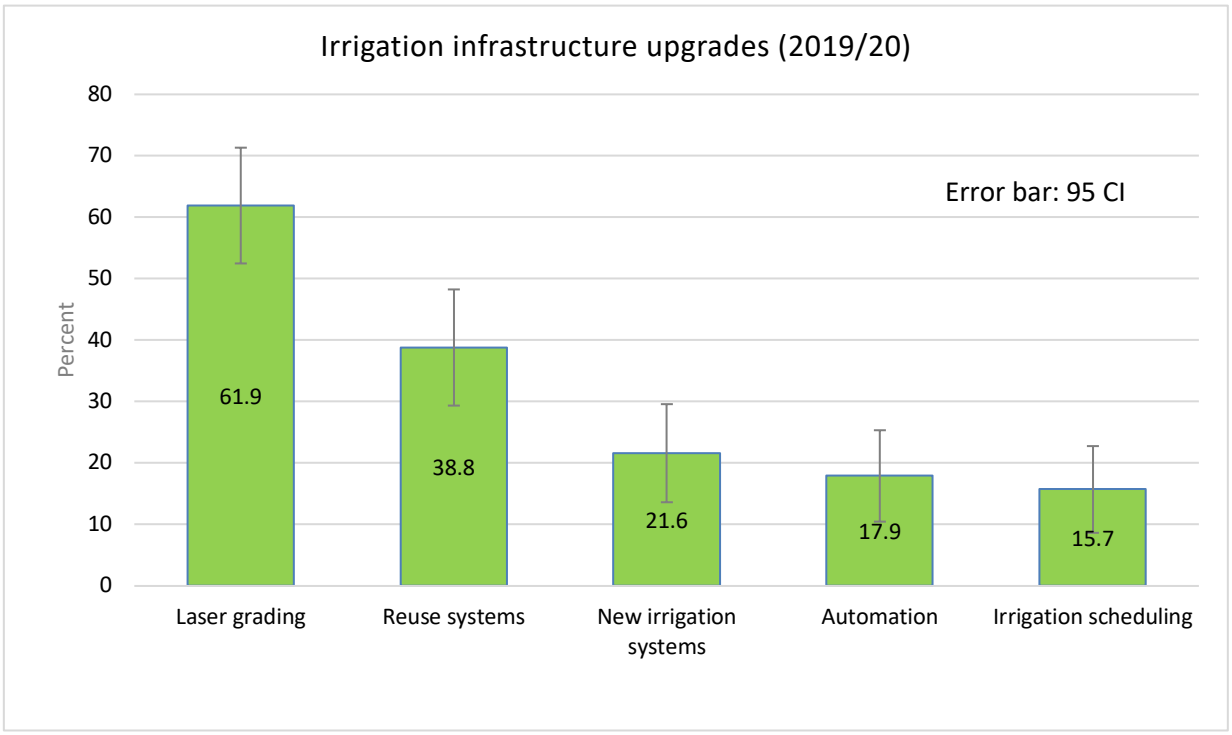

Figure 7: Type of on-farm irrigation infrastructure upgrades

3.4.4. Funding of irrigation system upgrades and future intentions

Irrigators who had upgraded their on-farm irrigation infrastructure were asked whether they had received funding (government or other i.e. private) in the last ten years to do so (e.g. through an irrigation efficiency program). In 2019/20, 41% of irrigators had received funding compared with 36% in 2015/16 (Figure 8). It should be noted that in 2015/16 when funding programs were more prevalent, the time-frame irrigators were given was in the 'last five years'.

In 2019/20, Dairy had the highest percentage who had received funding (58%) and Grazing the least (30%). In 2015/16, Horticulture (orchard) had the highest percentage who had received funding (50%) and Cropping the least (25%). The types of funding programs were queried but showed no valuable results due to the broad range of responses.

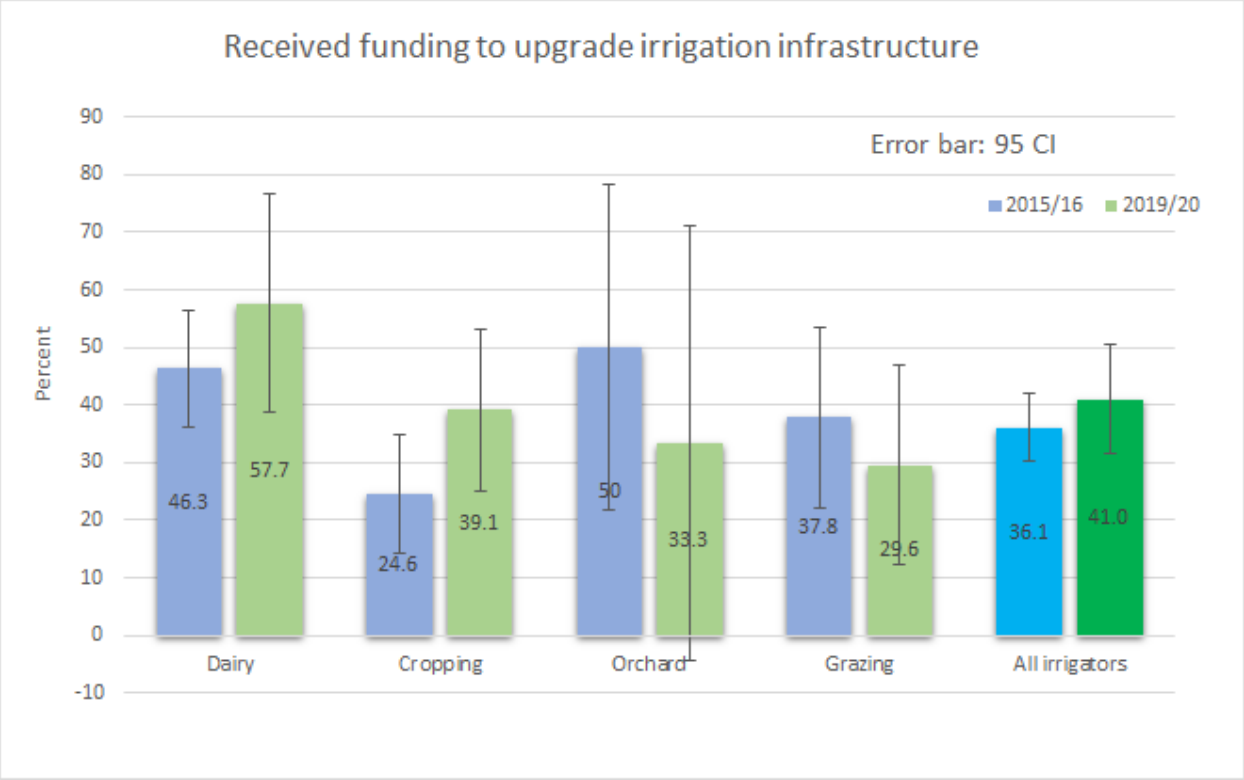

Figure 8: Received funding (government or other) to upgrade their irrigation infrastructure (%).
Note: Responses from 2019/20 and 2015/16 pertain to the last 10 and 5 years respectively.

Statistical analysis showed an association between '*those who have upgraded on-farm infrastructure'* and '*industry groups*,' with dairy industries more likely to have upgraded on-farm infrastructure than the other land uses (Table 10).

Table 10: Chi-square test result showing association between 'those who have implemented on-farm irrigation upgrades' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*those who have upgraded on-farm infrastructure'* and '*industry groups.*'	$\chi 2$ (n=126)	11.33	3	0.01

In 2019/20, when irrigators were asked about their intention to change their irrigation infrastructure in the next five years, 28% plan to do so. The figures were lower than in 2015/16, when 49% of irrigators intended to upgrade their infrastructure (Figure 9). This is not surprising given that 80% of irrigators had improved their on-farm irrigation systems.

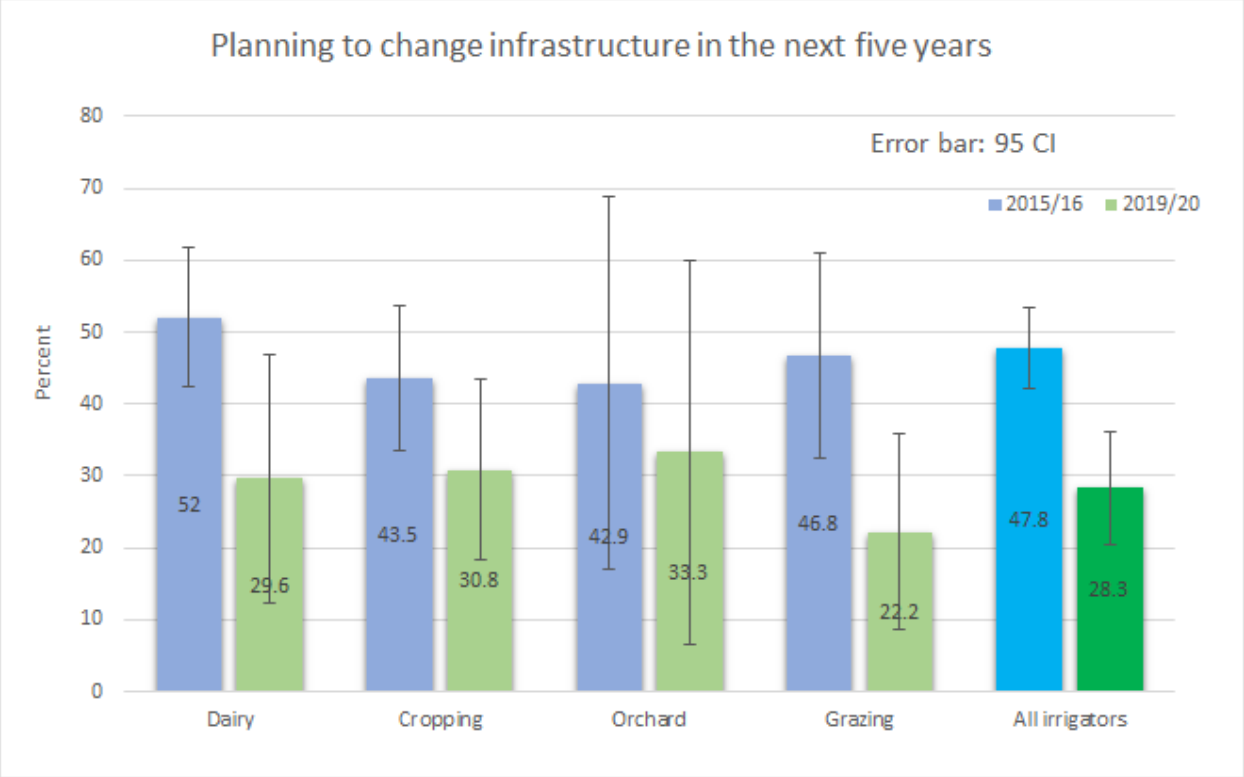

Figure 9: Planning to change irrigation infrastructure in the next five years (%)

3.4.5. Barriers to changing irrigation management practices

Irrigators were asked to identify significant barriers to changing their on-farm irrigation management practices (Table 11). The top three barriers in 2019/20 included uncertainty of water allocation (65%), lack of financial resources (47%) and inadequate water availability (43%). These three were also the highest three barriers in 2015/16, while in 2004/05 lack of time narrowly (by 0.7%) replaced inadequate water availability in the top three. Uncertainty of water allocation and inadequate water availability increased by 17% and 24% respectively since 2004/05, while lack of time has decreased (5%) along with connections/outlet modernisation being a barrier (down by 15%).

Table 11: Barriers to changing irrigation management practices (%)

Barriers [1]	2019/20 %	2015/16 %	2004/05 %
Inadequate water quality	**7.5**	**13.8**	**2.3**
Uncertainty of water allocation	**64.7**	**53.9**	**47.1**
Lack of financial resources	**46.8**	**52.6**	**50.2**
Lack of time	**14.9**	**21.1**	**20.0**
Insufficient or inadequate information	**6.3**	**7.6**	**3.6**
Doubts about likely success	**14.8**	**9.4**	**12.1**
Age or poor health	**23.8**	**17.7**	**12.9**
Inadequate water availability	**43.0**	**46.1**	**19.3**
Connections/outlet modernisation	**11.4**	**26.3**	**N/A**
No barriers	**-**	**5.5**	**N/A**

[1]Respondents (irrigators) provided multiple responses

3.5. Water ownership, allocation trading and carry over

3.5.1. Water ownership

Irrigators were asked how much High Reliability Water Share (HRWS) they own (2019/20 season). Fifty-three percent of the irrigators that responded to the question (n=115) reported owning less than 200ML of HRWS in 2019/20, compared to 49% in 2015/16. The number of irrigators owning no water share was 2.6%, which has decreased since 2015/16 when 7.8% owned no water share. In 2019/20, 47% reported owning more than 200ML HRWS, of which 25% owned more than 500ML. There was variation in the ownership of water entitlements among different industry groups, including 69% of dairy farmers owning more than 200ML, compared to 33% of Horticulture (orchard) (Table 12).

Table 12: Ownership of High Reliability Water Share (HRWS) (%)

High Reliability Water Share (HRWS)	Dairy (n=26)	Cropping (n=50)	Horticulture (orchard) (n=9)	Grazing (n=30)	All irrigators 2019/20 (n=115)	All irrigators 2015/16 (n=356)
No water shares	3.8	2.0	11.1	0.0	2.6	7.8
1-200 ML	26.9	52.0	55.6	66.7	50.4	41.6
201-500ML	34.7	20.0	11.1	16.7	21.8	28.7
More than 500 ML	34.6	26.0	22.2	16.7	25.2	21.9

In 2019/20, nearly 43% of irrigators did not own enough water entitlements to meet their irrigation needs, down from 64% in 2015/16. This could be due, at least in part, to there being lower allocations in 2015/16 compared to 2019/20. Fifty-nine percent of Dairy did not have the amount of water entitlements they require, compared to 33% of Horticulture (orchard) (Table 13).

Table 13: Response to a statement – 'I have the amount of water entitlements to irrigate my property that I require' (%)

Industry	Disagree	Undecided	Agree
Dairy (n=29)	58.6	6.9	34.5
Cropping (n=49)	38.8	8.2	53.1
Horticulture (orchard) (n=12)	33.3	16.7	50.0
Grazing (n=37)	37.8	10.8	51.4
All irrigators (2019/20) (n=127)	**42.5**	**9.4**	**48.0**
All irrigators (2015/16) (n=354)	**63.6**	**9.6**	**26.8**

This study also found that there is a strong relationship (r= +0.69) between the size of the irrigated property and ownership of HRWS (Table 14), where the larger the size of the land, the higher the level of HRWS ownership.

Table 14: Correlation result between 'size of irrigated land owned' and 'amount of High Reliability Water Share'

Result	Test	Test value	Statistical significance
There is a correlation between '*size of the irrigated property*' and '*ownership of HRWS.*'	Correlations (n=106)	+0.688	0.000

3.5.2. Water trading

Irrigators were asked if they had decreased, held or increased their water holdings in the last ten years. Nearly 35% of irrigators in 2019/20 had decreased, 44% had held and 21% had increased their water holdings in the last 10 years (Table 15). The responses were not statistically different among industry groups (p=0.89).

Table 15: Changes to water holding in the last 10 years (%)

Industry	Decreased	Held	Increased
Dairy (n=21)	38.1	38.1	23.8
Cropping (n=38)	38.9	41.7	19.4
Horticulture (orchard) (n=6)	16.7	50.0	33.3
Grazing (n=23)	30.4	52.2	17.4
All irrigators (2019/20) (n=86)	**34.9**	**44.2**	**20.9**

Analysis of responses to 'water holding in the last ten years (decreased, held or increased)' and 'those who upgraded on farm infrastructure' (Table 16) found a statistically significant association between decreased water holdings and upgrades to on-farm infrastructure. This could suggest that irrigators sold water to upgrade their irrigation systems.

Table 16: Chi-square test result showing association between 'water holding' and 'those who upgraded on-farm infrastructure'

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*water holding (decreased, held or increased in the last 10 years)* and *'those who upgraded on-farm infrastructure'*. Those who have upgraded their irrigation systems have decreased their water holding.	$\chi 2$ (n=81)	6.92	2	0.03

Irrigators were asked whether they were a net trader-in (buyer) or net trader-out (seller) of irrigation allocation in the 2019/20 irrigation season. Overall, more than half (59%) of irrigators identified as purchasers (net trade in) of allocation water, compared to 41% of sellers (net trade out). The majority of dairy and Horticulture (orchard) industries reported being net buyers (95%) compared to net sellers (5%). Cropping and Grazing reported that they were (net) sellers (57%) compared to 43% (net) buyers (Table 17). The differences in water trading between industries were statistically significant (Table 19).

Table 17: Net trader in or trader out during 2019/20 season (%)

Industry	Net trader in	Net trader out
Dairy & Horticulture (orchard) (n=22)	94.7	5.3
Cropping and Grazing (n=45)	42.9	57.1
All irrigators (2019/20) (n=67)	**59.0**	**41.0**

Irrigators were asked to give an indication of the volume of their net trade-in and out during the 2019/20 irrigation season. The average amount of water allocation traded-in and traded-out by industry group is shown in Table 18. Overall, the median amount of water traded-in and traded-out by the irrigators was 100ML. On average, 173ML of water was traded in and 400ML traded out. Dairy had the highest average net trade-in (228 ML) and Cropping the highest average net trade-out (562ML). Horticulture (orchard) irrigators did not report trade-out of allocation (Table 18).

Table 18: Water allocation traded-in and traded-out (ML)

Industry	Trade in (ML)		Trade out (ML)	
	Mean	Median	Mean	Median
Dairy	228	200	110	100
Cropping	168	100	562	125
Horticulture (orchard)	92	70	-	-
Grazing	48	30	155	96
Total	**173**	100	400	100

A statistically significant association between those 'who trade-in or trade-out water' and 'industry groups' was identified, with Dairy and Horticulture (orchard) (combined) being more likely to trade-in water than cropping and grazing (combined) (Table 19).

Table 19: Chi-square test result showing association between 'those who trade-in or trade-out water' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*those who trade-in or trade-out'* and '*industry groups*' With Dairy and Horticulture (orchard) more likely to trade-in water than Cropping and Grazing.	$\chi 2$ (n=67)	15.04	1	0.001

3.5.3. Carryover water

Irrigators were asked whether it was part of their business plan to carry over water annually. Seventy-one percent of irrigators indicated that they use this tool to manage their irrigation water (Figure 10). Although a higher percentage of dairy (79%) and cropping (74%) irrigators indicated use of carryover, there was not a statistically significant difference in carryover use among industry groups (Table 20).

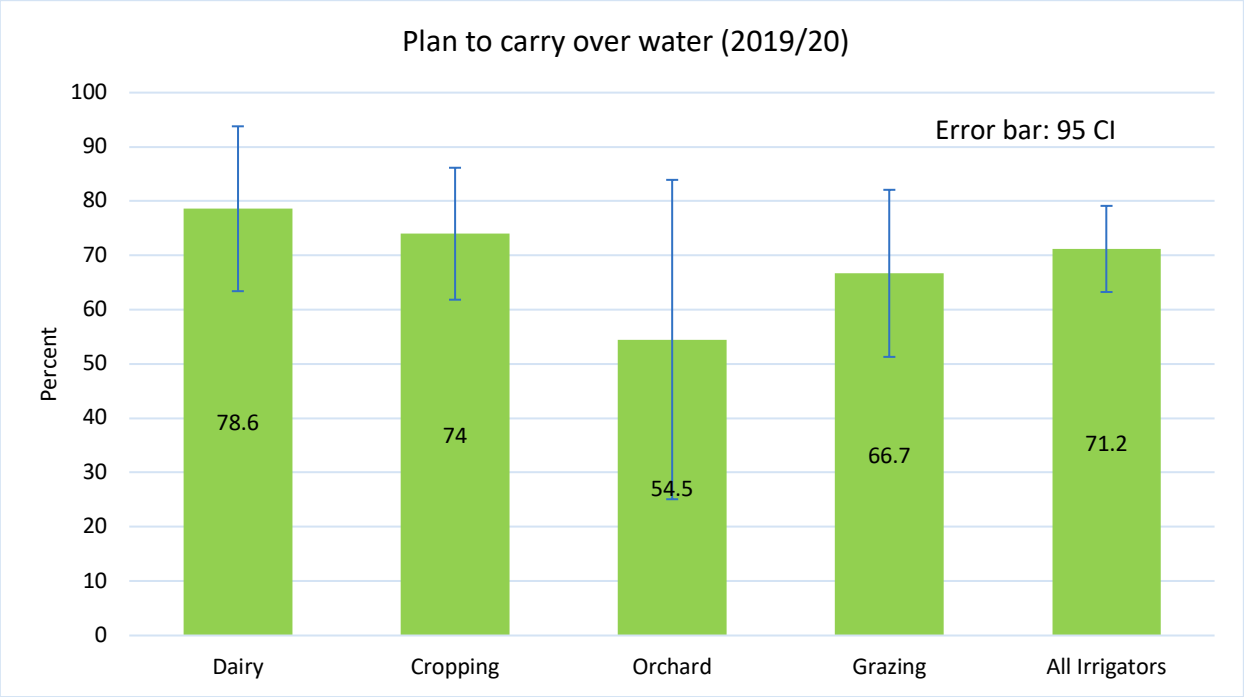

Figure 10: Part of business plan to carry over water (%)

Table 20: Chi-square test result showing no significant association between 'plan to carry over water' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is no association between '*plan to carryover water*' and '*industry groups*'	$\chi 2$ (n=125)	2.79	3	0.426

Irrigators were asked what percentage of their total allocation they plan to carry over annually. Irrigators look to carry over on average 34.5% of their HRWS annually, with variation among industries (Table 21). However, these variations were not statistically significant (p=0.71).

Table 21: Percent of total allocation to carry over annually (%)

Industry	Median (%)	Mean (%)	Minimum (%)	Maximum (%)
Dairy (n=19)	30.0	31.2*	5	100
Cropping (n=34)	27.5	38.8*	5	100
Horticulture (orchard) (n=6)	17.5	30.0*	10	100
Grazing (n=22)	25.0	32.1*	10	100
All irrigators (2019/20) (n=81)	**25.0**	**34.5**	**5**	**100**

When asked why they carry over water, irrigators frequently answered:

- Security for the next season (e.g. security for winter/spring crops);
- Unused allocation;
- Early irrigation and cost of temporary water; and
- Total allocation comes out too late.

Other reasons provided for why carryover is used included: dry conditions; growing feed in spring; domestic use (i.e. to fill dams); to maximise farm business income; to have enough water at the start of the season and avoid purchasing later; low allocation; and risk management.

Irrigators were asked if it was part of their long-term business plan to use allocation trade to manage through the irrigation season. More than 50% of irrigators in 2019/20 and 2015/16 agreed; with the highest affirmative response in both years from Dairy (61% in 2015/16 and 67% in 2019/20). Cropping and Horticulture (orchard) affirmative responses increased by 20% and 10% respectively since 2015/16 (Figure 11).

A statistical association was observed between '*those who have implemented on-farm irrigation upgrades'* and '*those who have a long-term plan to use allocation trade'*, indicating those who have implemented upgrades are more likely to use allocation trade (Table 22). However, it is not clear if this is trade-in or trade-out.

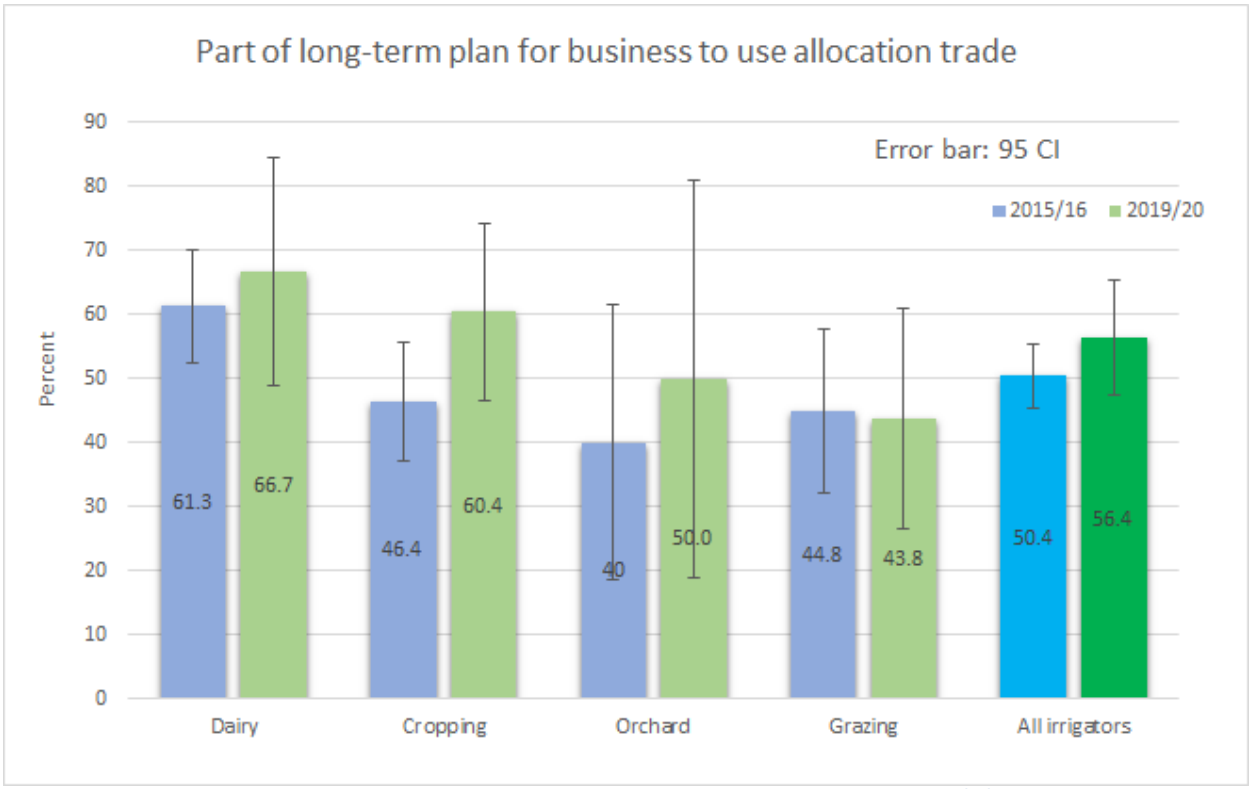

Figure 12: Part of long-term business plan to use allocation trade to manage through the season (%)

Table 22: Chi-square test result showing association between 'those who have implemented on-farm irrigation upgrades' and 'those who have a long-term plan to use allocation trade'.

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between *'those who have implemented on-farm irrigation upgrades*' and '*those who have a long-term plan to use allocation trade'*.	$\chi 2$ (n=112)	5.07	1	0.024

3.5.4. Reliance on allocation trade

In 2019/20, 39% of irrigators relied heavily (large reliance) on the allocation trade market to meet their water needs, 18% had 'some reliance' and 43% had 'no or little reliance'. The majority of Horticulture (orchard) (50%) and Dairy (46%) had a 'large reliance' on allocation trade, in comparison to the majority of Grazing (51%) and Cropping (42%) who had 'no or little reliance'. The overall responses from irrigators were similar to those provided during the 2015/16 study (Table 23). No statistical significance was observed between industry groups with regard to their reliance on allocation trade (Table 24).

Table 23: Reliance on allocation trade to manage through the irrigation season (%)

Industry	No or little Reliance	Some Reliance	Large Reliance
Dairy (n=28)	35.7	17.9	46.4
Cropping (n=48)	41.7	18.8	39.6
Horticulture (orchard) (n=12)	41.7	8.3	50.0
Grazing (n=35)	51.4	20.0	28.6
All irrigators (2019/20) (n=123)	**43.1**	**17.9**	**39.0**
All irrigators (2015/16) (n=369)	**42.0**	**21.4**	**36.6**

Table 24: Chi-square test result showing no association between 'reliance on allocation trade' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is no association between '*reliance on allocation trade*' and '*industry groups'*	$\chi 2$ (n=123)	4.83	6	0.566

3.5.5. Impact of allocation trade

Irrigators were asked whether allocation trade had a negative or positive impact on their ability to make a profit. In 2019/20, 39% of irrigators indicated allocation trade negatively impacted their ability to make a profit, down from 47% in 2015/16. The negative impact figure was higher for Dairy (50%) compared with other industries (Table 25). A negative or positive impact to profit is most likely indicative of whether allocation price inhibits or enables irrigators to purchase water for productive use or to profit from selling water.

The 2004/05 survey (GMW 2006) indicated that 69% of irrigators found allocation trade positively impacted their ability to make a profit, compared with 19.5% in 2015/16 and 37% in the 2019/20 (Table 25). For approximately one quarter of all irrigators in 2019/20 (24%) allocation trade was having no impact on their ability to make a profit, particularly Grazing (Table 25). No statistical significance was observed between industry groups with regard to allocation trade impacting their ability to profit (Table 26).

Table 25: Allocation trade affecting ability to make a profit (%)

Industry	Negative impact	No impact	Positive impact
Dairy (n=26)	50.0	19.2	30.8
Cropping (n=50)	38.0	16.0	46.0
Horticulture (orchard) (n=12)	41.7	25.0	33.3
Grazing (n=30)	30.0	40.0	30.0
All irrigators 2019/20 (n=118)	**39.0**	**23.7**	**37.3**
All irrigators 2015/16 (n=339)	**47.2**	**33.3**	**19.5**
2004/05 data	**15.1**	**15.6**	**69.3**

Table 26: Chi-square test result showing no statistical association between 'allocation trade affecting the ability to make profit' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is no association between '*allocation trade affecting the ability to make profit*' and '*industry groups*'	$\chi 2$ (n=118)	8.09	6	0.231

The analysis found allocation trade was having an impact on farm businesses, with purchased allocation making up a significant proportion of water use and allocation prices affecting water purchase and selling decisions. For 41% of irrigators, allocation trade negatively affected their ability to plan and implement a water budget (Table 27). The figures were higher for Dairy (46%), although there was no statistically significant difference between industry groups (Table 28). The responses were similar to 2015/16, with indication of allocation trade having more of a positive impact during the 2019/20 season (27%) compared with 2015/16 (17.5%). In response to the same question in 2004/05, only 14% of irrigators reported that allocation trade had a negative impact on their ability to plan and implement a water budget.

Table 27: Allocation trade affecting the ability to plan and implement a water budget (%)

Industry	Negative impact	No impact	Positive impact
Dairy (n=26)	46.2	30.8	23.1
Cropping (n=50)	44.0	30.0	26.0
Horticulture (orchard) (n=12)	41.7	33.3	25.0
Grazing (n=30)	30.0	36.7	33.3
All irrigators 2019/20 (n=118)	**40.7**	**32.2**	**27.1**
All irrigators 2015/16 (n=337)	**46.6**	**35.9**	**17.5**
2004/05 data	**14.4**	**32.9**	**52.7**

Table 28: Chi-square test result showing no statistical association between 'allocation trade affecting the ability to plan and implement a water budget' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is no association between '*allocation trade affecting the ability to plan and implement a water budget*' and '*industry groups*'	$\chi 2$ (n=118)	2.08	6	0.912

3.5.6. Allocation (water) price

Irrigators were asked at what allocation price does irrigation water become unviable. Irrigators were highly sensitive to allocation price in 2019/20 and 2015/16, with 76.9% and 95% of all irrigators (respectively) indicating that allocation prices greater than $250/ML were not viable for their business (Table 29). A higher percentage of irrigators (23%) were prepared to pay more than $250/ML during the 2019/20 season than in 2015/16 (5%). This could be indicative of the higher than average temporary water prices in 2019/20.

Table 29: Price above which allocation water becomes unviable (shown as %)

Industry	No.	Less than $150/ML	$150-$250/ML	More than $250/ML
Dairy	n= 21	19.0	52.4	28.6
Cropping	n= 38	44.7	44.7	10.5
Horticulture (orchard)	n= 9	11.1	11.1	77.8
Grazing	n= 27	37.0	44.4	18.5
All irrigators (2019/20)	**n=95**	**33.7**	**43.2**	**23.2**
All irrigators (2015/16)	**n= 222**	**33.7**	**61.3**	**5.0**

The median price above which purchase of allocation water becomes unviable for irrigators was $200/ML with variation among different industry groups (Table 30). Victorian Water Trade Data identified that average allocation water prices peaked in January 2020 at $665/ML in zone 1A (Greater Goulburn), $660 in zone 3 (Lower Goulburn), $640/ML in zone 6 (Vic Murray to Barmah) and in November 2019 at $939/ML in zone 7 (Vic Murray Barmah to SA). By the end of the season the average prices had dropped to $195/ML in zone 1A (Greater Goulburn) and $230/ML in zone 7 (Vic Murray - Barmah to SA) likely due to rain and favorable outlooks (Annual Water Trade report, 2019/20).

Table 30: Price above which allocation water becomes unviable (shown as $/ML)

Industry	No.	Median	Mean	Minimum	Maximum
Dairy	n=21	200	219	100	400
Cropping	n=38	150	184	25	700
Horticulture (orchard)	n=9	500	500*	100	800
Grazing	n=27	170	211	50	1000
All irrigators (2019/20)	**n= 95**	**200**	**230**	**25**	**1000**
All irrigators (2015/16)	**n= 222**	**150**	**173**	**40**	**700**

The price at which allocation water becomes unviable was significantly different between Horticulture (orchard) and other industry groups. Statistical analysis using Scheffe test indicated that the price above which purchasing allocation water becomes unviable for Horticulture (orchard) (average of $500/ML) was significantly higher compared with other industry groups (Table 31).

Table 31: Analysis of Variance showing the effect of 'unviability of water price' by 'industry groups'

Result	Test	Test value	Statistical significance
The price allocation water becomes unviable was significantly different between *Horticulture (orchard)* and '*other industry groups'*. Analysis using Scheffe test indicated that the price for *Horticulture (orchard)* was significantly higher than other industries.	ANOVA & Scheffe test	F (3,91) =10.02	0.000

Nearly three-quarters of irrigators in 2015/16 (71%) and 2019/20 (74%) reported that the price of temporary water during these irrigation seasons affected their water purchase and selling decisions. In 2019/20 the responses were similar across dairy (78%), Cropping (84%) and Horticulture (orchard) (80%) industries but significantly different for Grazing (54%) (Figure 12 and Table 32). Grazing irrigators also had the least reliance on allocation trade and traded-in the least amount of water in 2019/20 (see Table 18 and 23).

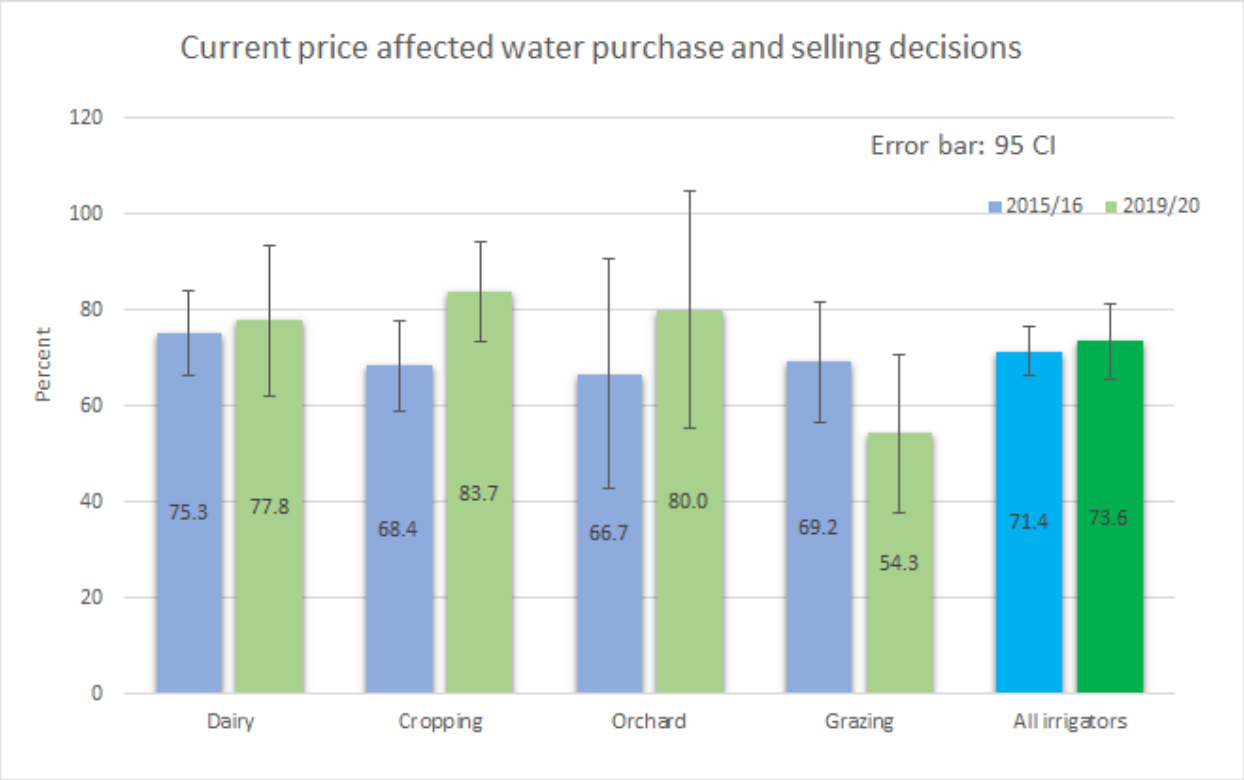

Figure 12: Whether current price affected water purchase and selling decisions (%)

Table 32: Chi-square test result showing association between 'price of allocation water affecting purchase or selling decisions' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between *'price of allocation water affecting purchase and selling decisions'* and *'industry groups'*	$\chi 2$ (n=121)	9.72	3	0.02

3.6. Transition of land use

In 2019/20 an additional section of questions on land use transition were included in the survey to improve our understanding of changing land use and irrigator intentions. When irrigators were asked whether they had transitioned from one main land use to another in the last 5 years, 23% had undergone land use transition on their properties (Table 33).

Table 33: Transition of land use (%)

Land use/crop transition (from)	Land use/crop transition (to)	Percentage
Dairy	Grazing/cropping	7.5
Grazing	Cropping	1.5
Orchard	Cropping	1.5
Cropping	Horticulture	1.5
Irrigated cropping	Dryland cropping	2.2
Dryland cropping	Irrigated cropping	2.2
Cropping (Lucerne)	Grazing (sheep)	1.5
Dairy (permanent pasture)	Dairy (annuals)	3.0
Dairy (pasture)	Dairy (barn-intensive)	1.5
Cropping (soybean)	Cropping (lucerne)	1.5
Total		**22.9**

When asked about the reasons for their transition, irrigators cited reasons such as water availability, cost of water, personal reasons (age, health) and ability to profit by trading water. Those who had transitioned land use/crop type all indicated the transition would be permanent.

3.7. Farm management practices (natural resource management)

3.7.1. Whole Farm Planning

Irrigators were asked whether they had a professionally prepared Whole Farm Plan for their properties, with 67% of all irrigators indicating that they had. This figure was slightly lower than reported in 2015/16 (74%). It is noted that the Whole Farm Plan figures are within the error bar with upper and lower bounds of 95% confidence interval showing that the differences are not statistically significant. Other reasons for the decline in Whole Farm Plans may also be attributed to changes in land ownership.

A large percentage of Dairy (85%) and Cropping (78%) irrigators had a professionally prepared Whole Farm Plan in 2019/20 (Figure 13). Horticulture (orchard) had the lowest percentage of irrigators who had completed professionally prepared Whole Farm Plan (33%), half of that in 2015/16 (67%). There was a statistical association between those who had prepared a whole farm plan and industry group, indicating Dairy and Cropping industries are more likely to have professionally prepared Whole Farm Plans than Horticulture (orchard) or Grazing (Table 34).

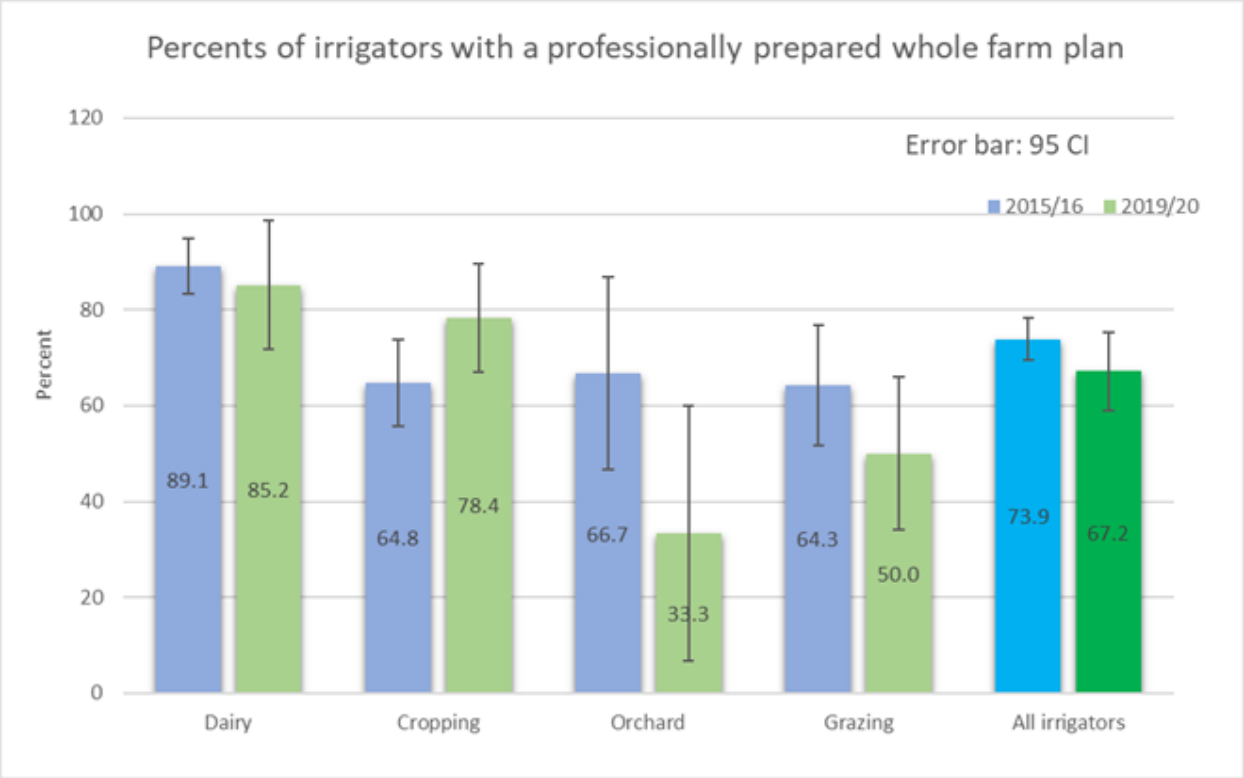

Figure 13: Percent of irrigators with a professionally prepared Whole Farm Plan (WFP) (%)

Table 34: Chi-square test result showing association between 'those who have a professionally prepared Whole Farm Plan' and 'industry groups'

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*those who have a professionally prepared Whole Farm Plan*' and '*industry groups'.* Dairy and Cropping industries were more likely to have professionally prepared Whole Farm Plans than Horticulture (orchard) Grazing.	$\chi 2$ (n=128)	18.22	3	0.001

Irrigators who had prepared Whole Farm Plans were asked when it was completed. In 2019/20, 23% had completed their Whole Farm Plan in the last five years, with another 24% completed six to ten years ago and 53% having completed it more than ten years ago. Cropping had their Whole Farm Plans in place for the longest period overall, with 60% of irrigators having had plans completed more than 10 years ago, while Horticulture (orchard) had 75% of Whole arm Plans developed in the last five years (Table 35).

Table 35: When was your Whole Farm Plan (WFP) completed? (%)

Industry	0-5 years	6-10 years	More than 10 years
Dairy (n=24)	33.3	20.8	45.8
Cropping (n=40)	10.0	30.0	60.0
Horticulture Orchard (n=4)	75.0	0.0	25.0
Grazing (n=19)	26.3	21.1	52.6
All irrigators (2019/20) (n=87)	23.0	24.1	52.9

When asked what portion of their Whole Farm Plan had been implemented on farm, the majority (63%) of irrigators in 2019/20 indicated they had implemented 75% or above. Dairy had the highest percentage (78%) of Whole Farm Plans that had been at least 75% implemented, followed by Grazing (61.5%) and Cropping (61%) (Table 36).

Table 36: Portion of the Whole Farm Plan (WFP) implemented on-farm (%)

Industry	0-49%	50-74%	75% and above
Dairy (n=18)	16.7	5.6	77.8
Cropping (n=33)	15.2	24.2	60.6
Horticulture Orchard (n=3)	66.7	33.3	0.0
Grazing (n=13)	30.8	7.7	61.5
All irrigators (2019/20) (n=67)	**20.9**	**16.4**	**62.7**
All irrigators (2015/16) (n=229)	**9.6**	**20.1**	**70.3**

3.7.2. Native vegetation and environmental features

In 2019/20, 34% of irrigators had undertaken native vegetation works on-farm (e.g. tree planting, direct seeding, fencing of remnants including wetlands). Dairy had the highest percentage who had undertaken native vegetation works (57%), followed by Cropping (36%) and Grazing (24%). None of the Horticulture (orchard) irrigators indicated they had completed native vegetation works in the last five years (Figure 14).

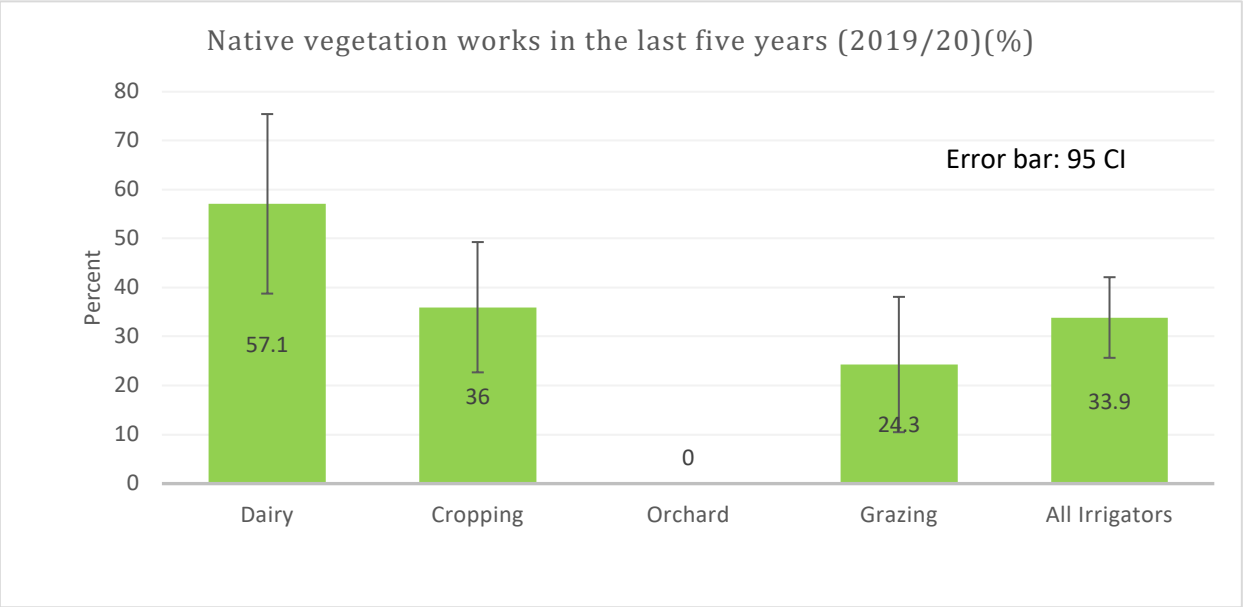

Figure 14: Native vegetation works undertaken in the last five years (%)

There was a statistical association between *'those who had carried out native vegetation works in the last 5 years*' and '*industry group'*, with dairy being significantly more likely to carry out native vegetation works than other industry groups (Table 37).

Table 37: Chi-square test result showing a significant statistical association between 'those who have carried out native vegetation works in the last five years' and 'industry group'.

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*those who have carried out native vegetation works in the last five years'* and '*industry group'* Dairy is more likely to carry out native vegetation works than other industry groups.	$\chi 2$ (n=127)	14.56	3	0.001

Irrigators were asked about their intention for undertaking native vegetation works in the next five years, with 37% of all irrigators and more than half of Dairy irrigators indicating they would (Figure 15). Statistical analysis also suggested that Dairy would be more likely to carry out native vegetation works in the future than any other industry groups (Table 38).

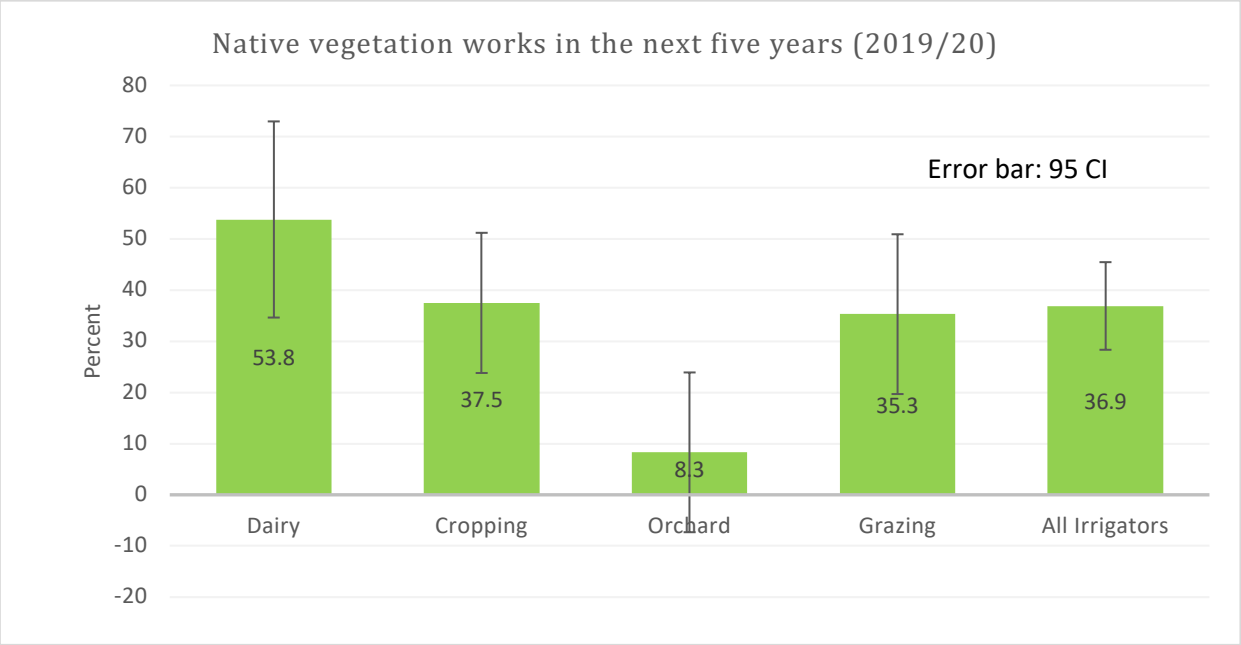

Figure 15: Native vegetation works in the next five years (%)

Table 38: Chi-square test result showing association between 'those who plan to carry out native vegetation works in the next five years' and 'industry group'.

Result	Test	Test value	Degree of freedom	Statistical significance
There is an association between '*those who plan to carry out native vegetation works in the next five years'* and '*industry group'* Dairy is more likely to carry out native vegetation works than other industry groups.	$\chi 2$ (n=122)	7.62	1	0.05

Irrigators were asked about their willingness (from 0 (low) to 5 (high)) to manage and protect environmental features, with 65% indicating they had a high willingness in 2019/20. This was slightly less than in 2015/16 (72%). Conversely, there was an increase in those with a low willingness to manage and protect environmental features between 2015/16 and 2019/20 from 2% to 6.5% (Table 39). No statistical relationship was observed between '*willingness to manage and protect environmental features*' and '*industry group*' (Table 40).

Table 39: Willingness to manage and protect environmental features on-farm (%)

Industry	No.	Low willingness (0,1)	Medium willingness (2,3)	High willingness (4,5)
Dairy	n=27	3.7	18.5	77.8
Cropping	n=48	2.1	25.0	72.9
Horticulture (orchard)	n=11	9.1	45.5	45.5
Grazing	n=38	13.2	34.2	52.6
All irrigators (2019/20)	**n=124**	**6.5**	**28.2**	**65.3**
All irrigators (2015/16)	**n=367**	**1.9**	**26.3**	**71.8**

Table 40: Chi-square test result showing no association between 'willingness to manage and protection environmental features' and 'industry group'.

Result	Test	Test value	Degree of freedom	Statistical significance
There is no association between '*willingness to manage and protect environmental features*' and '*industry group*'	$\chi 2$ (n=124)	9.89	6	0.13

3.7.3. Salinity management

Irrigators were asked about their willingness to manage salinity issues. In 2019/20, 66% of irrigators indicated they have a high willingness to manage salinity issues, compared to 87% in 2015/16. Dairy had the highest willingness to manage salinity with 75%. Those with a low willingness to manage salinity has increased since 2015/16 (from 2.5% to 7%) (Table 41).

Table 41: Willingness to manage salinity issues on-farm (%)

Industry	No.	Low willingness (0,1)	Medium willingness (2,3)	High willingness (4,5)
Dairy	n=28	7.1	17.9	75.0
Cropping	n=48	2.1	29.2	68.8
Horticulture (orchard)	n=11	0.0	36.4	63.6
Grazing	n=38	15.8	28.9	55.3
All irrigators (2019/20)	**n=125**	**7.2**	**27.2**	**65.6**
All irrigators (2015/16)	**n=367**	**2.5**	**10.4**	**87.2**

There was no significant association between '*those who plan to carry out salinity works in the next 5 years'* and '*industry group'* (Table 42).

Table 42: Chi-square test result showing no association between 'willingness to manage salinity issues' and 'industry group'.

Result	Test	Test value	Degree of freedom	Statistical significance
There was no significant association between '*willingness to manage salinity issues*' and '*industry group*'**.**	$\chi 2$ (n=125)	8.86	6	0.18

4. Discussion

This section summarises the findings and key inferences of the study.

4.1. Land use (industry) and land cover

This project was based on four main land uses (industries), Dairy, Cropping, Horticulture (orchard) and Grazing. These are the most extensive primary land uses in the GMID, accounting for 94% of the total land use area in the GMID (GB CMA 2021a).

Of the irrigators surveyed, Dairy and Cropping had the largest average property size with 210ha and 188ha respectively, while Grazing and Horticulture (orchard) had the smallest property sizes (60ha and 44ha). Approximately two-thirds of irrigators were growing annual pastures (61.5%), half were growing winter grain/fodder (50%) and approximately one-third growing perennial pasture and Lucerne, noting that multiple responses could be provided. Only 7% reported growing summer grain/fodder which requires access to irrigation water over summer. These land types were similar to that reported in 2015/16, except for winter grain/fodder which increased from 32% to 50% between the 2015/16 and 2019/20 surveys, suggesting differences in Spring and Summer water availability during these irrigation seasons. The majority of cropping land use (78%) were growing winter grain/fodder, while Dairy and Grazing were mainly growing annual pasture (93% and 59% respectively).

4.2. Farm context

In 2019/20 irrigators had been farming an average of 35 years and 83.5% own their properties, which has reduced since 2015/16 (96.5%). However, there has been an increase since 2015/16 in those who own and also lease, manage, or share farm additional properties. For example, in 2015/16, 1.5% of irrigators reported owning and leasing land, compared to 5% in 2019/20. This suggests a changing structure of agricultural enterprises and business risk management, with multiple properties owned.

In 2019/20, 75% of irrigators expected their properties would be irrigated in the next five years. The result suggests as per 2015/16, irrigators have a long-term vision to continue operating their properties and pass the properties to family, despite increasing uncertainty about whether they would continue to irrigate. There was a statistically significant association between those who have been farming for longer and those who would pass their property to family. This suggests those who have been farming for longer have had time to consider succession planning, while those who have been farming for a lesser duration may not have considered succession planning or do not as yet have family to pass the property to. There was no association between succession planning and industry, because there are other social and economic factors that need to be considered for succession planning.

4.3. Irrigation systems

Gravity irrigation channel remains the common irrigation delivery method for Dairy, Cropping and Grazing (>90% of irrigators for each land use), while Horticulture (orchard) are using micro drip and sub-surface irrigation (>90%). There is an increasing use of pipe and riser, centre pivots and micro drip and sub-surface irrigation.

4.4. Modernisation of irrigation infrastructure (supply and on-farm)

The majority (93%) of irrigators are connected to Goulburn-Murray Water modernised supply points, with more farms connected in 2019/20 than in 2015/16 when the modernisation project was underway. Grazing had the least number connected (86%), compared to Dairy, Cropping and Horticulture (orchard) (>90%).

Of the irrigators who had their supply points connected, two-thirds (62%) indicated irrigation management improvements, particularly Dairy (78%) and Cropping (62%) compared to Horticulture (orchard) (58%) and Grazing (50%). The reasons for improvement were not captured in the study, however detailed evaluation of productivity gains for irrigators following on-farm irrigation modernisation in the region (GB CMA 2017), identified productivity benefits (e.g. irrigation efficiency and effectiveness, improved pasture growth, labor efficiencies and equipment savings).

Thirty percent more irrigators have upgraded their on-farm infrastructure in 2019/20 (80%), compared to 2015/16, when only half had upgraded infrastructure. Dairy (92%) and Cropping (88%) had a higher percentage who had completed on-farm irrigation upgrades, compared to Horticulture (orchard) (64%) and Grazing (66%). This may be due to various factors such as the existing suitability of on-farm irrigation infrastructure to meet the properties' irrigation needs. The common on-farm upgrades included laser grading (62%), reuse systems (39%), new irrigation systems such as centre pivots and linear moves, pipe and risers, upgrade of channels and outlets (22%), automation (18%) and installation of irrigation scheduling systems (16%). Data suggests that irrigators who were intending to upgrade their irrigation infrastructure had done so, except for those who had recently purchased new land. We note that there is anecdotal evidence of large farmers/businesses moving to the region, purchasing land and upgrading infrastructure at a large scale, which has not been captured in the 2019/20 results.

Less than half of irrigators who had modernised their on-farm irrigation infrastructure had received funding (government or private) to do so in the last five years, with Dairy (58%) and Cropping (39%) more likely to have received funding compared to Grazing (30%).

4.5. Barriers to changing irrigation practices

Uncertainty of water allocation, lack of financial resources and inadequate water availability remain the top three barriers to upgrading irrigation infrastructure. Concerns from irrigators regarding uncertainty of water allocation and inadequate water availability, were a theme throughout the 2019/20 and 2015/16 surveys, with negative comments such as "a nightmare", "squeezing viability", "a total concern" and that "water is the biggest item facing primary industries". These themes have been evident since the 2004/05 surveys (GMW 2006), however the significant difference is in the increase in the number of irrigators with inadequate water availability and uncertainty of water allocation. Irrigators may be reluctant to invest further in farm upgrades and improved practices due to uncertainty about accessing enough water, at a price they can afford to operate the modernised systems and have a return on investment.

4.6. Water ownership and allocation trading

In 2019/20 53% of irrigators had less than 200ML of HRWS, and therefore nearly 50% more than 200ML. Given this, and that nearly 3% own no water share, it is not surprising that 57% of all irrigators (68% of Dairy) reported that allocation trade forms a part of long-term plan for their business. There was a strong relationship between the size of the irrigated property and ownership of HRWS, where the larger the size of the land, the higher the level of HRWS ownership. More than 42% of irrigators had the amount of water entitlement (HRWS) required to irrigate their properties. This figure reduced since 2015/16 (64%).

In the last decade, more than a third of irrigators decreased their water share, while over half held, and approximately one-sixth increased their water share. While there were interesting differences between industries, there was no statistical significance between industry groups. There was however an association between those who had upgraded their irrigation infrastructure and those who had decreased their water holding, potentially where irrigators were selling water to fund new irrigation systems.

In 2019/20, nearly two thirds of irrigators, mainly Dairy and Horticulture, were trading-in water, compared to 40% (mainly Cropping and Grazing) trading-out water. The average amount of water traded-in was 173ML, with a higher average for Dairy (228ML). The average amount of water traded-out was 400ML, with Cropping trading an average of 562ML, three and a half times higher than any other industry group. Given Dairy has the highest percentage of irrigators who own more than 201ML, this trading-in of water by Dairy, has less to do with the amount of water owned at the start of the season, and more to do with the demand for water to meet critical business needs during the season. The differences in water trading between these industries was statistically significant, with Dairy and Horticulture more likely to trade-in water.

Nearly two-thirds of irrigators had a 'large' to 'some' reliance on allocation trade to manage in the 2019/20 irrigation season, similar to 2015/16. It is noted that both seasons were dry across the southern connected Murray Darling Basin in terms of stream flows and storage volumes. Allocated water volumes were low, and prices were high for the majority of the irrigation season. Consequently, half of Dairy irrigators reported a negative impact on ability to make a profit. Dairy (46%), closely followed by Cropping and Horticulture (44% and 42%), with allocation trade affecting ability to plan and implement a water budget. However, 40% of irrigators indicated no or little reliance, with no statistical association between industries; while for over two-thirds of irrigators allocation trade was having a positive impact on ability to make a profit (highest with Cropping, potentially due to their high net trading (out) of water).

An increased reliance on allocation trade and greater exposure for irrigators to the temporary market, impacts on irrigators ability to meet the market price and remain competitive. Irrigators were highly sensitive to temporary water price with 77% of all irrigators indicating water price greater than $250/ML was not viable for their business. However, there were more irrigators in 2019/20 who were prepared to pay more than $250/ML compared to 2015/16, suggesting an adaptation of irrigation business models to match market demands for water, and utilising tools such as changing land cover, buying in of feed as an alternative, and use of tools such as carryover.

The mean price of water was significantly different between Horticulture (orchard) and other industry groups. The mean price above which temporary water was unviable for Horticulture (orchard) was $500/ML compared to Dairy ($219/ML), Cropping ($184/ML) and Grazing ($211/ML). The median number for Horticulture (orchard) was $500/ML, significantly higher than other land uses. The maximum price for Grazing was $1000/ML, compared to $400/ML for Dairy. As would be expected in a highly competitive market, for over 70% of irrigators price of allocation water affected their water purchase and selling decisions, highest amongst Cropping, Horticulture (orchard) and Dairy.

4.7. Carryover water

More than two-thirds of irrigators use carryover as a tool to manage their irrigation water. The main reasons for using carrying over included, security for the next season such as growing winter/spring crops; unused allocation; early irrigation and cost of temporary water; and to maximise farm business income. The average percentage of water entitlement irrigators plan to carryover was 34.5% and was similar amongst industry groups (between 30-39%) indicating all industries plan to use carryover as a management tool. This is further supported with half of all irrigators indicating it is part of their business plan to use allocation trade. There was an association between those who upgraded irrigation

infrastructure and those who have a long-term plan to use allocation trade. Even in 2019/20 when allocation prices were comparatively high and peaked at $665/ML in zone 1A (Greater Goulburn) (Victorian Water Register, 2021), irrigators elected to carry over one-third of water rather than trade.

4.8. Transition of land use

Evidence shows land use transition in the GMID is occurring rapidly, compared to a decade ago. Therefore the 2019/20 farm irrigation survey added questions relating to land use transition, to ascertain reasons for that transition. A quarter of irrigators were involved in land use transition in the last five years. Common transition included transition from dairy to grazing/or cropping, permanent pasture to annuals, irrigated cropping to dryland cropping and predominantly pasture to dairy barn. The reasons for transition related to issues such as water availability, cost of water, and age and health factors. We could expect transition to be higher, because this does not account for irrigators who have exited the industry and did not want to participate. Reasons given for non-participation included selling, leasing or having a manager on the property, which although not included in the tabulated results, provided further indication that land transition is occurring in the region.

4.9. Farm management practices (natural resource management)

Over 67% of irrigators had a professionally prepared Whole Farm Plan, which was lower than 2015/16 (74%). This is within the error margin figures for both periods and therefore the changes may be in our sample and not in the population. Whole Farm Plans were popular with both Dairy (85%) and Cropping (78%). This correlates with the intensive irrigation requirements and lay-outs required for these land uses, to sustain efficient and effective Dairy and Cropping practices. Irrigators have implemented more than 75% of their Whole Farm Plan, with Dairy leading with 78% completion.

Native vegetation works (e.g. tree planting, direct seeding, and protecting remnants including wetlands) were carried out by only one-third of irrigators, mostly by Dairy (57%), and Cropping (36%). Just over a third of irrigators indicated they would be implementing native vegetation works in the next five years. Interestingly, over two-thirds had a high willingness to manage and protect environmental features on-farm, but for potential reasons (e.g. lack of knowledge, funding and time) have not done so.

Over two-thirds of irrigators (66%) indicated a ‘high’ willingness to manage salinity issues on farm, with no correlation with industry type (land use). This decreased from 87% in 2015/16 potentially due to low rainfall in the last five years and perceived risk.

5. Conclusion

Like any surveys, sample size is an important marker of the quality of survey research which can influence the validity and generalisability of study results. Conclusions drawn from larger sample sizes are more accurate than conclusions drawn from smaller samples. The accuracy of data in this report is shown by examining the standard error and/or the confidence intervals for the estimates. Care must be exercised in drawing conclusions about sub-groups of population when the number of units captured by the sample in the subgroup is very small such as Horticulture (orchard).

The land and water use profile in the GMID continues to evolve, more rapidly than pre-2010, in response to factors such as seasonal rainfall, allocation trade, commodity prices, changing irrigator demographics, and changes in water and planning policies. A quarter of irrigators were involved in land use transition in the last five years.

In 2019/20, as per 2015/16, irrigators remain reliant on the allocation trade market to meet their production needs and are exposed to higher water prices compared to a decade ago. Irrigators are highly sensitive to allocation trade water price which impacted ability to make a profit and plan and implement a water budget.

It was unviable for three-quarters of irrigators to participate in the water market once the price reaches $250/ML; and for more than one-third of irrigators allocation trade was having a negative impact on their ability to profit. Horticulture irrigators overall were willing to pay higher prices, compared to other industry groups for temporary water, although we note the smaller sample size and therefore caution must be taken in interpretation of these results.

There was an association between irrigators who trade-in and trade-out water, and industry group. Dairy and Horticulture (orchard) were more likely to trade-in water compared to Cropping and Grazing, who were more likely to trade-out. Overall, allocation trade forms a large part of farm water use for irrigators, with more than 55% of irrigators' long-term business plan to use allocation trade to manage through the season. Irrigators were using carryover as a tool to manage their irrigation needs for the coming season. The use of this tool for business planning was common among all the industry groups.

There was evidence of irrigators upgrading irrigation infrastructure to increase productivity and use water more efficiently. Less than half have undertaken works with government funding, while others have financed works privately. Irrigation infrastructure upgrades included laser grading, reuse system installation, new irrigation systems like pipe and risers, centre pivot and linear moves, and upgrade of channels and outlets. There was an association between those who had upgraded irrigation infrastructure and those who had sold water. There was also an association between those who had upgraded irrigation infrastructure and those with long-term plans to use allocation trade. This supports findings from previous studies which show participation in on-farm programs that fund irrigation upgrades in exchange for water entitlements makes irrigators more reliant on the allocation market.

More than two-thirds of irrigators had developed and were implementing a professionally prepared Whole Farm Plan, which showed willingness to improve water use efficiency. Irrigation systems remained predominantly gravity channel fed, with examples of modernisation to pipe and riser and pressurised systems like centre pivots, linear moves and sub-surface drips. This showed evidence of different industries attempting to increase flexibility to cope with seasonal water market volatility. As noted in 2015/16 (GB CMA 2016) the challenge for industries is to adopt integrated and flexible production systems that are able to adjust from one year to the next, to make best use of the water available, and still remain profitable.

Significant barriers remain for irrigators in upgrading their irrigation infrastructure including uncertainty of water allocation, lack of financial resources and inadequate water availability. These barriers were also reported during 2015/16 study.

Irrigators had been farming on average for more than 35 years and 83.5% own their property; with more than half expecting to pass their property to a family member. The ageing demographic highlights the importance of understanding the barriers to succession planning and encouraging transition of younger generations into irrigated agriculture.

There are indications that irrigators are adopting resilience strategies, as highlighted in the Goulburn Murray Resilience Strategy (Victorian State Government, 2020). The adoption of improved on-farm irrigation systems by 80% of irrigators, indicates that irrigators are trying to increase their water use efficiency to make their enterprise viable. This study showed evidence of irrigators participating in water trading activities for economic benefit. This is an indication of water moving towards high value production during high demand. In 2019/20, water has been traded-in by Dairy and Horticulture (orchard) and traded-out by Cropping and Grazing industries. This showed irrigators are reliant on allocation trade and are starting to see a positive impact of allocation trade on ability to make a profit. In 2015/16, allocation trade had a positive impact for 19.5% of irrigators, compared to 37.5% in 2019/20.

Irrigators were using carryover as a tool to manage their water requirements for the next irrigation season in 2019/20, which could be considered as a resilience strategy to manage early irrigation and cope with the cost of temporary water. A quarter of irrigators were transitioning from one main land use to another, to manage water availability and the cost of water. The challenge for the GMID is understanding the changing land uses and operating environment, so we can continue to remain at the forefront of a competitive and sustainable irrigation region that can withstand volatilities, well into the future. For example, opportunities exist to assist irrigators and industry groups to prepare for and adapt to change, through regional and on-farm infrastructure investments and business planning to enhance decision making. A continuous focus on resilience capacity building by continually engaging with irrigators, remains crucial for improving decision making during future extreme events.

This project provides on-going assessment and reporting on land and water use in the GMID, to inform regional, national and state water policy. Analysis and interpretation of the data collated will continue, providing a valuable and extensive resource to inform future planning and policy across a range of industries in the GMID.

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7. Appendices

Appendix 1 – Stakeholder Reference Group & Technical Working Group

A Stakeholder Reference Group representing each of the participating organisations has provided a collaborative approach to this study; along with a Technical Working Group to provide technical input to this study.

Stakeholder Reference Group	
Organisation	**Representatives**
Goulburn-Murray Water	John Weber, Graeme Hannan, Matthew O'Farrell
Agriculture Victoria	Andy McAllister, Rabi Maskey, Mardi Tress, Terry Batey, Rebecca Pike, Matthew Hawken
DELWP	Bonnie Glaister, Sasha Johnson, Sara Bundze
GB CMA	Carl Walters, Bek Caldwell, Vicki Mackenzie
NC CMA	Mandy Coulson, Rachel Murphy
Murray Dairy	Jenny Wilson
HMC Property Group	Marcus Hann
Fruit Growers (Vic)	Michael Crisera, Mel Floyd
Irrigated Cropping Council	Damian Jones, Charlie Aves

Technical Working Group	
Organisation	**Representatives**
Goulburn-Murray Water	John Weber, Peter King
Agriculture Victoria	Andy McAllister, Rabi Maskey
DELWP	Bonnie Glaister, Sasha Johnson
GB CMA	Carl Walters, Bek Caldwell, Vicki Mackenzie
NC CMA	Mandy Coulson
Murray Dairy	Lachlan Barnes
HMC Property Group	Marcus Hann

Appendix 2 – Farm Irrigation Survey 2019/20

Please answer all questions based on the 2019/20 IRRIGATION SEASON (15th August 2019 to 15th May 2020)

There is an additional page at the end of this survey if more space is needed to answer any of the questions.

The following questions (1 & 2) relate to the land covered by the above Water Use Licence (WUL) Number

1. What is the **business type** you are operating using the above **Water Use Licence (WUL) Number?** (tick all that apply)			
Dairy ☐	Cropping ☐	Horticulture ☐	Grazing ☐

2. In the **2019/20 irrigation season**, what did you grow on the land covered by this **Water Use Licence (WUL) number?**	**Hectares?**	**Tick If double cropped**
Perennial pasture		
Annual pasture (pasture irrigated in spring and/ or autumn)		
Irrigated Lucerne		
Winter grain or fodder crop (e.g. wheat, barley, canola, faba beans, oats)		
Summer grain or fodder crop (e.g. maize, millet, sorghum, soybean)		
Any other irrigated crops or irrigated fallow		
Other irrigated plantings - **please specify**:		
Miscellaneous non-irrigated areas e.g. laneways, buildings, remnants		

The rest of the survey is based on ALL THE IRRIGATED LAND that you have within the GMID

FARM CONTEXT & INTRODUCTION TO PROPERTY & IRRIGATION SYSTEMS	**Write the answer or circle**		
3. How long have you been farming?	Years		
4. Overall do you **own**, **lease**, **manage** **OR** **share-farm** the land? (circle all that applies)			
OWN / LEASE / MANAGE	SHARE-FARM		
5. What is the **total area** of all your properties in the GMID?	Ha		
6. What is the **total irrigatable area** for all of your properties in the GMID?	Ha		
7. Do you expect to pass your properties on to another person in the family?	YES	NO	N/A

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8. What **irrigation methods** do you use on your properties in the GMID?	**Tick all**	**Approximate hectares**
Gravity channel irrigation		
Pipes and Riser		
Travelling irrigators, centre pivots/linear move		
Fixed sprinkler systems with knocker type action		
Furrow Irrigation		
Sub surface drip		
Others (**Please specify**)		

MODERNISATION OF SUPPLY POINT TO YOUR IRRIGATED LAND IN THE GMID	**Write the answer or circle**		
9. Have your irrigation **supply point/s** been **modernised**?	YES	NO	
If yes, following modernisation of your irrigation supply point/s, has your irrigation management improved?	YES	NO	N/A
ON-FARM IRRIGATION PRACTICES IN THE GMID			
10. Have you upgraded your **on-farm** irrigation infrastructure? (please circle timeframe below)	YES	NO	
[0-5 years ago]____ / [6-10 years ago]__ / [>10 years ago]_____	[15+ years ago]_____		
11. If yes, what **irrigation infrastructure upgrades** have you undertaken?	**Tick all that apply**		
New irrigation system e.g. Pipe and riser **Please specify:**			
Re-use system			
Converted to automation			
Soil moisture monitoring (SMM)			
Lasered property			
Irrigation scheduling equipment			
12. If you did make upgrades, did you receive **government (or other) funding** to improve your irrigation system in the last 10 years?	YES	NO	
If yes, please **list the Program**? (if known e.g. Farm Water)			
13. Do you **intend** to change your irrigation infrastructure in the next 5 years?	YES	NO	

If so, please **list changes proposed**; OR if not, please explain why?

14. What are the **barriers** to changing your irrigation management practices?	0 No barrier	1	2	3	4	5 Significant barrier
Inadequate water quality						
Uncertainty of water allocation						
Lack of financial resources						
Lack of time						
Insufficient or inadequate information						
Doubts about likely success						
Age or poor health						
Inadequate water availability						
Connection/Outlet Modernisation						
Other barriers if applicable? (**please specify**)						

ALLOCATION TRADE FOR ALL YOUR IRRIGATED LAND	**Write the answer or circle**	
15. How much water share do you **currently own**? HRWS and (LRWS if known)	HRWS ML_____ LRWS ML_____	
16. Have you **decreased**, **held**, **OR increased** your water holding in the **last 10 years**?		
If possible, please explain **why this has occurred**?		
17. In the **2019/20 irrigation season** were you a **net trader in OR out of irrigation allocation?** (please circle answer and specify volumes below)	Net Trade-in	Net Trade-out
Net Trade-in	ML _____	
Net Trade-out	ML _____	
18. Is it part of your business plan to **carry over water**?	YES	NO
What **% of your total allocation** would you look to carryover annually?	_____% (0-100%)	
Why do you **carryover water**? Please explain		

19. Was it part of your **long-term business plan** to use allocation trade to manage through the irrigation season?	YES	NO
20. During the irrigation season **did price of allocation affect your water purchase** and/or selling decisions?	YES	NO
If possible, please explain (in general) your **decisions around this**?		
21. At what price does irrigation become **unviable** for you? Please explain	$/ML_____	

22. How **reliant** are you on allocation trade to manage through the irrigation season? (e.g. is the entitlement you have enough to cover your production needs?) (mark the box that applies)	0 No reliance	1	2	3	4	5 Large reliance

23. Do you feel that **selling and buying allocation trade water** has? (*mark the box that applies for both questions*)					
A). Affected your ability to **make a profit**	Large negative impact	Slight negative impact	No impact	Slightly positive impact	Large positive impact
B). Affected your ability to **plan and implement a water budget**	Large negative impact	Slight negative impact	No impact	Slightly positive impact	Large positive impact

24. Please respond to these **statements** (*mark the box that applies for both questions*)					
A). I think this property **will be irrigated** in 5 years' time	Strongly disagree	Slightly disagree	Undecided	Slightly agree	Strongly agree
B). I have the **amount of water entitlements** to irrigate my property that I require	Strongly disagree	Slightly disagree	Undecided	Slightly agree	Strongly agree

CHANGING LAND USES / INDUSTRIES FOR ALL YOUR IRRIGATED LAND (Note: there is more room on page 5 if you wish to detail this response)		**Write the answer or circle**	
25. Have you **transitioned** from one main **land use** to another land use/s in the last **5 years**? (e.g. dairy to irrigated cropping)		YES	NO
A). If so, **FROM** what land use/s?	**TO** what land use/s?	N/A (no transition)	

B). If you are able to, please explain **why you transitioned and any issues with the transition**?						
C). Will your transition be **permanent**? (or do you intend to return to the original use? Please explain						
FARM MANAGEMENT PRACTICES				**Write the answer or circle**		
26. Do you have a professionally prepared **Whole Farm Plan** for your irrigated land, and if so, how long ago was it completed? (mark relevant year below)				YES		NO
[0-5 years ago]_____	[6-10 years ago]_____			[>10 years ago]_____		
27. Approximately what **%** of your Whole Farm Plan has been **implemented?** (include multiple answers if you have more than one Whole Farm Plan)				_____% _____% (if more than 1 WFP) _____% (if more than 2 WFP's)		
28. Have you **done any native vegetation works** (e.g. tree planting, direct seeding fencing of trees/remnants, protecting wetlands) in the **last 5 years**?				YES		NO
If so how many hectares?				_____Hectares		
29. Are you planning on doing any **native vegetation works** in **the next 5 years**?				YES		NO
30. Please respond to these statements (*circle the box that applies for both questions*)						
A). How would you rate your **willingness** to manage **salinity** issues on all your land in GMID?	0 (low)	1	2	3	4	5 (high)
B). How would you rate your **willingness** to manage and protect **environmental features** on all your land in the GMID?	0 (low)	1	2	3	4	5 (high)

Additional comments/detail welcome here and over the page if needed (please include the question number so we can relate back to the specific question).

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