COOPERATIVE RESEARCH CENTRE FOR **CATCHMENT HYDROLOGY**

WATER TRADING IN THE GOULBURN-MURRAY IRRIGATION SCHEME

TECHNICAL REPORT
Report 02/9
December 2002

H. A. Wijedasa / H. M. Malano / T. A. McMahon / H. N. Turral / G. S. Smith

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Alankarage, Wijedasa Hewa 1955 -

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ISBN 1 876006 90 0

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333.913099454

Keywords
Irrigation
Rights
Marketing
Water Allocation
Water Use
Land Use
Security
Transferability
Farms and Farming
Costs
Statistical Analysis
Water Resources
Groundwater
Commercial Availability

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Preface

CRC Project 3.1: 'Integration of water balance, climatic and economic models' aims to integrate hydrologic and economic modelling to examine the economic and environmental impacts of water allocation policies. This process comprises the selection and development of integrated modelling tools to support policy and management decision-making processes by water authorities.

CRC for Catchment Hydrology Associate Project 3.6 involves the integration of hydrologic modelling with economic modelling to study the potential impacts on environmental flows arising from temporary and permanent trading in water entitlements in the major Victorian rivers. This present report presents the findings of a survey of temporary and permanent water traders in Victoria designed to ascertain the main drivers of water trading and quantify their relative importance.

The findings of the survey also enabled the quantification of critical economic relations that form part of a comprehensive water demand model designed to complement the existing modelling framework used by Victorian water authorities. The modelling framework can play a vital role in predicting the potential environmental externalities resulting from expanding water markets.

John Tisdell
Program Leader
Sustainable Water Allocation Program

Executive Summary

This document presents the outcomes of the study of permanent and temporary water trading in irrigation areas within the Goulburn-Murray Irrigation Scheme (GMIS). The study is based on a survey conducted on permanent and temporary water traders in the GMIS from March to May 2001 and past water records of the GMIS. The survey results have also been compared to outcomes of studies based on two previous surveys conducted in 1994 and 1996 and an irrigation farm census conducted in 1997.

The survey results show that over 40% of permanent water entitlements have been purchased to satisfy the needs of existing irrigated areas. This percentage has slowly reduced in the last 10 years. Purchase of permanent water entitlements for expansion of farming enterprises accounts for around 50% of total purchases. Purchases for expansion of farming enterprises and non-farming uses has been gradually increasing.

Horticulture and dairy farming account for more than 80% of purchases of permanent water entitlements. The region that comprises Shepparton, Central Goulburn and Rochester irrigation areas, and Campaspe Irrigation District is a major importer of permanent water entitlements. More than 50% of lands in this region are used for high value farming and more than 50% of permanent water entitlement purchases have been made externally. A significant proportion of permanent water entitlement has also been sold to external buyers in the recent past. This is a result of the relaxation in restrictions for transferring permanent water entitlements to outside the GMIS. In this case, water transfer regulations are playing an important role in water trading.

Around 50% of permanent water entitlements have been sold as a result of excess water from sleeper/ dozer licences. The major source of water entitlements traded on the permanent water market for last 10 years is cropping and grazing farming. Cropping and grazing farmers account for 80% of permanent water entitlements sold. Pyramid-Boort, Kerang and Swan Hill areas and private river diverters are the main source of water for the permanent water market in the GMIS.

The majority of trades have taken place within irrigation areas/ districts and the majority of traders surveyed have indicated no explicit preference to purchase internally or externally.

The analysis shows that there exist significant differences between buyers and sellers of permanent water entitlements with regard to the irrigation method, availability of farm dams, problems of marketing products, soil degradation and soil salinity, and area fertilized and grain use as supplementary feeding. Although the differences are not statistically significant, buyers of permanent water entitlements are in a better position than sellers regarding access to groundwater, availability of surface drains, reuse of drainage water, extent of the farm laser graded, problems of market access and problems of high groundwater table.

The survey results suggest that buyers of permanent water entitlements adopt advanced and efficient farming technology. This is consistent with the fact that water has been moving mainly in the direction of high value farming. This is also consistent with outcomes from previous studies conducted in the study area on transfer of permanent water entitlements.

The main alternative available for farmers to restructure their water availability is to change the volume of permanent water entitlement per unit area. This study, as well as previous studies, shows that about 50% of buyers of permanent water entitlements and 40% of sellers trade their permanent water entitlements because of shortage (buyers) or excess (sellers) of water in existing irrigated areas. Consistent stocking rates and the ratio of annual pasture to perennial pasture in dairy farming have also been observed in the study area. Therefore analyses were undertaken in order to find out whether farmers are interested in achieving a particular level of water availability by transferring (buying or selling) water entitlements and changing their permanent water entitlements per unit area.

In this study, the desired water availability of permanent water traders expressed in terms of water entitlement per unit area has been analysed for three farm types: dairy, horticulture, and cropping and grazing. The outcomes of this analysis were compared with desired availability calculated from temporary water trading data.

The analysis shows that permanent water traders desire to achieve a particular level of water availability as a measure of water security. This value is unique for each farm type. The mean values of desired water availability are 5.70 ML/ha (based only on perennial pasture) for dairy, 3.10 ML/ha for horticulture and 1.91 ML/ha for cropping and grazing farm types.

The desired water availability of buyers and sellers of permanent water entitlements is sensitive to prices of farm products. The analysis shows a reduction in level of water availability desired by farmers when farm product prices reduce. Compared with cropping and grazing, the desired water availability of dairy and horticulture farmers is more sensitive to price reductions. It also reveals that sellers of permanent water entitlement would have opted for higher water availability by retaining their water entitlements if prices of farm products had been higher. For example, cropping and grazing sellers would have maintained 1.82 ML/ha instead of 1.47 ML/ha if commodity prices had been 10% higher.

It is noted from the survey that long-term structural changes in water use dominated permanent water transfers, but seasonal factors dominated temporary water transfers. Seasonal shortage is the major reason for purchases of water on the temporary water market while there are farmers who buy water due to cheaper water prices at end of the water-year mainly to irrigate annual pasture. More than 75% of water buyers on the temporary water market are dairy farmers. On the other hand, about two-thirds of water sellers are cropping and grazing farmers. It seems that farmers are selling excess water attached to their water entitlements on the temporary water market.

Two-thirds of temporary water transfers took place within irrigation areas/ districts. In this regard, more than 90% of respondents had no particular preference to trade internally or externally. Less than 10% of respondents were unable to trade the quantities they wanted due to reasons other than high or low prices. The study shows that water buyers on the temporary water market cannot be distinguished from sellers as being more efficient users of advanced farm technology.

Analysis of water prices on the temporary water market shows that prices are variable at the beginning of the water-year, stable in the middle of the year, and declining towards the end of the water-year. However, farmers' memory of water price variation at the end of previous water-years could have impacted on the low price variation at beginning and mid of the 2000/ 01 water-year in addition to rainfall and allocation changes.

A farmer's decision to purchase water on the temporary market is sensitive to water prices as well as to farm product prices. The maximum price that buyers are prepared to pay on the temporary water market depends on water uses. Survey responses show that the median of the maximum water price that dairy farmers are prepared to pay during the last quarter of the water-year is 41 $/ML and 32 $/ML for regular irrigation and for irrigating annual pasture respectively. The respective price that cropping and grazing farmers are prepared to pay to irrigate annual pasture is 21 $/ML.

Finally, the study concludes that the factors that drive the transfer of permanent water entitlements and temporary water trading are different. The aspiration of long-term farm structural changes is an important driver for purchase of water entitlements. The desire for achieving a particular level of water availability is part of such changes. In contrast, seasonal water excesses and shortages are the main drivers for temporary water trading.

List of Tables

List of Figures

Part I - General

1. Introduction

This document analyses permanent and temporary water trading in water use areas in the Goulburn-Murray Irrigation Scheme (GMIS). The scheme consists of northern flowing river catchments stretching from the Upper Murray River to the Loddon River. Figure 1 shows the scheme area.

The analysis is based on a survey conducted on permanent, and temporary water traders in the GMIS from March to May 2001. Analyses have also been extended to past water trading records of rural water authority, Goulburn-Murray Water (G-MW).

The analysis in this study includes three main areas:

- water buyers against sellers,
- geographical distribution of trading, and
- trading by farm type and water use.

Farm enterprises/water uses considered in the study are dairy, horticulture (annual and perennial), cropping, grazing, cropping and grazing, and other uses. The survey revealed that hardly any difference exists between cropping, grazing, and cropping and grazing in terms of land use, water use and availability of water entitlement per unit area. This is a situation particular to Victoria (Douglass *et al*., 1998). Therefore all three categories are denoted as Cropping and Grazing in this analysis.

Part I of the document deals with the survey design, survey areas, responses to the survey, and description of statistical analysis procedure. In Parts II and III, issues applicable to permanent, and temporary water trading respectively are analysed. Part IV is dedicated to the analysis of water security aspirations of irrigators. Conclusions of outcomes of the analyses are presented in Part V.

2. Survey Design and Survey Areas

2.1 Survey Design

The purpose of the survey was to collect data to identify drivers of water trading, trends in water trading, factors that are normally associated with water trading, and security aspirations of irrigators. Because water users use permanent and temporary water trading for different purposes, two participant groups were selected from these two types of traders. The questionnaire design reflects these differences. There were similar questions for both groups for comparative purposes as shown in the questionnaire contained in Appendix 2.

Permanent Water Trading

All permanent water traders in the GMIS in 1999/2000 water-year were surveyed. A water year is defined as the period from 1st July to 30th June. In all, there were 480 transactions, however due to multiple trading by some participants, the numbers of participants was limited to 315.

Temporary Water Trading

In the GMIS, there are large numbers of temporary water transactions in each water-year. For instance, in 1999/2000 water-year, there was a total of 7216 transactions in the scheme. Therefore it was decided to randomly select water traders who participated in temporary water trading in 1999/2000 water-year from two irrigation zones: Rochester (RO) and Swan Hill (SH) which have shown extensive temporary water trading in the last five-year period (G-MW, 1995-2000). Rochester is a net importer of water whereas Swan Hill is a net exporter of water. Dairy farming, which consumes comparatively more water, is the predominant type of farm enterprise in Rochester while cropping and grazing is the main farm type in Swan Hill. There were 703 traders who conducted 1189 transactions in 1999/2000 water-year in these two zones. The study included 75 buyers and 75 sellers randomly selected from Rochester; and 75 randomly selected sellers and all 58 buyers from Swan Hill. Thus the total number of participants to the survey was 283.

2.2 Survey Areas

For the purpose of this study, the study area was divided into 12 irrigation zones as shown in Table 1. These divisions are in line with irrigation area/ district boundaries defined by the Water Authority on geographical and water service boundaries (see Figure 1).

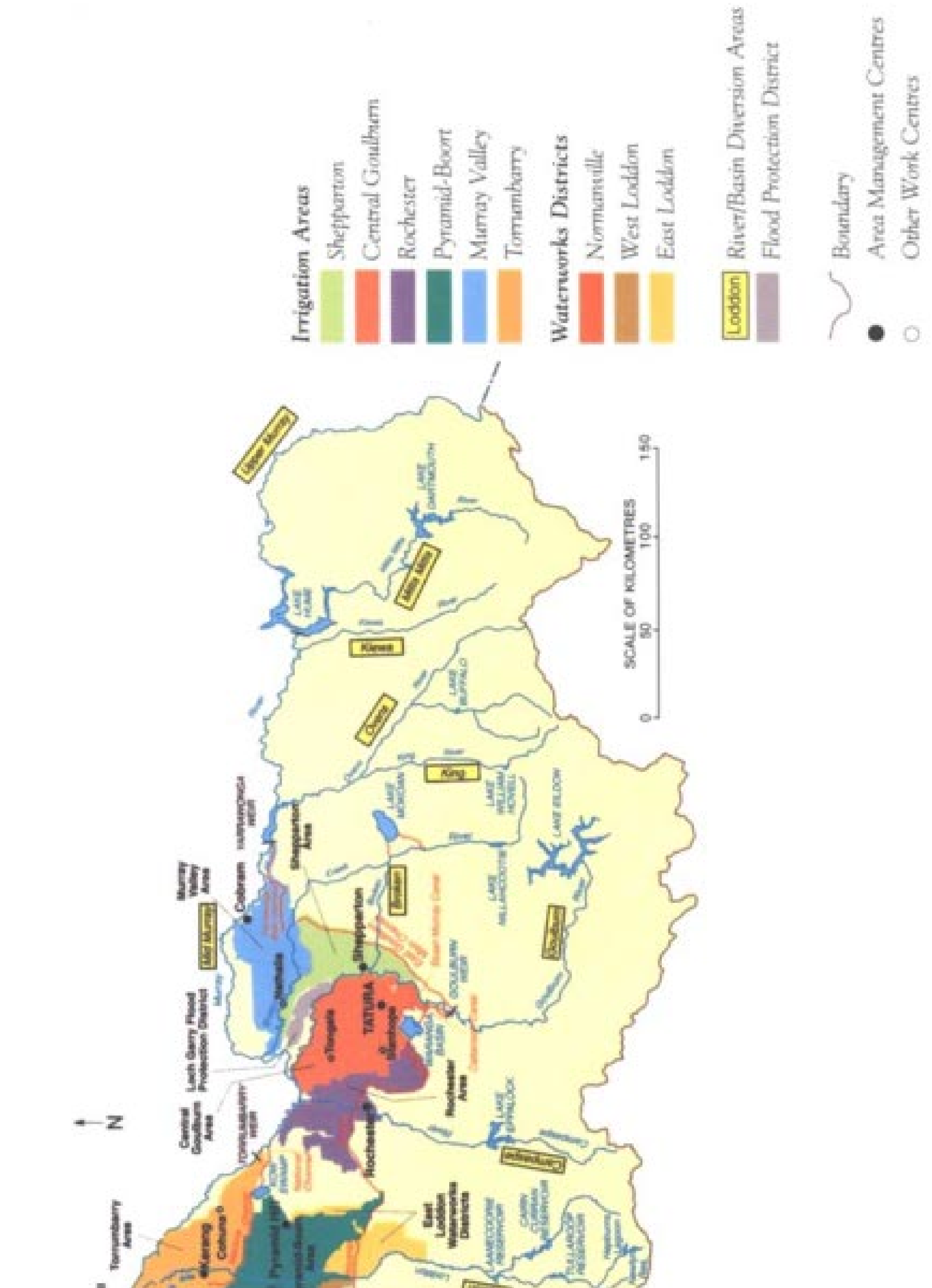

Figure 1. Goulburn- Murray Irrigation Scheme (Adapted from G-MW (1999b))

For the analysis of spatial distribution of permanent water transfers, the irrigation zones have been categorised into seven regions, by amalgamating several zones into one region on the basis of land use and the past trends of water transfers.

This amalgamation is also important for statistical testing because the numbers of responses from some zones were insufficient to satisfy requirements of the statistical tests. The grouping of zones into regions is as follows:

- Region 1: Shepparton, Central Goulburn, Rochester, and Campaspe,
- Region 2: Pyramid Hill and Boort,
- Region 3: Murray Valley,
- Region 4: Torrumbarry (Swan Hill, Kerang and Cohuna),
- Region 5: Regulated rivers,
- Region 6: Unregulated rivers, and
- Region 7: Others (Nyah, Tresco and other small pumping districts).

Region 7 consists of small pumping districts and as there are insufficient water trades to carry out a statistical analysis, this region has been excluded from the statistical analysis.

The survey of temporary water traders was confined to two zones: Rochester and Swan Hill. As a result, responses from these zones were analysed individually.

Table 1. Definition of Irrigation Zones

Irrigation zone	**Notation**	**Irrigation areas (as defined by the Water Authority) come under the zone**
Shepparton	(SP)	Shepparton Irrigation Area
Central Goulburn	(CG)	Central Goulburn (Rodney, Tongala and Deakin) Irrigation Area
Rochester	(RO)	Rochester Irrigation Area
Pyramid Hill	(PH)	Pyramid Hill Irrigation Area
Boort	(BO)	Boort Irrigation Area, and Normanville and west Loddon Water Works District
Campaspe	(CD)	Campaspe Irrigation District
Murray Valley	(MV)	Murray Valley Irrigation Area
Swan Hill	(SH)	Swan Hill Irrigation Area
Kerang and Cohuna	(KECO)	Kerang and Cohuna Irrigation Areas
Regulated Rivers	(RR)	Regulated private diverters from the Upper Murray River to the Loddon River
Unregulated rivers	(UR)	Unregulated private diverters from the Upper Murray River to the Loddon River
Nyah, Tresco and Woorinen	(NTW)	Nyah, Tresco and Woorinen pumping districts

3. Responses Received and Adequacy of the Survey

There were 97 (32% of questionnaires received by participants) and 103 (36%) valid responses from permanent and temporary water traders respectively. The distribution of responses is shown in Tables 2 and 3.

The responses received must constitute a representative sample of the population to ensure the validity of the results. The statistical analysis of samples to determine if they are the true estimates of the population parameters is shown in Appendices 3 and 4 for permanent and temporary water trading respectively. The analysis shows that the samples are reliable estimates of the parameters concerned and also satisfy the homogeneity criteria.

Table 2. Distribution of Valid Responses of the Survey of Permanent water Traders

Basis of the distribution		Number of valid responses
Buyers/ Sellers	Buyers	48
	Sellers	49
Region	1: Shepparton, Central Goulburn, Rochester and Campaspe district	21
	2: Pyramid Hill and Boort	13
	3: Murray Valley	11
	4: Swan Hill, Kerang and Cohuna	15
	5: Regulated rivers	22
	6: Unregulated rivers	15
Farm type/water use	Dairy	22
	Horticulture	25
	Cropping and grazing	37
	Others	8
	Not stated	5
Total		97

Table 3. Distribution of Valid Survey Responses of Temporary Water Traders

Basis of the distribution		Number of valid responses
Buyers/ Sellers	Buyers	49
	Sellers	54
Zones	Rochester	56
	Swan Hill	47
Farm type/water use	Dairy	42
	Horticulture	14
	Cropping and grazing	45
	Others	2
All		103

4. Statistical Analysis

Several statistical tests that were used in the analysis and their purposes are tabulated in Table 4. The significance of statistical tests was compared at 0.05 significance level (95% confidence interval) unless otherwise stated. Thus the null hypothesis that two or more groups are different for a particular variable is true if the significance value is 0.05 or less. All the significance values are based on two-tailed distributions unless otherwise stated.

Most of the factors that were considered in this analysis have been measured on an ordinal scale. Participants were asked to rate their position on these factors on a 1-5 scale (1 denotes lowest level of agreement and 5 denotes highest level of agreement).

Statisticians have differing views on the application of parametric tests (t-test, regression analysis, ANOVA), and some non-parametric tests (Shapiro-Wilk test, Mann- Whitney 'U' test, Kolmogorov- Smirnov test) for data measured on an ordinal scale. Some researchers agree that these tests can be applied to measured data not only on interval or ratio scales but also on an ordinal scale (Anderson, 1961; Lord, 1953; Tabachnick and Fidell, 1996). However, Siegel (1956) disagrees in that these tests can be applied only to data measured on interval or ratio scales. He argues that data measured on an ordinal scale are not truly numerical data, and therefore applications of numerical operations to such data are not meaningful.

Anderson (1961) disagrees with Siegel (1956) and claims that the use of statistical tests does not rely on a measurement scale but depends solely on statistical considerations. Lord (1953) agrees with the application of both types of statistical tests on measured data on an ordinal scale, and argues that the validity of statistical test results does not depend on the type of measuring scale used for data collection.

Table 4. Statistical Tests Used in the Analyses

Test	**Notation in the analyses**	**Purpose**
Mann-Whitney 'U'	MWU	This non-parametric test is used to determine whether two groups have come from populations with the same mean. It is used when parametric tests are not suitable.
2-sample Kolmogorov-Smirnov	2- KS	This non-parametric test is used to determine whether two groups have come from populations with the same statistical distribution.
Chi-squared		Test homogeneity of a categorical variable.
Kruskal- Wallis	KW	This non-parametric test is used to determine whether two or more groups have come from populations with the same mean. This is applied when parametric tests are not suitable.
Fisher's exact		Tests homogeneity of data in a 2x2 matrix, and is applied when conditions for the application of the Chi-squared test are not met.
1-sample 't'	1- t	Tests whether mean of a group is significantly different from a particular value.
2-sample 't'	2- t	Tests whether means from two groups are significantly different.
F	F	Tests equality of variance when samples are normally distributed.
Levene		Tests equality of variance, and apply when 'F' test cannot be applied due to non-normality.
Shapiro-Wilk	SW	Tests normality when sample size is not large (<50) enough for Kolmogorov-Smirnov test.

Although there is equivocation on this matter, the application of both types of tests can be justified if the scale contains many ratings and if the variable can be defined in quantitative terms. The scale of 1 to 5 adopted in this study can be considered as a surrogate for quantitative values of a variable because participants were asked to rate their answers from 1 (lowest) to 5 (highest) without their selection being influenced in any particular way. Furthermore, the adopted scale is considered appropriate since it was selected for comparative rather than predictive purpose of the variables involved.

In this study, both parametric and non-parametric tests were applied to ordinal data. However, statistical inferences were made only from non-parametric test results to ensure consistency. Parametric test results were only used to compare with results from non-parametric tests. Data measured on interval and ratio scales were always analysed using parametric tests except in those cases where insufficient number of observations ($n<20$) were available.

There were two surveys for permanent water trading conducted in the study area for the periods 1991-94 and 1994-96, covering several issues included in this survey (Bjornlund and McKay, 1995; Bjornlund, 2000). Also there was an irrigation farm census conducted for the study area in 1997 (Douglass *et al*., 1998). Results from this study have been compared with these previous studies in order to generalize the results.

Part II - Permanent Water Trading

This section analyses the responses received from permanent water traders, and past permanent water trading records of the rural water authority. Wherever possible, results of the analysis are also compared with findings of previous studies carried out in the study area by Bjornlund (2000) and Douglass *et al*. (1998). This section also includes the following analysis:

- Spatial distribution of permanent water trading,
- Drivers of permanent water trading, and
- Analysis of factors associated with trading of permanent water entitlements.

5. Spatial Distribution of Permanent Water Trading

5.1 General

Spatial trends of permanent water trading between regions were analysed from two sources of data: survey responses and past water records of the water authority. Spatial analysis of permanent water trading, based on water records of the water authority, is important to understand the trends in water trading during past several years in the study area.

In the analysis of past data, meaningful comparisons with the period before 1994 are not possible due to zonal limitations imposed on permanent water trading. Therefore the analysis has been limited to the period between the 1994/95 water-year and 1999/2000 water-year.

There are similarities in past permanent water trading trends in all zones (SP, CG, RO and CD) attached to Region 1 (G-MW, 1995-2000). These are net water importing zones with more than 50% of the land area allocated to high value farming (Douglass *et al*., 1998). However, SP recorded a net export of water for the period 1994/95 to 1999/2000. This is mainly due to large water availability (water entitlements per unit area) in the zone. Region 2 (zones PH and BO) is a net water exporter. In this region, more than 80% of land area is under cropping and grazing. Water supplies to Regions 3 (MV) and 4 (zones KECO and SH) are mainly from the Murray River system. Water users in these regions have experienced higher water allocations in the recent past compared to other users supplied from Goulburn, Broken, Campaspe and Loddon river systems in the study area. The zones under Region 4 are geographically together and are net exporters of water. Around 60% of land areas in Region 4 are under cropping and grazing.

Private diverters from regulated and unregulated rivers hold annual and 15-year diversion licences. More than 70% of land areas under private diversion are cropped and grazed. Nyah, Tresco and Woorinen are small pumping districts with horticultural farming as the predominant farm type.

Table 5 shows the contribution of outside sources (basically from other zones) to permanent water trading. A clear trend in water movement emerges from these figures. Zones such as SP, CG, RO and CD depend on external purchases for more than 50% of the total purchases. Zones that obtain less than 50% of their water purchases externally are observed as net water exporting areas.

Similarities in past permanent water trading trends and crop culture of irrigation zones as explained above have also been taken into account in amalgamating several zones to a region.

5.2 Permanent Trading Rules

Trading rules are enforced in the study area for permanent water transfers. Geographical location, ability to physically transfer water, availability of channel capacity, impact on environmental flows and lack of knowledge of impacts of transfers are major issues considered in defining permanent trading rules (Earl and Turner, 2000).

In general, up to of 2% of total water entitlements in the zone is allowed for permanent water transfers in each year. Water transfers between zones depend on the capacity of the water conveyance system that supplies each zone. Table 6 shows the water supply systems and zones attached to them in the study area. Private diverters listed in Table 6 include diverters on both regulated and unregulated streams. The following permanent water trading rules apply to water supply systems and zones attached to them in the study area:

- Water transfers are usually allowed within each water supply system.

Table 5. Comparison of Internal and External Water Purchasing in Zones from July 1994 to June

Zone	**Permanent water entitlements purchased internally (%)**	**Permanent water entitlements purchased externally (%)**
Shepparton	33	67
Central Goulburn	26	74
Rochester	22	78
Campaspe district	24	76
Pyramid - Boort (Region 2)	92	8
Murray Valley	79	21
Torrumbarry (Region 4)	91	9
River private diverters (Regions 5 and 6)	83	17
Others (Region 7)	13	87

(Source: G-MW annual reports from 1994/95 to 1997/98)

Table 6. Water Supply Systems and Zones Attached to them

Water supply system	**Zones attached**
Greater Goulburn	SP, CG, RO, PH, BO and upper Goulburn private diverters
Broken	Private diverters in the Broken River
Lower Goulburn	Lower Goulburn private diverters
Campaspe	CD and Campaspe private diverters
Loddon	Private diverters in the Loddon River
Murray - Hume to Barmah	MV, and private diverters of the Murray River upstream of Barmah and Mitta Mitta River
Murray - Downstream of Barmah	SH, KECO, private diverters of the Murray River downstream of Barmah and pumping districts of Region 7
Ovens and King	Private diverters of Ovens and King Rivers
Kiewa	Private diverters of the Kiewa River

- Transfers from the Goulburn system to the Murray system are allowed. However, transfers from the Murray system to the Goulburn system are allowed on substitution[1].
- Water transfers in the downstream direction of the Waranga Western Channel (main supply route for zones CG, RO, PH and BO) are allowed on substitution. Transfers in the upstream direction are encouraged.
- Transfers from the Campaspe system to the Goulburn systems are allowed. Transfers from Goulburn to Campaspe system are allowed on substitution.

5.3 Permanent Water Trading by Regions

The spatial distribution of water transfers is analysed with respect to the regions defined in Section 2. Quantities of water purchased and sold since the inception of permanent water trading to the end of 1999/2000 water-year are shown in Figure 2. Similar trends can be observed if the distribution of number of buyers and sellers for the whole population of water traders during the 1999/2000 water-year, instead of quantity, is considered in Figure 2.

Permanent water transfers in the study area commenced in January 1992. Figure 2 must be interpreted within the following restrictions to trading that applied in the study area:

- As described earlier specific water trading rules and boundaries are applicable to several zones and regions.
- Water transfers were not approved in region 3 (Murray Valley) until 1994. In 1994, internal transfers were allowed and inter-zonal transfers have been allowed since 1995.
- Originally, no water transfers were allowed from region 4 to region 1. This has been relaxed, and transfers subjected to capacity constraints are allowed to Shepparton and Central Goulburn.
- Before 1994, transfers were not allowed between private diverters in regions 5 and 6 and other zones.

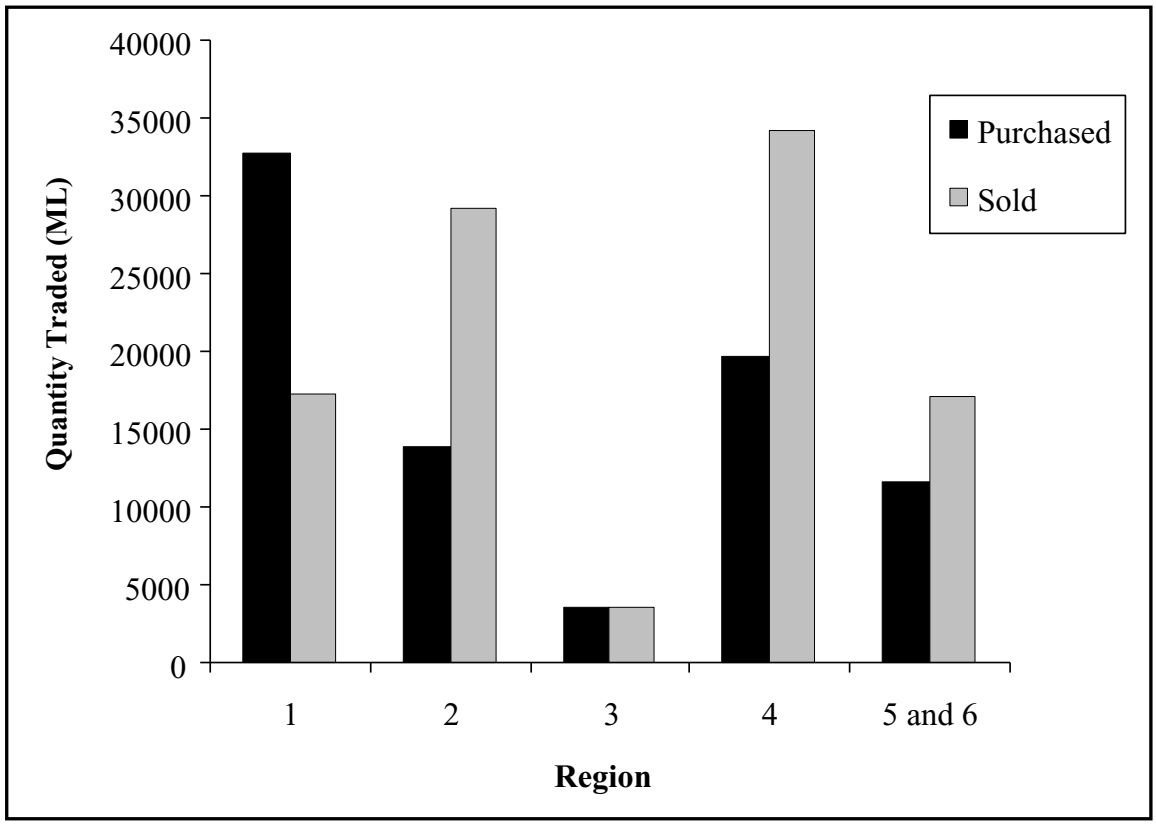

Figure 2. Distribution by Regions of Water Entitlements Purchased and Sold from 1992 to 2000

(Source: Annual reports of Rural Water Commission of Victoria from 1991/92 to 1993/94, and G-MW from 1994/95 to 1997/98)

[1] To allow transfer of a particular volume of water entitlements from Zone A to Zone B, requires the same volume to be transferred from Zone B to Zone A.

Regions 1 and 7 are net water importers in general while regions 2, 4, 5 and 6 are major exporters. However, it is interesting to note that except for region 1, negative net transfers of more than 50 ML for all regions occurred in the 1999/2000 water-year. The recent trend of transferring permanent water entitlements beyond the boundary of the study area such as Sunraysia and Mallee regions has contributed to this situation.

Despite region 1 overall having a positive net water transfer, Shepparton is a net exporting zone. The large water availability in Shepparton has contributed to this situation (Douglass *et al*., 1998). The same reason applies to the higher percentage of sales in regions 5 and 6 (private diverters in rivers).

6. Drivers of Permanent Water Trading

6.1 Purchasing of Water Entitlements

Participants in the survey, who were water buyers, were requested to identify one or more reasons out of the following as their reasons for buying water entitlements:

1 - increase in application of water for existing irrigated area,

2 - secure existing crops from possible drought,

3 - increase in irrigated area of existing crops,

4 - starting new irrigated crops,

5 - domestic, industry, and non-irrigated farming uses, and

6 - others.

Figure 3 shows the distribution of percentage of buyers and quantities of water bought against the reasons for purchasing.

The six reasons for buying water can be grouped into three main categories: water needs for existing irrigated areas (security against droughts, increased application), expansions (increase of existing areas or new farming) and others. It can be observed in Figure 3 that around 50% of farmers buy water entitlements to meet requirements of their existing irrigated areas while 30% of purchases are for expansions. The percentage under each category has changed little since 1994. A mail survey conducted for water traders during 1991-1994 in the study area, showed that these figures were 52% and 40% respectively (Bjornlund and McKay, 1995).

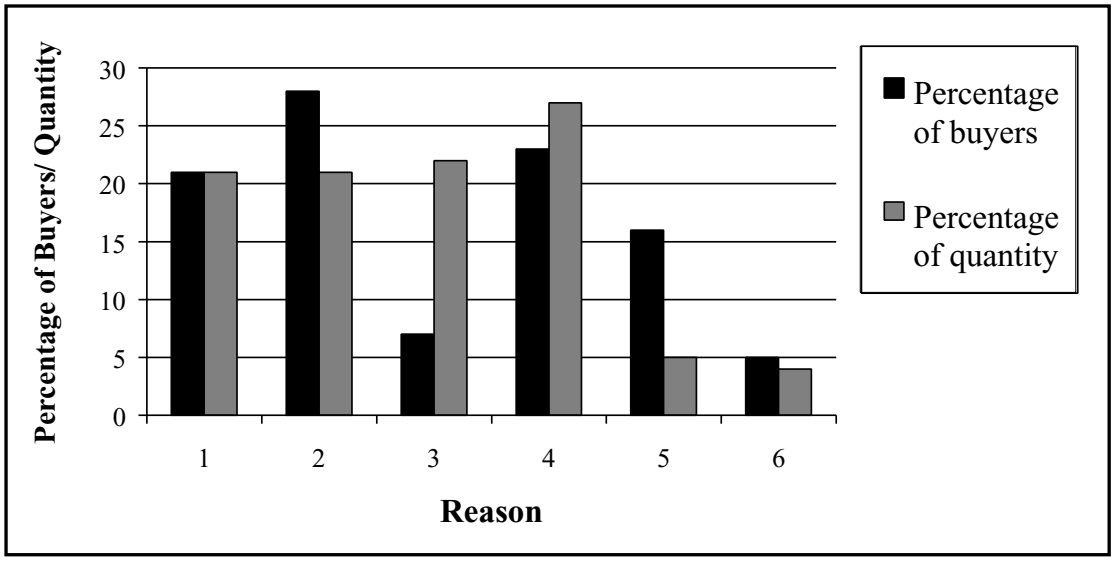

Figure 3. Reasons for Purchasing Water Entitlements

Spatial Distribution

The reasons for purchasing water entitlements in different water trading regions are shown in Table 7.

Fifty percent or more of water purchases both in number and quantity in regions 1, 2, 3, and 4 have been directed to existing irrigated areas. Water purchases in regions 5 and 6 (private diverters) show a more even distribution between existing and new expansion areas.

Distribution on Farm Types

The reasons given by respondents for buying water entitlements in the 1999/2000 water-year for different farm types are shown in Table 8. Farm expansions appear to be confined to dairy and horticultural farm enterprises. A different trend emerges if quantities of water transfers are compared. Large quantities of water purchased by few farmers for expansion have contributed higher percentages for expansions on a quantity basis. Cropping and grazing farmers purchase water entitlements almost exclusively for existing irrigated areas.

Table 7. Reasons for Purchasing Water Entitlements - Based on Water Trading Regions

Region	Percentage of respondents			Percentage of quantity purchased		
	Needs in existing irrigated area	Expansions	Other reasons	Needs in existing irrigated area	Expansions	Other reasons
1	75	8	17	62	25	13
2	50	50	0	50	50	0
3	75	25	0	97	3	0
4	100	0	0	100	0	0
5	21	37	42	28	57	15
6	37	46	17	30	69	1
All	49	30	21	42	49	9

Table 8. Reasons for Purchasing Water Entitlements according to Farm Types

Farm type	Percentage of respondents			Percentage of quantity purchased		
	Needs in existing irrigated area	Expansions	Other reasons	Needs in existing irrigated area	Expansions	Other reasons
Dairy	83	17	0	41	59	0
Horticulture	47	53	7	54	46	0
Cropping and grazing	100	0	0	100	0	0
Other uses	0	14	86	0	36	64
All	49	30	21	42	49	9

In comparing the results in Table 8 with the findings of Bjornlund (2000), the following observations can be made:

- Horticultural and dairy farms account for more than 80% of water purchases. The two main reasons are needs in existing areas and expansions. Water purchases for dairy farming have reduced from 79% in 1991-94 to 69% in 1994-96 to 47% in 1999-2000.
- Water purchases for dairy: 58% went to existing areas in 1994-96 and 41% in 1999-2000. Similar figures for expansions are 42% and 59% respectively. In general, the demand from existing areas of dairy farming has been reduced. This may be due to the achievement of a desired level of water availability by some farmers. By contrast, the amount of water purchases for expansions has remained unchanged.
- Purchases of water entitlements for horticultural farming have increased from 6% in 1991-94 to 35% in 1999-2000. Needs of existing irrigated areas and expansions account for 54% and 46% respectively.
- Purchases of water entitlements for cropping and grazing farming decreased from 15% in 1991 to 3% in 2000. Water needs of existing areas are the sole purpose for purchases in 2000.
- Purchases of water entitlements for non-irrigation uses (industries, as investments for future etc.) have increased from 0% in 1991 to 15% in 2000.

It seems that the importance of purchasing water entitlements for dairy farming has gradually reduced because (i) a reduction in the need to acquire water entitlements for existing irrigated areas, and (ii) expansions of horticultural farming and non-irrigation water uses.

6.2 Sale of Water Entitlements

Sellers of water entitlements were asked to identify which of the following seven reasons applied to them:

1 - more water than required,

2 - reduction of irrigated area,

3 - stopping irrigated farming,

4 - retiring from irrigated farming,

5 - Interest of doing other business,

6 - financial requirements for other purposes, and

7 - others

Figure 4 shows the distribution of percentage of sellers and quantities of water sold against the reasons for selling. Among these, reason 1 does not entail a reduction of the existing irrigated area while reasons 2, 3, 4 and 5 contribute to a reduction in the existing irrigated area. Reason 6 may or may not be linked to a reduction in the existing irrigated area. Including reason 6, more than 40% of sellers who responded to the survey sold water entitlements due to excess water availability. Around 50% of sellers reduced their irrigated area as a result of selling water entitlements. In regard to the quantities sold, 37% of water entitlements are sold due to excess water while 50% due to reductions in irrigated areas.

- ❖ Around 50% of farmers buy water entitlements to meet the requirement of their existing irrigated areas while 30% of purchases are for expansions.
- ❖ Horticultural and dairy farms account for more than 80% of water purchases.
- ❖ Although 50% of water entitlements are still purchased for dairy farming, the percentage of water entitlements purchased for dairy farming has gradually reduced from 1991 to 1999 while percentages for horticulture and other uses have increased.

Based on a survey of water users who traded water entitlements in the period 1994-96, Bjornlund (2000) found that around 50% of water sellers were selling sleeper or dozer licences. Survey respondents were asked to indicate the number of seasons in which the water sold had been previously used. As shown in Figure 5, sleeper water entitlements still contribute to about 50% of the transfers while around 50% of sellers still sell their water entitlements due to excess water irrespective of the reason they stated for selling.

Spatial Distribution

Table 9 combines the distribution of number and volumes of sales of water entitlements according to trading zones. Some important observations can be made from Table 9:

- Water entitlement sales are mainly due to reductions of cropping and grazing irrigated areas in region 2; and
- Water sales in unregulated rivers are solely due to excess diversion licences (region 6).

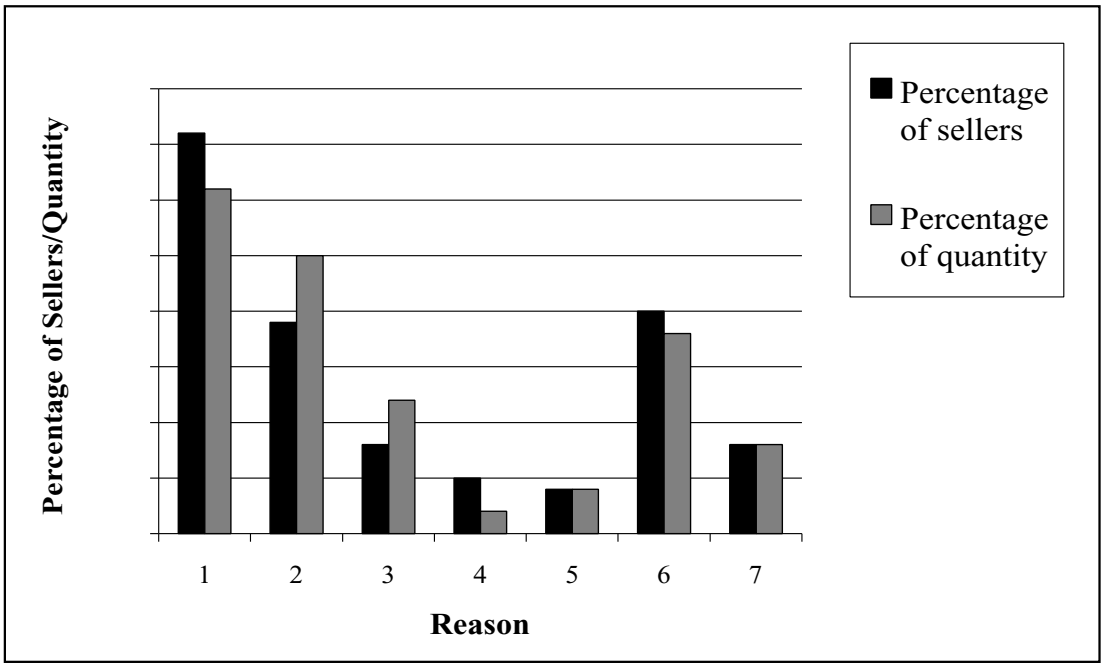

Figure 4. Reasons for Sale of Water Entitlements

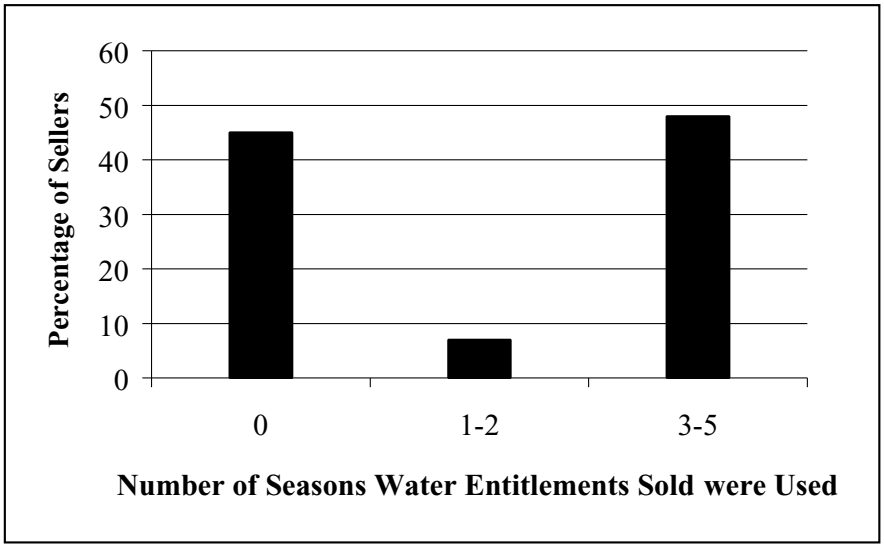

Figure 5. Transfer of Water Entitlements that have not been Activated Before

Distribution on Farm Types

Table 10 shows the distribution of sales of water entitlements based on farm enterprises and reasons for selling.

The following observations can be made from Table 10:

- The major source of water sold in the permanent water market is from cropping and grazing farmers. This figure has remained unchanged for the last 10 years, contributing approximately to 80% of water sales. Considering the water entitlements sold by cropping and grazing farmers, excess water and reduction of areas are responsible for 43% and 57% of sales respectively.
- The small percentage of water entitlements sold from dairy farming (9%) and horticultural farming (8%) has remained largely unchanged. The main reasons for water sales of water entitlements by these farmers are reductions of irrigated area and excess water.

Table 9. Reasons for Water Entitlement Sales- Based on Water Trading Regions

Region	Percentage of respondents			Percentage of quantity sold		
	Excess water	Reductions	Other reasons	Excess water	Reductions	Other reasons
1	33	50	17	29	48	23
2	11	89	0	10	90	0
3	60	20	20	56	11	33
4	64	27	9	64	18	18
5	33	50	17	43	54	3
6	67	0	33	73	0	27
All	43	45	12	37	50	13

Table 10. Reasons for Water Entitlement Sales- Based on Farm Types

Farm type	Percentage of respondents			Percentage of quantity		
	Excess water	Reduction of irrigated areas/uses	Other reasons	Excess water	Reduction of irrigated areas	Other reasons
Dairy	20	80	0	19	81	0
Horticulture	67	33	0	85	15	
Cropping and Grazing	48	52	0	43	57	0
Other uses	0	0	100	0	0	100
All	43	45	12	37	50	13

- ❖ More than 40% of farmers sell water entitlements due to excess water while around 50% of sales are due to reduction of irrigated area.
- ❖ Sleeper or dozer water entitlements contribute to about 50% of sales.
- ❖ Cropping and grazing farms account for 80% of water sales.

7. Analysis of Factors Associated with Trading of Permanent Water Entitlements

7.1 Factors Associated with Permanent Water Entitlement Trading

There are various factors identified as associated with, and having potential influence on permanent water trading. The questionnaires of the survey of water traders contained questions related to factors that have been recognized as influencing water trading (Earl and Turner, 2000; G-MW, 1995-2000). These factors were included to develop an understanding of how water buyers differ from sellers and to determine what factors have contributed to turn water users into water buyers and sellers. The factors listed in Table 11 were included in the survey of permanent traders.

Some of these factors can be considered to have negligible impact on permanent water trading. However, they have been included in the survey for the purpose of comparison with temporary water trading. Although some of these factors have been allocated to a particular category, they may be common also to some other categories. As an example, the use of groundwater depends on the farmer efficiency as well as having a groundwater licence.

In order to understand how water buyers are different from sellers with regard to these factors, statistical analyses of water buyers against sellers were carried out. Differences in a particular factor between water buyers and sellers can actually be due to spatial differences or differences in farm type. As an example,

Table 11. Factors/ Issues Considered in the Analysis

Trading Factors	Category of factor	Type of analysis
Internal against external trading	Restriction/ other	A*, B*, C*
Property area	Other	A, B, C
Water entitlement attached	Other	A, B, C
Irrigation method	Efficiency/ other	A
Dependency on temporary water market	Alternative water use	A, B, C
Availability of off-quota water	Alternative water use	A, B, C
Groundwater use	Alternative water use	A, B, C
Availability of farm dams	Alternative water use	A, B, C
Access to regional drainage	Other	A, B, C
Availability of surface drains	Efficiency	A, B, C
Reuse of drainage water	Efficiency	A, B, C
Whether the farm is laser graded	Efficiency	A, B, C
Problems of market access	Spatial	A, B, C
Problems of marketing products	Other	A, B, C
Problems of soil degradation	Spatial	A, B, C
Problems of soil salinity	Spatial	A, B, C
Problems of high groundwater table	Spatial	A, B, C
Area fertilized and grain use	Efficiency	D* and G*
Stocking rate of dairy farmers	Other	D
Annual-perennial pasture area ratio	Other	D
Allowable application rates	Restriction	A, B, C
Soil type	Spatial	A, B, C
Water price	Other	Buyers
Age of the water user	Other	A

Note: * A - Water entitlement buyers against sellers, B - Spatial distribution, C - Farm types/ water use, D - Dairy farmers, D and G - Dairy and grazing farmers

a high groundwater table is a spatial factor in the study area (Bjornlund, 2000). Therefore, analysis of factors between regions and farm types are useful to understand the real causes of any significant difference between buyers and sellers. Such analyses have been carried out on selected factors using the statistical tests described in Part I.

7.2 Analysis of Factors between Buyers and Sellers, Regions, and Farm Types

Intra-zonal and Inter-zonal Water Trading

Intra-zonal water trading is defined as trading occurring within a single irrigation zone. If the buyer or the seller belongs to different zones then the trading is considered to be inter-zonal.

The majority of water buyers (67%) who responded to the survey have purchased water entitlements within their own zone. On the other hand, 53% of sellers sold water entitlements to buyers within their own zones. There is no significant difference between buyers and sellers regarding the area with which they traded at 0.05 significance level (Pearson Chi-squared test of significance: 0.41 and Fisher's exact test of significance: 0.51).

More than two-thirds of water buyers did not have specific reasons for buying water entitlements from a particular area. Few buyers, only 16%, responded that they have been affected due to water trading boundaries stipulated by the water authority. On the other hand, over 95% of sellers did not have specific reasons to sell to a particular zone.

Property Area and Distribution of Water Entitlements

Property area and water entitlements attached to properties of respondents were obtained from the survey questionnaire. In addition, these data are also available for the population of water traders from water records of G-MW.

The Chi-squared test was applied to the population data by re-coding property area into ranges in order to test the difference in property area between buyers and sellers of water entitlements. There is no significant difference in the size of property area between buyers and sellers (Pearson Chi-squared test of significance = 0.45). Average property areas for buyers and sellers are 101.3 ha and 94.6 ha respectively. Bjornlund (2000) suggested that water was moving to larger farms. He found that the average size of buyer farms and seller farms were 116 ha and 84 ha respectively, although the difference was not statistically significant.

There is a significant difference between buyers and sellers in respect of water entitlements attached to their properties (Pearson Chi-squared test of significance = 0.01). Comparatively buyers have larger water entitlements. The average size of water entitlement for buyers and sellers are 252 ML and 169 ML respectively. Water entitlements attached before the transfer for both buyers and sellers were used in the analysis.

These findings suggest that sellers anticipate higher risk with regard to water availability. This aspect will be analysed in more detail in relation to the desired level of security of water traders in Part IV.

Irrigation Methods

Farmers who participated in the survey were requested to indicate their farm irrigation methods. The methods considered are flood irrigation, furrow, overhead sprinklers, drip, centre pivot, under canopy sprinklers, trickle, and others. The first three methods are considered traditional irrigation methods and less efficient than the others. The outcomes of the survey are shown in Figure 6.

Buyers and sellers of water entitlements are significantly different regarding the type of irrigation method used on their farm (both Pearson Chi-squared and Fisher's exact tests of significance = 0.01). More buyers use efficient irrigation methods relative to sellers. However, as shown in Figure 6, there is above 60% of buyers who use traditional methods due to the widespread use of flood irrigation on dairy pastures.

Alternative Water Uses and Water Storage

The survey questionnaire included a set of questions regarding the following water use and storage aspects:

- dependency on temporary water market,
- availability of off-quota water,
- availability of farm dams to store irrigation water, and
- groundwater use for irrigation.

It is a general belief that water users purchase water on the temporary market to satisfy seasonal shortages and detailed analysis of temporary water trading issues is included in Part III.

Irrigators can access excess water, which is unable to be harvested at reservoirs, available in the water supply system in flood or excess raining periods. This water is known as off-quota water. Availability of off-quota water is a facility that varies from season to season and region to region. There is no impact of the interest and the capability of an irrigator on the availability of off-quota water. Therefore, availability of off-quota water cannot be considered as a measure of farmer efficiency.

The availability of farm dams and the use of groundwater depend primarily on the interest and capability of the farmer although they are subject to licence by the water authority.

The behaviour of permanent traders in relation to their dependency on temporary water market and off-quota water, groundwater use and availability of farm dams was analysed by contrasting buyers against sellers, spatial distribution and farm types. Figure 7 shows the behaviour of buyers and sellers in relation to these facilities.

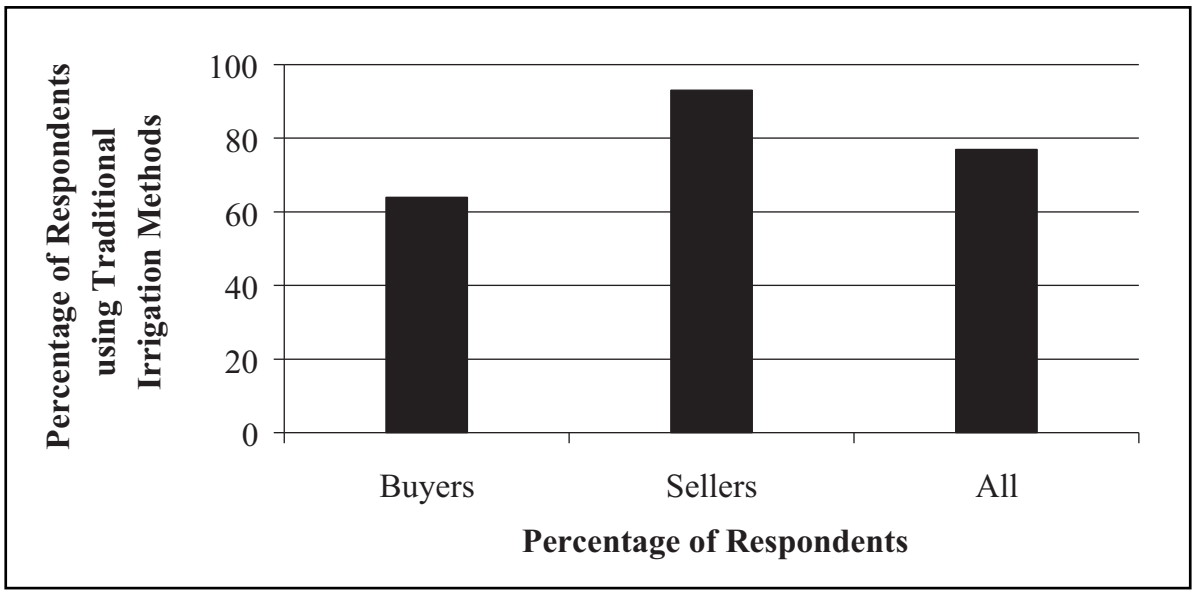

Figure 6. Percentage of Respondents Using Traditional Irrigation Methods

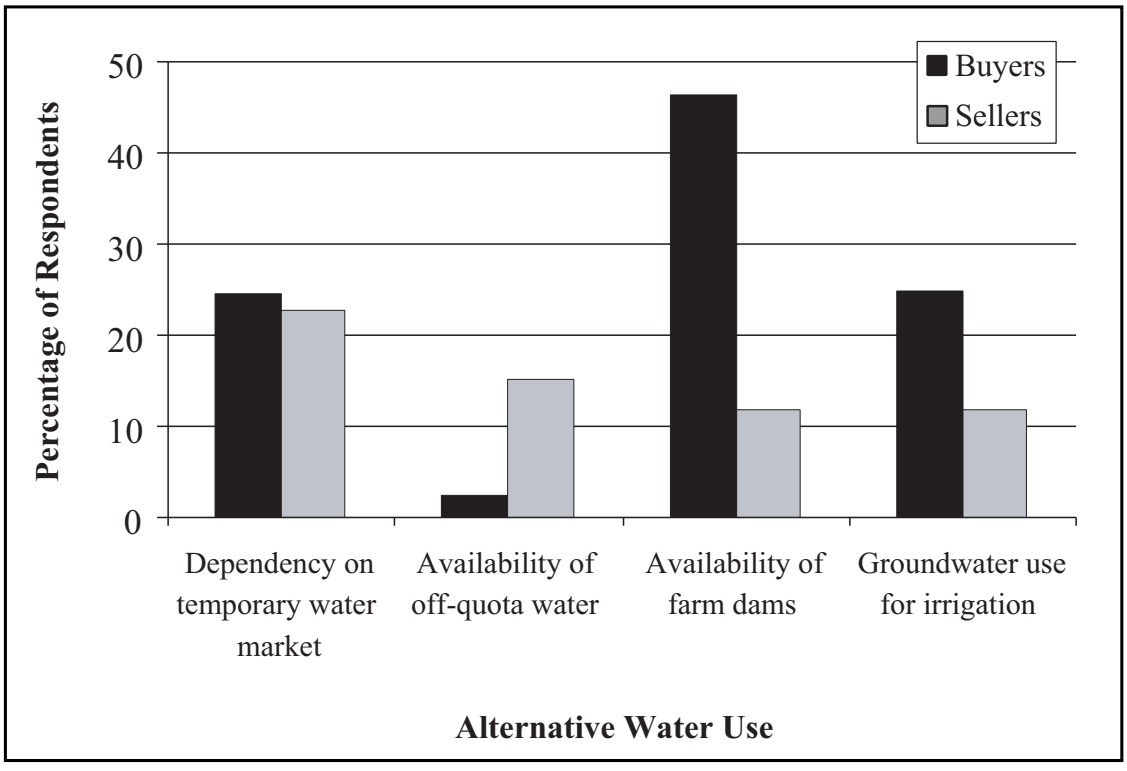

Figure 7. Percentage of Buyers and Sellers that Depend on Alternative Sources of Water

Dependency on the Temporary Water Market: The behaviour of buyers and sellers in relation to purchases on the temporary water market was analysed on a regional basis and according to farm types as shown in Figures 8 and 9. These figures need to be considered together with Figure 7 for comparative purpose.

The following observations can be made from the analysis of survey responses:

- There is no significant difference regarding dependency on the temporary water market between buyers and sellers (Pearson Chi-squared test of significance: 0.87).
- Significance tests on a regional basis cannot be applied because cell frequency requirements for Chi-squared tests are not satisfied for certain regions. However, there is no clear trend of dependency on temporary water market by regions.
- A significantly large number of dairy farmers, when compared with horticultural, cropping and grazing farmers, depend on the temporary water market (Pearson Chi-squared test of significance: 0.03).

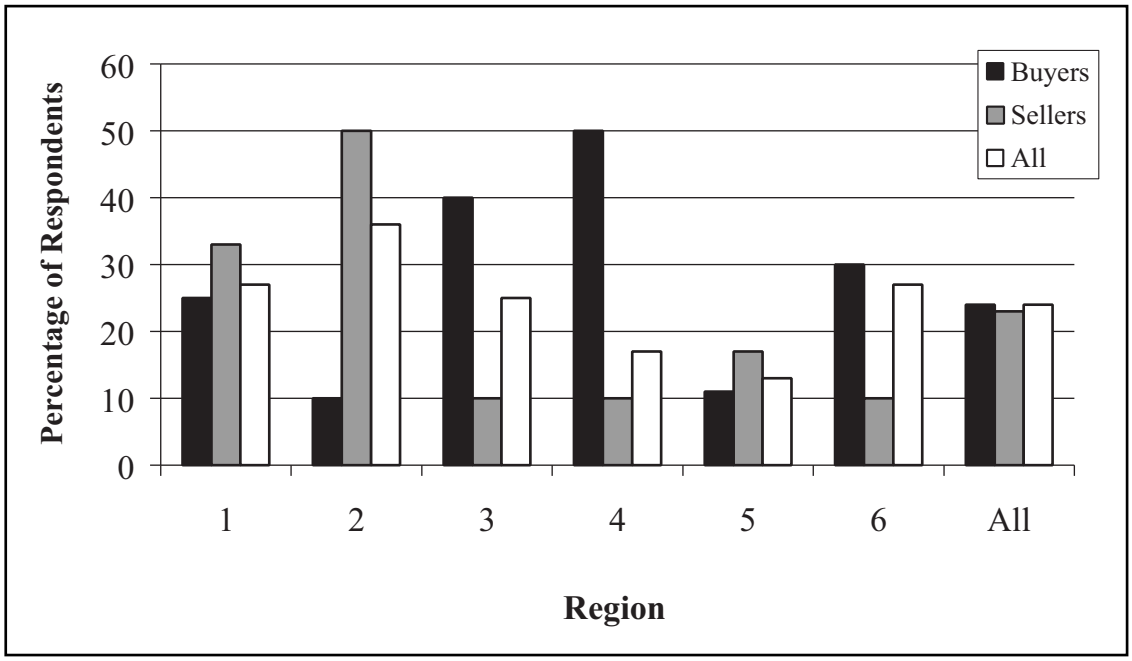

Figure 8. Percentage of Regional Dependency on the Temporary Water Market

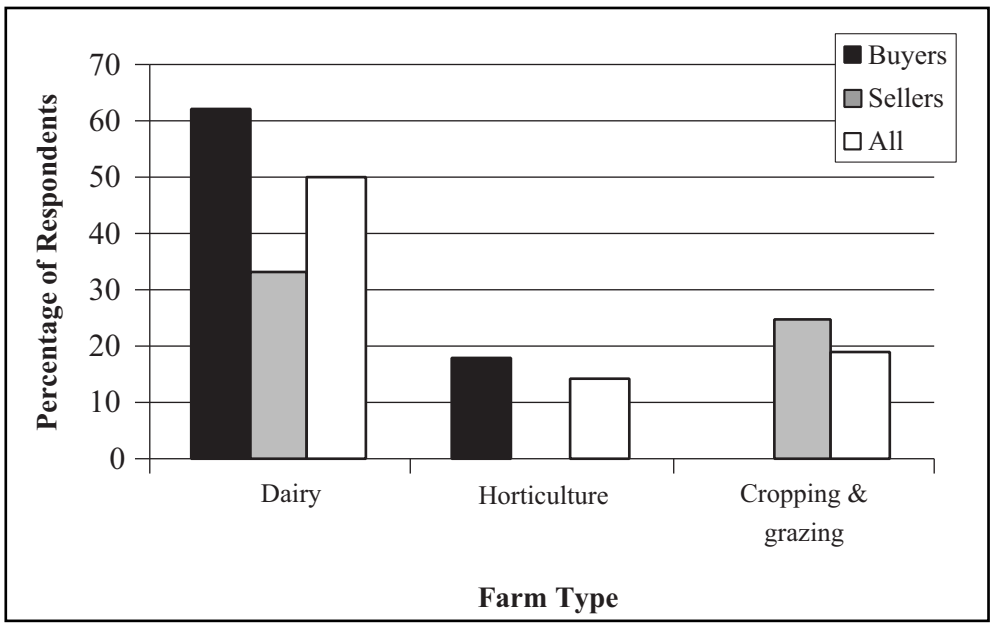

Figure 9. Dependency on Temporary Water Market According to Farm Types

These results indicate that there is no direct relation between permanent water trading and purchase of water on the temporary water market. It seems that dairy farmers mainly buy water on the temporary water market because they use the highest amount of water per unit area (Douglass *et al*., 1998).

Availability of Off-quota Water: The use of off-quota water by water traders on a regional basis and according to farm types is shown in Figures 10 and 11.

The following observations can be made from Figures 7, 10 and 11:

- More sellers than buyers use off-quota water although the difference is not significant, (Pearson Chi-squared significance: 0.05, Fisher's exact test of significance: 0.06).
- A greater number of water traders in regions 2 (Pyramid-Boort) and 3 (Murray Valley) use off-quota water compared to other regions. In these two regions, more sellers than buyers make use of this water source. There is negligible use of off-quota water in most of other regions.
- There is no significant difference in the use of off-quota water for different farm types, although comparatively a higher percentage of cropping and grazing respondents use this source (Pearson Chi-squared test of significance: 0.17).

Use of off-quota water, which depends on availability, is beyond the control of water users. Figure 11 shows that cropping and grazing farmers are the main users of off-quota water. Overall, more sellers than buyers have been shown as using off-quota water because the majority of sellers who responded in the survey are cropping and grazing farmers.

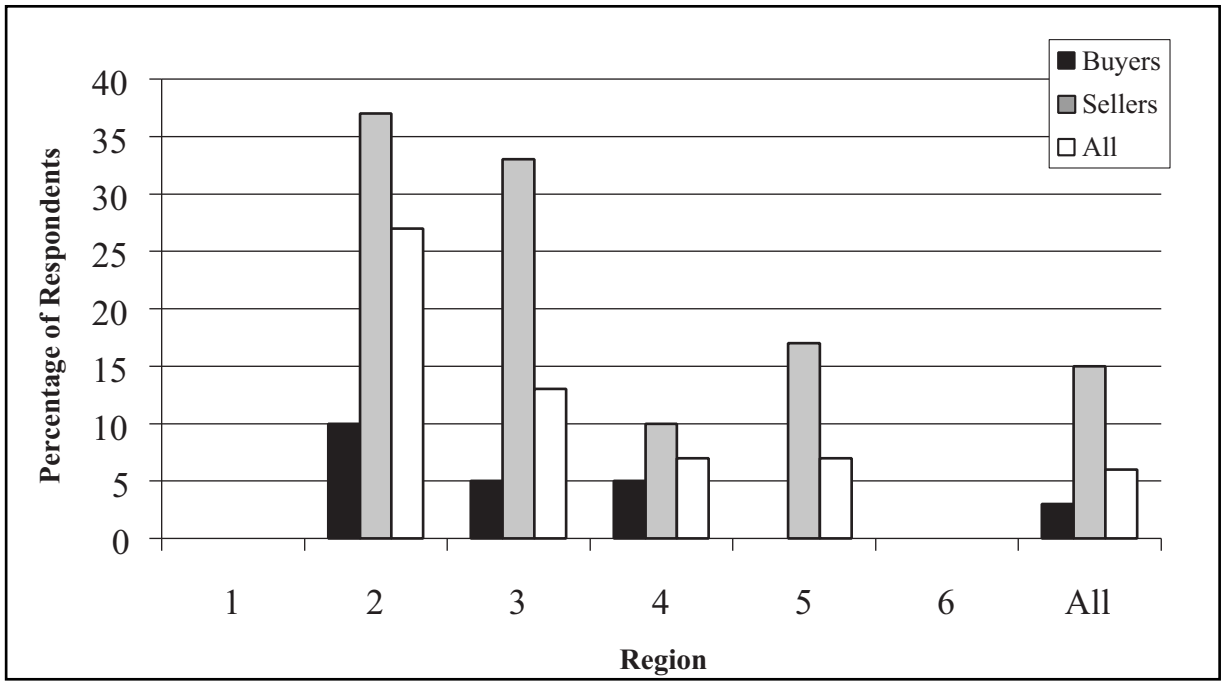

Figure 10. Regional Use of Off-quota Water by Water Traders

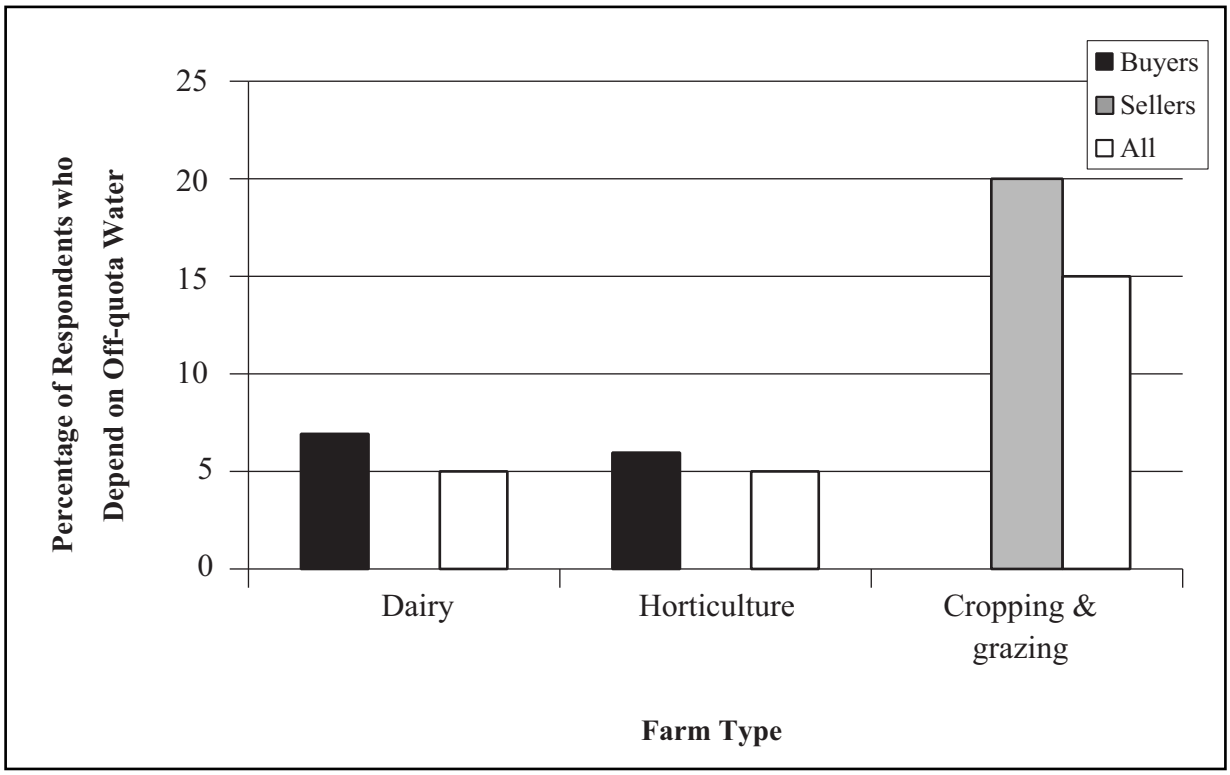

Figure 11. Use of Off-quota Water by Water Traders According to Farm Types

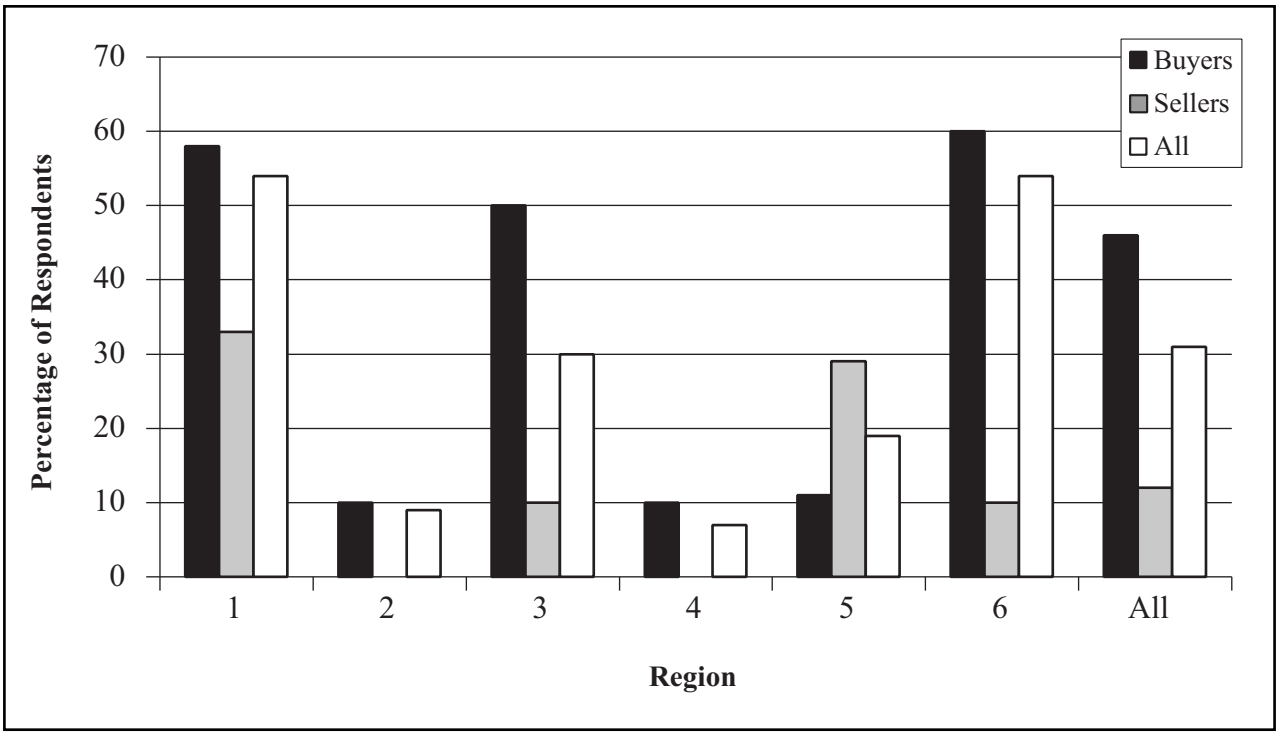

Figure 12. Availability of Farm Dams to Store Water for Irrigation in Different Regions

Availability of Farm Dams: The availability of farm dams to store water for irrigation in the various regions and by farm types is shown in Figures 12 and 13.

Based on the information displayed in Figures 7, 12 and 13 concerning the availability of farm dams, several observations can be made:

- A significantly higher number of buyers than sellers have farm dams (Pearson Chi-squared test of significance: 0.01, Fisher's exact test of significance: 0.01).
- More buyers than sellers in regions 1, 3 and 6 have this facility. Availability of farm dams can be considered as a security measure for Region 6, which lacks regulation facilities.
- The differences observed between farm types regarding the availability of farm dams are not significant (Pearson Chi-squared test of significance: 0.18).

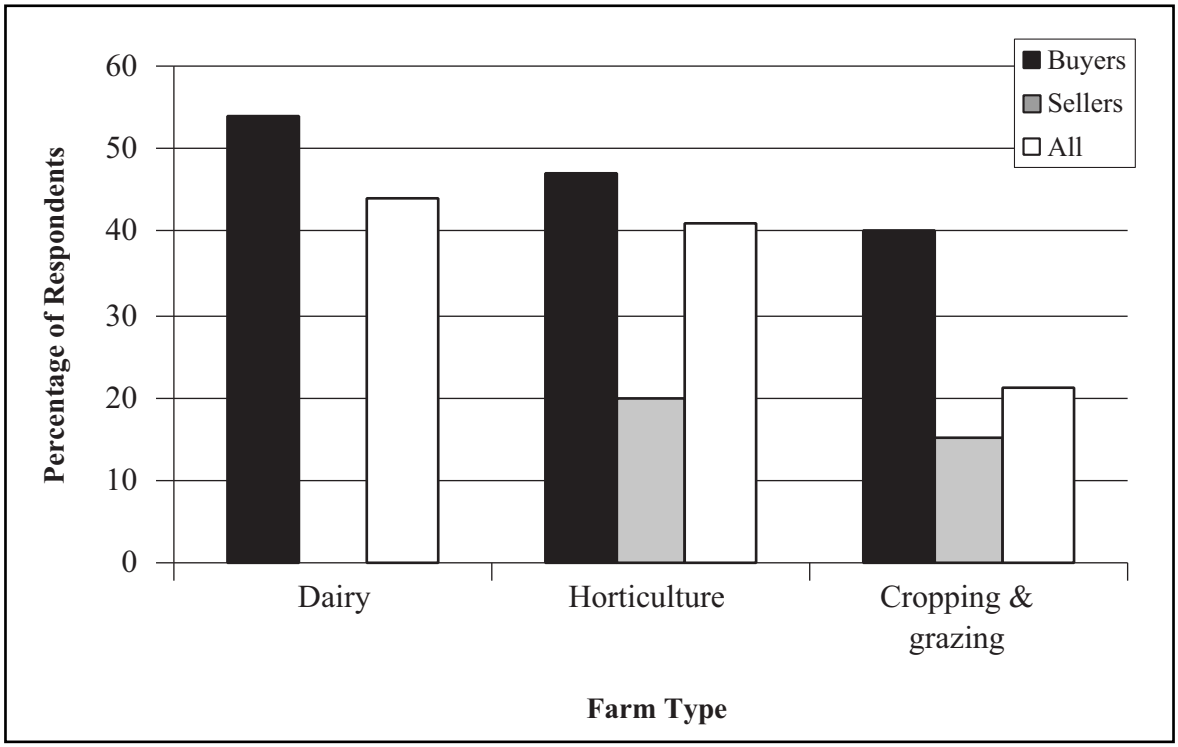

Figure 13. Availability of Farm Dams according to Farm Type

Groundwater Use for Irrigation: The use of groundwater for irrigation by respondents based on the various trading zones and the distribution according to farm types are shown in Figures 14 and 15.

The following inferences that can be made from Figures 7, 14 and 15 regarding the use of groundwater:

- More buyers than sellers use groundwater although the difference is not statistically significant (Pearson Chi-squared test of significance: 0.16, Fisher's exact test of significance: 0.12).
- More water traders in regions 1 and 6 relative to other regions depend on groundwater. Region 1 is the largest net buyer of water entitlements. River

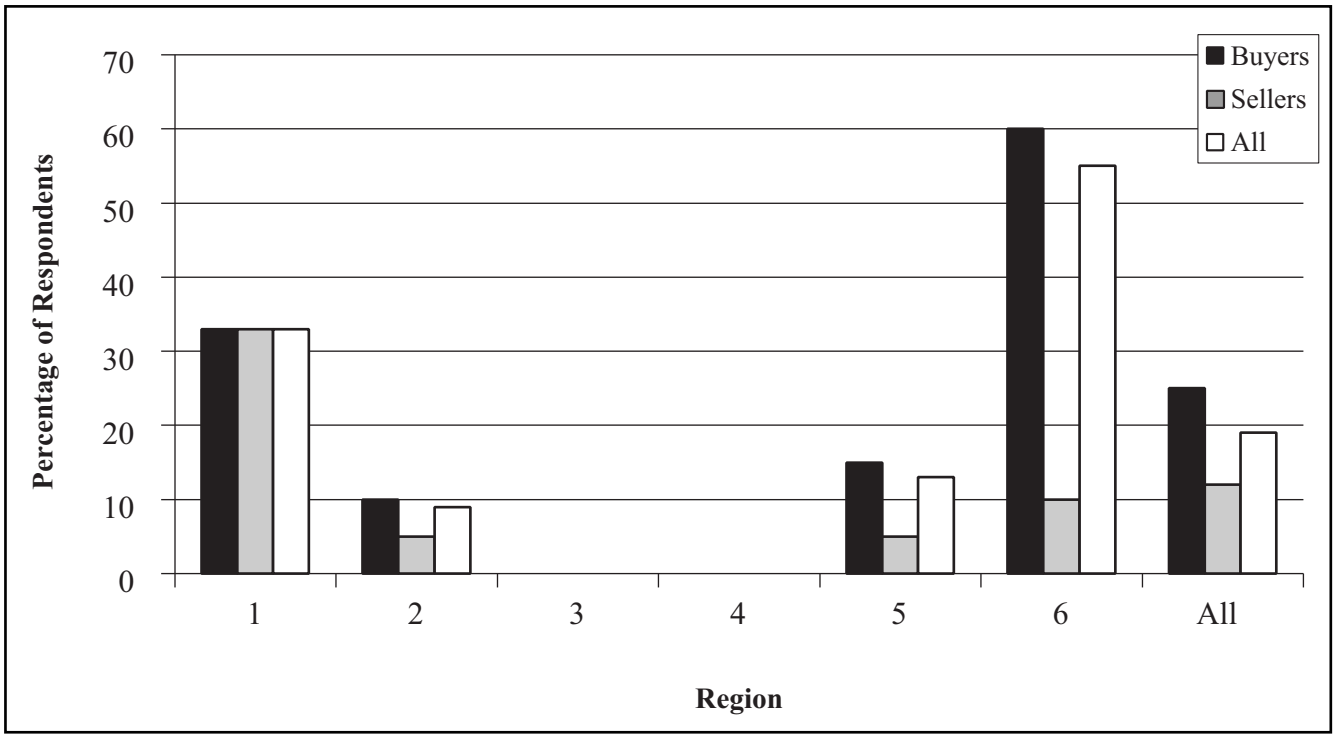

Figure 14. Regional Use of Groundwater for Irrigation

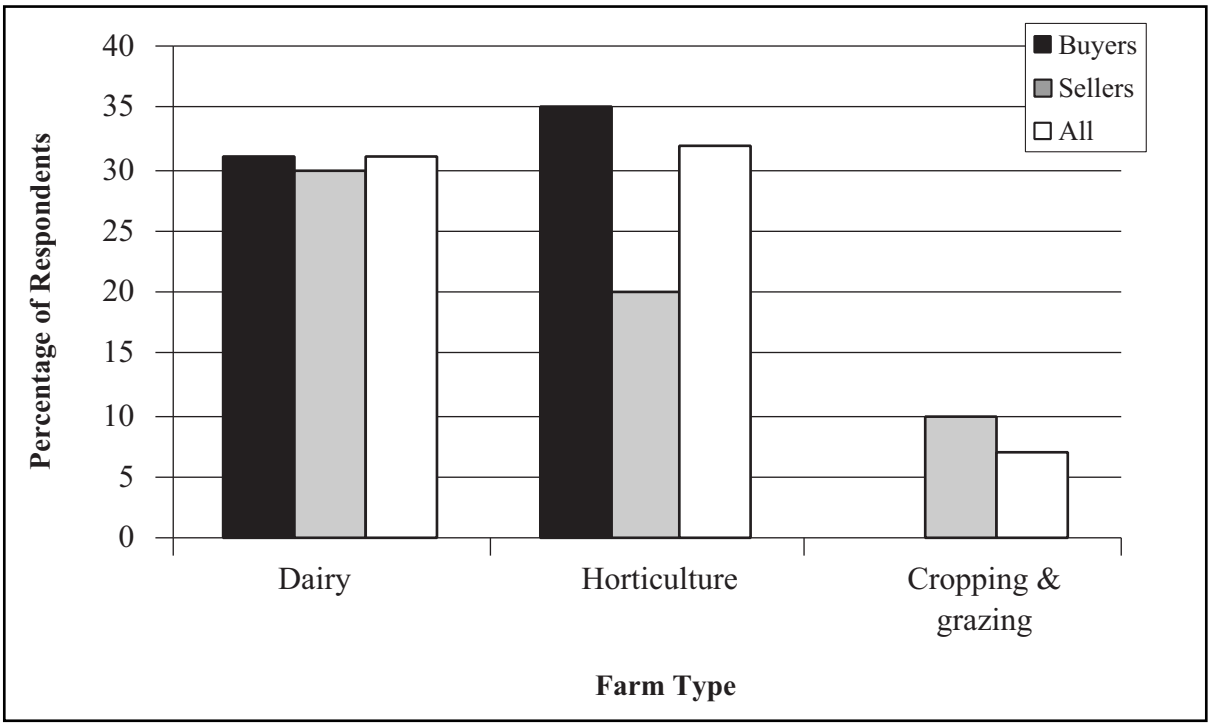

Figure 15. Use of Groundwater for Irrigation According to Farm Types

flows in region 6 are unregulated. Since there is a lack of regulation facilities, farmers need to secure water supply by increasing dependence on groundwater. Moreover, more buyers than sellers in region 6 depend on the source.

- The number of water traders (buyers and sellers) in the dairy and horticultural farming groups that use groundwater is significantly higher than the number of water traders who are cropping and grazing farmers (Pearson Chi-squared test of significance: 0.05).

Analysis of Alternative Water Use and Water Storage: Temporary water market and off-quota water are facilities available to water users to augment their supply. These sources however impose limitations, which are beyond their control.

Use of groundwater and availability of farm dams are also subjected to limitations. On the other hand farmer efficiency and capability play a key role in accessing these two facilities. Use of these two facilities can therefore be considered as general indicators of farming efficiency and capability. Because more permanent water buyers than sellers use these alternative water facilities, it appears that buyers are in a better position than sellers to take advantage of them.

Respondents from regions 1 and 6 also show a greater use of groundwater and availability of farm dams. The majority of water users in region 1 are high value water users (Douglass *et al*., 1998). As discussed in Section 6, the majority of water entitlement buyers are also farmers growing high value crops. Comparatively, the use of these two facilities is high in region 6 as they are important tools for risk management.

Analysis of Selected Factors

The questionnaire included several questions, which are analysed together because they are all measured on a 1-5 ordinal scale and all were analysed using the same statistical tests. The related issues include:

- access to regional drainage,
- availability of surface drainage facility,
- reuse of drainage water,
- extent of the farm laser graded,
- problems of market access (transporting products to the market),
- problems of marketing products (no market, lower prices),
- soil degradation;
- soil salinity, and
- high groundwater table.

The survey participants were asked to rate the importance of these issues with 1 denoting lowest level of importance or agreement and 5 denoting the greatest level of importance or agreement. The notations stated for statistical tests in following tables are consistent with those in Table 4.

Access to Regional Drainage: Access to regional drainage depends on the availability of regional drainage facilities, limitations in the system and need of access by the farmer. Access to regional drainage is compared among permanent water buyers and sellers, regions, and farm types in Table 12. The analysis is based on survey respondents who wished to have the facility.

There is no significant difference regarding access to regional drainage either between buyers and sellers or between farm types: dairy and cropping and grazing. There are, however, regional differences. For instance, farmers in regions 1 and 2 have significantly greater access than farmers in regions 5 and 6. These regional differences are consistent with the fact that access to regional drainage is of a spatial nature, often beyond the control of irrigators.

Availability of Surface Drainage: Data on the availability of on-farm surface drainage facilities were collected in the survey. These data were analysed in order to understand the behaviour of this factor and results are presented in Table 13 for the different categories considered in the analysis.

Farmers in regions 1 and 2 (particularly buyers) have more surface drainage facilities available compared with those available in other regions. The differences between these two regions and other regions are statistically significant at 0.05 level. Availability of surface drainage in dairy farms is significantly higher than that of cropping and grazing farms.

Over the entire study area as well as in regions 1 and 2, mean responses for buyers are higher than those of sellers although the difference is not statistically

Table 12. Comparison of Access to Regional Drainage among Buyers and Sellers Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of Difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	2.31	0.77	0.99	na
	Sellers	2.48			
Regions	1	3.46	(i)		0.01*
	2	3.09			
	3	2.00			
	4	2.60			
	5	1.77			
	6	1.00			
Farm types	Dairy	3.20	(ii)		na
	Horticulture	na			
	Cropping and grazing	2.48			
All		2.39			

Note: Total number of response: 64, na: not available
* Significant at 0.05 significance level
(i) Regions 1-3, 1-5, 1-6, 2-5, 2-6 and 4-6 show significant differences
(ii) No significant difference between farm types.

Table 13. Comparison of Availability of Surface Drainage among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	3.17	0.44	0.74	na
	Sellers	2.79			
Regions	1	3.71	(i)		0.04*
	2	3.90			
	3	2.86			
	4	3.09			
	5	2.15			
	6	1.63			
Farm types	Dairy	4.27	(ii)		na
	Horticulture	na			
	Cropping and grazing	3.18			
All		2.97			

Note: Total number of response: 63,
na: not available
* significant at 0.05 level
(i) Regions 1-5, 1-6, 2-5 and 2-6 show significant differences
(ii)Farm types dairy and cropping and grazing show significant difference

significant. Moreover, the majority of respondents in the dairy farming group are buyers and the majority in the cropping and grazing groups are sellers. This result suggests that buyers have more surface drainage facility than sellers.

Reuse of Drainage Water: Respondents were asked to rank the extent to which they reuse their irrigation and rainfall runoff on farms. The analysis of responses is shown in Table 14.

Farmers in region 1 (particularly buyers) have significantly higher drainage reuse facilities compared to farmers in regions 2, 4 and 6 and the differences are significant at 0.05 level.

There is no significant difference either between buyers and sellers or between farm types: dairy and cropping and grazing. However, the mean response for buyers is higher than that of sellers. In principle this could indicate that buyers use more drainage water than sellers. Similarly, the mean response for dairy farmers is higher than that of cropping and grazing farmers although the difference is not significant. Further analysis reveals that these outcomes are comparable with regional differences on the basis that:

- More than 50 % of the irrigated land is under dairy farming in region 1 (Douglass *et al.*, 1998) whilst land under dairy farming in regions 2, 4 and 6 are 13%, 40% and 16% respectively. In contrast, a major portion of land in latter regions is under cropping and grazing farming.
- The majority of respondents in the dairy and cropping and grazing farming groups are buyers and sellers respectively.

Table 14. Comparison of Reuse of Drainage Water among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	2.78	0.27	0.70	na
	Sellers	2.30			
Regions	1	3.57	(i)		0.15
	2	1.90			
	3	3.00			
	4	2.09			
	5	2.46			
	6	1.86			
Farm types	Dairy	3.27	(ii)		na
	Horticulture	na			
	Cropping and grazing	2.79			
All		2.55			

Note: Total number of response: 62
na: not available
(i) Regions 1-2, 1-4 and 1-6 show significant differences
(ii) No farm type shows significant difference

Extent of Farm Laser Grading: Respondents were also asked to rate their property on the basis of the extent to which it has undergone laser grading. Table 15 compares the extent of the farm laser graded for different categories of respondents.

Differences in the extent of farm laser grading have been observed only on a regional scale. The extent of farm laser grading is significantly high in major irrigated areas (regions 1 to 4) compare to private diverters (regions 5 and 6).

Market Access Problems: The severity of problems associated with transport of farm products to the market was mainly tested to compare how water entitlement buyers and sellers perceive the degree of difficulty with market access. The results of the analysis are presented in Table 16.

A significant difference in the problem of market access is observed between respondents of dairy and cropping and grazing farming. However no significant differences have been observed either between regions or between buyers against sellers. These results are consistent with the fact that dairy farmers have better access to the market through a well-organized milk collecting infrastructure. Although the difference is not significant, the mean response for buyers is less than that of sellers probably indicating that water users who perceive fewer problems with regard to market access are more likely to purchase water entitlements.

Problems with Marketing of Products: The perceptions of respondents on issues like low commodity prices and low product demand are grouped together as the problems related to marketing of farm products. The results of the analysis of survey responses are shown in Table 17.

Based on the results presented in Table 17, the following observations are made:

- Sellers believe they have a significantly higher incidence of marketing problems than buyers. This finding is consistent with those of ABARE

Table 15. Comparison of Extent of Laser Grading among Buyers and Sellers, Regions and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	2.97	0.36	0.87	na
	Sellers	2.56			
Regions	1	3.14			
	2	3.50			
	3	3.43			
	4	3.08	(i)		0.01*
	5	1.69			
	6	1.71			
Farm types	Dairy	3.40	(ii)		na
	Horticulture	na			
	Cropping and grazing	3.34			
All		2.76			

Note: Total number of response: 63,
na: not available
* significant at 0.05 significance level
(i) Regions 1-5, 1-6, 2-5, 2-6, 3-5, 3-6, 4-5 and 4-6 show significant differences
(ii) No farm type shows significant difference

Table 16. Comparison of Market Access Problems among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	1.66	0.66	0.99	na
	Sellers	1.90			
Regions	1	1.57	(i)		0.33
	2	2.09			
	3	2.00			
	4	2.17			
	5	1.29			
	6	1.75			
Farm types	Dairy	1.27	(ii)		0.11
	Horticulture	1.79			
	Cropping and grazing	2.11			
All		1.77			

Note: Total number of response: 65,
na: not available
(i) No region shows significant difference
(ii) Difference between dairy and cropping and grazing farm types is significant.

Table 17. Comparison of Problems with Marketing of Products among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	2.41	0.04*	0.59	na
	Sellers	3.10			
Regions	1	2.79	(i)		0.82
	2	2.55			
	3	2.75			
	4	3.08			
	5	2.77			
	6	2.13			
Farm types	Dairy	2.44	(ii)		0.03*
	Horticulture	2.25			
	Cropping and grazing	3.30			
All		2.71			

Note: Total number of response: 66
na: not available
* significant at 0.05 level
(i) No region shows significant difference
(ii) Differences between dairy- cropping and grazing and Horticulture- cropping and grazing are significant

(1999) and Telford *et al*. (1997), which revealed less marketing problems for high value producers. Permanent water entitlement buyers are primarily high value producers (Section 6.1).

- There are no regional differences.
- Despite the uncertainties in the marketing of milk associated with the deregulation of the dairy industry, dairy farmers perceived fewer problems in relation to cropping and grazing farmers. The majority of respondents within the dairy and cropping and grazing groups are buyers and sellers respectively. This may have some bearing on the difference of responses between dairy and cropping and grazing farmers.

Problems of Soil Degradation: Degradation of the farmland is believed to strongly influence water trading decisions made by farmers. Salinity, presence of high groundwater table, loss of fertility and erosion are considered major soil degradation problems. Salinity and presence of high groundwater problems were perceived to be important soil degradation problems by farmers in a previous study (Bjornlund and McKay, 1995). Therefore these two issues as well as soil degradation problems in general have been individually addressed in this survey. Table 18 summarizes the results of the analysis of soil degradation problems. Two important observations that can be made are that:

- Buyers have less soil degradation problems although MWU test does not show significant difference between buyers and sellers at 0.05 significance level.
- There are no significant regional differences with regard to this problem.
- Horticultural farmers face significantly less soil

Table 18. Comparison of Problems of Soil Degradation among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	1.81	0.16	0.88	na
	Sellers	2.30			
Regions	1	2.21			
	2	2.30			
	3	2.25			
	4	1.75	(i)		0.65
	5	1.79			
	6	2.00			
Farm types	Dairy	2.00	(ii)		0.02*
	Horticulture	1.47			
	Cropping and grazing	2.43			
All		2.03			

Note: Total number of response: 66
na: not available
* significant at 0.05 significance level
(i) No region shows significant difference
(ii) Difference between horticultural and cropping and grazing farmers is significant.

degradation problems compared to cropping and grazing farmers. The mean value of responses for respondents who belong to the dairy farming group is less than that of the cropping and grazing group. This observation is consistent with previous observations given that the majority of buyers are in the dairy and horticultural farming groups. Purchase of water entitlements by high value farmers who have established their farms on better lands with less soil degradation problems have been observed by Bjornlund (2000).

Soil Salinity Problems: Due to the severity of soil salinity related problems faced by a section of water users in the study area (Bjornlund and McKay, 1995), the issue was addressed separately in the survey and the analysis. A summary of the analysis of the problems related to soil salinity is presented in Table 19.

The analysis of the results in Table 19 indicates that:

- Buyers perceive less soil salinity problems than sellers although the MWU test does not show significant difference.
- Respondents from region 2 perceive the highest level of soil salinity problems and the difference is significantly higher than that of region 6.
- The perception of soil salinity problems is not significantly different among respondents who belong to three farm types. However, mean responses from the dairy and horticultural farming groups are lower than that for the cropping and grazing farmer's group. This observation is compatible with the analysis of buyers against sellers as the majority of buyers belong to dairy and horticultural farming.

The previous observations suggest that farmers who established their farms on land without salinity problems tend to buy water entitlements. This trend can be found in all regions although the salinity problem is prevalent in areas like Pyramid Hill and Swan Hill, which are part of regions 2 and 4. Findings by Bjornlund (2000) and Douglass *et al.* (1998) further corroborate this observation.

Table 19. Comparison of Problems of Soil Salinity among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	1.69	0.08	0.69	na
	Sellers	2.33			
Regions	1	2.29	(i)		0.32
	2	2.40			
	3	1.71			
	4	1.83			
	5	2.00			
	6	1.38			
Farm types	Dairy	1.69	(ii)		0.31
	Horticulture	1.63			
	Cropping and grazing	2.26			
All		1.98			

Note: Total number of response: 66
na: not available
* significant at 0.05 significance level
(i)Regions 2-6 show significant differences
(ii) No farm type shows significant difference

Problems of High Groundwater Table: The reasons stated to consider soil salinity as a separate issue in the study equally apply to problems of high groundwater problems. Problems associated with high groundwater table are thus analysed separately from general soil degradation problems. Table 20 presents a summary of the analysis.

An inspection of Table 20 reveals that:

- Despite there being no significant difference between the two groups regarding the presence of a high water table, the average response from buyers is less than that of sellers indicating that farmers with comparatively low groundwater problems tend to buy water entitlements.
- The level of severity of the problem perceived by respondents from region 1 is significantly higher than that of respondents from regions 4, 5 and 6. This agrees well with previous studies conducted in the study area (Bjornlund and McKay, 1995; Douglass *et al.,* 1998). To mitigate the problem, application rates in these areas have been restricted and buyers are required to prepare a drainage plan before water entitlements can be purchased into region 1.
- Dairy and horticultural respondents have low mean responses. Moreover, the severity of the problem faced by horticultural farmers is significantly lower than that faced by cropping and grazing farmers. It seems that horticultural farmers have established their farms on lands having less problems of high groundwater table. This is consistent with the fact that horticultural farming involves high capital investment and crops are sensitive to high water table.

Issues Specific to Dairy and Grazing Farming

This section deals with several issues specific to dairy and grazing farmers. They include pasture area fertilized, grain use for animal feeding, stocking rate and annual to perennial pasture area ratio. The last two issues are analysed only for dairy farmers.

Table 20. Comparison of Problems of High Groundwater Table among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Mean**	**Significance of difference**		
			MWU	**2-KS**	**KW**
Buyers against sellers	Buyers	1.81	0.33	0.94	na
	Sellers	2.19			
Regions	1	2.67	(i)		0.09
	2	2.20			
	3	2.00			
	4	1.67			
	5	1.64			
	6	1.50			
Farm types	Dairy	2.06	(ii)		0.11
	Horticulture	1.47			
	Cropping and grazing	2.24			
All		1.99			

Note: Total number of response: 67
na: not available
*Significance has been tested at 0.05 significance level
(i) Differences between regions 1-4, 1-5 and 1-6 are significant.
(ii) Difference between horticultural and cropping and grazing groups is significant.

The percentage of pasture area fertilised and annual grain per animal used were analysed for buyers of water entitlements and sellers in the dairy and cropping and grazing farming groups. The aim of the analysis is to determine whether there is a difference in the level of inputs used between buyers and sellers of water entitlements. ABARE (1997) found that stocking rate in region 4, among dairy farmers, was about twice that in New South Wales (NSW). High stocking rate inevitably requires secure water supply for pasture. It was therefore important to analyse whether there is a high stocking rate in the study area among dairy farmers and whether they achieve greater water security through permanent water trading. The level of security for these farmer groups is analysed in Part IV. The stocking rate and annual to perennial pasture ratio observed for permanent water traders was compared with that of temporary traders and findings of previous studies in order to justify results of this study.

Pasture Area Fertilised and Grain Use: Percentage of fertilised pasture area and annual grain use, among buyers and sellers of water entitlements in the dairy and cropping and grazing farming groups, were analysed. The binomial distribution with normal approximation was used to test percentage of fertilised pasture area (Walpole and Myers, 1989). Binomial test values were based on the median value of percentage of pasture area fertilised of the sample. The MWU test, KS two sample test, and two-sample t-test were used in the analysis of annual grain use. Tables 21 and 22 show a summary of the survey results.

Table 21. Comparison of Fertilized Pasture Area among Water Entitlement Buyers and Sellers who belong to Dairy and Cropping and Grazing Farming Groups

Basis for comparison		**Median percentage**	**Significance of difference based on binomial distribution**
Buyers against sellers	Buyers	100	0.0003*
	Sellers	28	
Farm types	Dairy	100	0.0002*
	Cropping and grazing	74	
All		80	

Note: Number of responses: 47
* Significant at 0.05 level

Table 22. Comparison of Grain Use among Animal Growers

Basis for comparison		**Mean (kg/year)**	**Significance of difference**		
			MWU	**2-KS**	**2-t**
Buyers against sellers	Buyers	555	0.02*	0.02*	0.04*
	Sellers	220			
Farm types	Dairy	943	0.00*	0.00*	0.00*
	Cropping and grazing	124			
All		373			

Note: Number of responses: 48, na: not available
* Significant at 0.05 significance level

Several observations can be made from the results in Tables 21 and 22:

- The percentage of fertilised pasture area and grain use per animal are significantly higher for buyers than for sellers.
- The percentage of pasture area fertilised and the grain use per animal for dairy farmers are significantly higher than those for cropping and grazing farmers.
- The majority of water buyers among animal growers are dairy farmers and the majority of sellers are cattle and sheep farmers.

It is clear that higher values for dairy farmers and low values for cropping and grazing farmers reported for fertilised area and grain used have influenced the difference between water entitlement of buyers and sellers. However, median responses for percentage of fertilised area by buyers and sellers in the cropping and grazing group are 95% and 25% respectively (significance value for comparison of differences based on the binomial distribution is 0.18). Therefore, it can be concluded that a higher percentage of area fertilised and higher grain use per animal among water entitlement buyers are not only due to differences of farming groups but also to type of enterprise.

Stocking Rate of Dairy Farmers: Stocking rate of dairy farmers were measured in the survey. The mean stocking rate for buyers of water entitlements, who are dairy farmers, is 2.29 head/ha (Shapiro-Wilk test of significance for normality: 0.99) based on the average total irrigated area in the last five years. If the average irrigated area of only perennial pasture is considered, the mean stocking rate is 3.35 head/ha (Shapiro-Wilk test of significance for normality: 0.77).

ABARE (1997) found that mean stocking rate in 1993/94, in region 4 of the study area as 2.33 head/ha based on total irrigated area. The stocking rate for Murray Valley of NSW in 1993/94 was 1.3 (ABARE, 1997). High dependence on annual pasture, and low use of supplementary feed may contribute to lower stocking rates in NSW.

Annual Pasture-Perennial Pasture Area Ratio: Annual pasture to perennial pasture ratio for water traders in the dairy farming group was also analysed. The mean ratio for all respondents in the dairy group is 0.54. This ratio is compared with relevant ratios from the temporary water trading analysis in Part III in order to test the consistency of results.

In the case of cropping and grazing farmers, more than one-third of respondents do not depend on perennial pasture at all for animal feeding.

Restrictions in Water Application Rate

Questions about restrictions in water application rates were also included in the questionnaire. The aim of these questions was to ascertain whether there is an impact on permanent water trading from restrictions in application rates. Table 23 presents a summary of the analysis of application rate restrictions as perceived by respondents. A few observations can be made from these results:

- A higher percentage of buyers than sellers are affected from restrictions in application rates although the difference is not statistically significant.
- A high percentage of respondents in region 1 are affected from restrictions in application rates, and the differences with other regions are statistically significant.
- A high percentage of dairy farmers are affected from restrictions in application rates and the difference with respondents in other farming groups are statistically significant.

It would appear that the problem of application rate restrictions is mainly confined to dairy farmers and region 1. This can be interpreted in the context of water use patterns in different farm types. Dairy farmers normally have higher water availability in order to irrigate pasture, which comprise a higher percentage of perennial pasture than annual pasture. They normally use flood irrigation, which is less efficient than those methods used by horticultural farmers.

A higher percentage of farmers who perceive application rates to be restrictive in region 1 was expected because problems related to excess water use (high groundwater table) are high in that region. Where application rates are restricted, dairy farmers is the group with the highest perception of restrictions in region 1. This was to be expected as the majority of farmers in region 1 and consequently the majority of respondents from region 1 are dairy farmers and the highest proportion of dairy respondents are from region 1. This is also consistent with the fact that a high percentage of water buyers are in region 1.

Table 23. Comparison of Application Rate Restrictions among Buyers and Sellers, Regions, and Farm Types

Basis for comparison		**Percentage of respondents affected from restrictions**	**Significance of difference**	
			Pearson Chi-squared test	**Fisher's exact test**
Buyers against sellers	Buyers	26	0.37	0.56
	Sellers	17		
Region	1	47	na	na
	2	30		
	3	13		
	4	15		
	5	7		
	6	11		
Region 1 and others		0.01*	0.01*	
Farm types	Dairy	50	0.02*	na
	Horticulture	14		
	Cropping and grazing	14		
Farm type: dairy and others			0.01*	0.01*
All		21		

Note: * Significant at 0.05 significance level
na: not available

Soil Types of Water Traders

In the survey, respondents were requested to state percentage of soil types represented in their farms: sandy soils, sandy loam soils, loam soils and clay soils. The dominant soil type is defined as the one that covers more than 50% of the farm. In the analysis of soil types, distinctions were made between farms with loam soils (sandy loam and loam) and extreme soils (sandy and clay). Table 24 summarises the results of soil types.

A few observations can be made from the results in Table 24:

- More buyers than sellers have established their farms on loam soils although the difference is not significant.
- Soil types applicable to respondents are significantly different for different regions. A higher proportion of sandy and clay soils in Pyramid Hill (an irrigation zone in region 2) and Swan Hill (an irrigation zone in region 4) has contributed to this difference.

It is clear that regional differences dominate the soil type distribution. However, the analysis has shown that water buyers have established their farms predominantly on loamy soils while sellers are predominantly located in areas with sandy and clay soils.

Agreed Price for Water

The price of water had gradually increased until 1998, but no increase has been observed thereafter (Bjornlund, 2000; G-MW, 2001b). The mean water prices for regions 1 and 2 in 1994/96, 1998/99 and 2000/01 in $/ML were 360, 851 and 707 respectively. A gradual reduction in the range between minimum and maximum prices has also been observed over the past 10 years. The following factors may have contributed to the present water price in permanent water trading:

- There were fewer than 60 trades in 1996. The number of trades has gradually increased and has now stabilised between 200 and 300. Spatial restrictions to permanent trading in some regions have gradually been removed. For instance, water traders in regions 3, 5 and 6 were not allowed to trade to region 1 at the inception of water trading. Lower variations between maximum and minimum prices in a water-year and lower spatial variation of prices have been observed after removing these restrictions (Bjornlund, 2000; G-MW, 2001b).

Table 24. Soil Types Applicable for Water Traders

Basis for comparison		**Percentage of respondents with loam soils**	**Significance of difference**	
			Pearson Chi-squared test	**Fisher's exact test**
Buyers against sellers	Buyers	63	0.21	0.24
	Sellers	49		
Region	1	53	0.02	na
	2	25		
	3	87		
	4	39		
	5	67		
	6	82		
Farm types	Dairy	63	0.06	na
	Horticulture	75		
	Cropping and grazing	42		
All		56		

Note: * na: not available

- There has been a gradual reduction in the annual percentage of water purchases from total water purchases by dairy farmers, which is the major water user group and, still the main group of water buyers (see Section 6). Furthermore, a reduction in purchases of water entitlements to satisfy the need of existing farms has also been observed. This may be due to a gradual satisfaction of the long-term water needs of farms in this group. This reduction in demand may have contributed to slowing or halting the rise in price of permanent water entitlements.
- The security aspirations of permanent water traders are discussed in detail in Part IV. Because of the decreasing marginal improvement in supply reliability with each additional unit of water availability on the farm, improvements in the reliability of supply from the purchase of additional water at a low level of availability is greater than at a high reliability level. Consequently, the cost incurred to improve water security is high at a high reliability level. At this stage water users need to compare the capital required to purchase an additional ML of water entitlement against the cost incurred to purchase water on the temporary market. The water security level achieved by water users who depend on the temporary water market is analysed in Part IV. This relation between permanent and temporary water prices may also have contributed to recent behaviour of water price in permanent water trading in the study area.
- As shown in Section 6, 50% of the water sold on the permanent water market is water not used or under-utilised. Because of this, farmers are not forgoing any income by selling this water yet have impacted the behaviour of water prices. Since, there is still water available from cropping and grazing farmers (Douglass *et al*., 1998), it might be expected that this source of water will play a key role in permanent water trading in future as well.

In order to analyse the reponse of farmers to water price and test the consistency of responses and existing records in relation to water price, the questionnaire included questions related to their water transactions. Descriptive statistics of purchase price and sale price agreed by water entitlement buyers and sellers are shown in Table 25.

Because requirements for parametric tests have not been satisfied, MWU and 2-sample KS tests were used to analyse the water price difference between buyers and sellers. Water prices between buyers and sellers are not significantly different at 0.05 level (MWU test of significance: 0.43, 2-sample KS test of significance: 0.46). However, water price distributions for buyers and sellers are not same as shown in Table 25. This difference could be due to the recent trend of water trading to the areas beyond study area.

Sales of water entitlements beyond the study area, mainly to Sunraysia, are taking place (G-MW, 1997-2000). Although all respondents bought water entitlements from irrigation zones within the study area, there could be respondents who sold water entitlements beyond the study area. This could have contributed to the observed difference in distribution of agreed price between buyers and sellers.

There is good agreement between the mean water price for buyers and sellers in this survey and that of the water records. Mean water prices for buyers and

Table 25. Descriptive Statistics of Water Prices

Statistic	**Water buyers**	**Water sellers**
Mean* ($/ML)	726	732
Median	725	750
Std. Deviation	117	96
Minimum	500	400
Maximum	950	825
Significance of Shapiro-Wilk test for normality	0.77	0.01

Note: * Transaction costs not included.

sellers in this survey, based on 26% of the total volume of trade, is $ 729 per ML. The respective value from water records for regions 1 and 2 based on 5% of the trade volume is $ 744 per ML (G-MW, 2001b).

It has also been found that there is no relation between the agreed purchase or sale price, and the month of the purchase, region and age of the buyer.

Age Distribution of Water Entitlement Buyers and Sellers

The questionnaire includes questions about the age group of the permanent water traders in order to analyse any trend in relation to buying or selling water. The mean, standard deviation and Shapiro-Wilk test of significance for normality for age of water entitlement buyers are 46.8 years, 10.8 years and 0.81 respectively. The respective values for sellers are 50.5 years, 14.3 years and 0.16 respectively. Despite the absolute difference in the average age of buyers and sellers, the difference is not statistically significant at 0.05 level (2-sample t test for unequal variances, MWU test and 2-sample KS test of significance: 0.29, 0.46 and 0.91 respectively).

- Most of the buyers (67%) and sellers (95%) of permanent water entitlements were able to select their trading areas freely despite some limitations and boundaries on trading that apply to some zones.
- There is no significant difference in the size of property area between buyers and sellers of permanent water entitlements.
- Permanent water entitlements of buyers are significantly larger than that of sellers.
- Water users who use efficient and non-traditional irrigation methods are more likely to purchase water entitlements.
- Buyers are in a better position than sellers to take advantage of alternative water use and on-farm storage facilities.
- Buyers of water entitlements are comparatively more efficient and use more irrigation technology than other users. They have also established their farms on lands with fewer environmental problems. These results agree well in general with previous studies carried out in the study area (Bjornlund, 2000; Douglass *et al*.; Pigram *et al*., 1992).
- It is observed that water is moving from other regions to region 1. In the preceding analysis, it is observed that region 1 is in a better position regarding access to regional drainage, availability of surface drainage, reuse of drainage water and extent of farm laser grading. This set of factors appears to be contributing to the movement of water to region 1. However, region 1 is in a worse position in relation to high groundwater table levels. Coincidentally, this movement of water towards the region could be contributing to the problem.

- Respondents in the survey who belong to dairy and horticultural farm groups used more irrigation technology compare to cropping and grazing farmers. They also reported fewer environmental problems.
- The analysis shows similarities of outcomes for buyers in region 1 and respondents in the dairy and horticultural groups. The number of buyers (and therefore responses) that belong to the dairy and horticultural groups is well above the number of sellers in these groups. Likewise, the number of sellers from the cropping and grazing group is well above the number of buyers in the same group. The largest proportion of the area in region 1 is occupied by dairy and horticultural farms. This also resulted in the majority of respondents in region 1 being dairy and horticultural farmers. This explains the similarities of outcomes shown for buyers in region 1 and respondents in the dairy and horticultural group.
- Water users who are in a better position with regard to fertilised pasture area and grain use for animal feeding are more likely to buy water entitlements.
- The higher stocking rate in the study area may contribute to aspirations for better water security, which met by purchasing water entitlements in order to irrigate perennial pastures.
- The perennial pasture area accounts for two-thirds of the pasture area of dairy farmers.
- The problem of water application rate restrictions is mainly confined to water users in region 1 and to dairy farmers.
- Comparatively more buyers of permanent entitlements have established their farms on loamy soils while more sellers are established on sandy and clay soils.
- The trend showing increased price of permanent entitlements observed until 1998/99, has not continued thereafter.
- No significant difference was observed between age of permanent entitlement buyers and sellers.

7.3 Overall Analysis of Factors Associated with Permanent Water Entitlement Trading

Table 26 summarises the statistical analysis performed on the various survey categories and questions.

The difference in water entitlements attached to buyer and seller properties is primarily due to differences between farm types. The majority of buyers of water entitlements are dairy and horticultural farmers who reside in region 1. The majority of sellers are cropping and grazing farmers.

- There are significant differences between buyers and sellers of water entitlements with regard to water entitlement attached to property, irrigation method, availability of farm dams, problems of marketing products, area fertilized and grain use as supplementary feeding.
- Buyers in general exhibit a higher level than sellers, of groundwater use, availability of surface drains, reuse of drainage water, extent of the farm laser graded, problems of market access, soil degradation, soil salinity and problems of high groundwater table although the differences are not significant.
- Results suggest that buyers of water entitlements are more efficient in terms of use of advanced technologies, improvement of productivity and water resource management.

Table 26. Summary of the Analysis of Factors that Associated with Permanent Water Entitlement Trading

Factor/issue	Is there significant difference between					Remarks
	Buyers and sellers	Regions	Farm type			
			D - H	D- CGR	H- CGR	
Internal against external trading	No	na	na	na	na	
Property area	No	Yes	Yes	No	Yes	Region 2- high, H- low
Water entitlement attached	Yes	Yes	Yes	Yes	No	Buyers/Regions 1,2,3,5/ D - high
Irrigation method	Yes	na	na	na	na	More buyers - advance methods
Temporary water market dependency	No	No	Yes	Yes	No	More dairy farmers depend
Dependency on off-quota water	No	na	No	No	No	
Availability of farm dams	Yes	na	No	No	No	More buyers. Regions 1, 3, 6 have
Groundwater use	No	na	No	Yes	Yes	More use by buyers/ farm types D and H
Access to regional drainage	No	Yes	No	No	No	Regions 1,2 - high, 5, 6 - low
Availability of surface drains	No	Yes	No	Yes	No	Buyers/regions 1,2/ D - high
Reuse of drainage water	No	Yes	No	No	No	Buyers and region 1 - high
Whether the farm is laser graded	No	Yes	No	No	No	Buyers and regions 1, 2 and 4 - high
Problems of market access	No	No	No	Yes	No	Buyers and farm types D and H- low
Problems of marketing products	Yes	No	No	Yes	Yes	Buyers and farm types D and H- low
Problems of soil degradation	No	No	No	No	Yes	Buyers and farm type: H- low
Problems of soil salinity	No	Yes	No	No	No	Buyers - low ,region 2 - high
Problems of high groundwater table	No	Yes	No	No	Yes	Buyers - low, H - low, region 1- high
Area fertilized and grain use	Yes	na	na	Yes	na	Buyers/ D- high
Stocking rate of dairy farmers	na	na	na	na	na	2.29 head/ha. for D
Annual-perennial pasture area ratio	na	na	na	na	na	0.54 for D
Application rate restrictions	No	Yes	Yes	Yes	No	Region 1/ D- high
Soil type	No	Yes	No	Yes	Yes	More buyers/D and H - loam soils
Water price	No	na	na	na	na	
Age of the water user	No	na	na	na	na	

Note: D - Dairy, H- Horticulture, CGR - Cropping and Grazing, na - not applicable
Significance has been tested at 0.05 significance level.

7.4 Comparison of Outcomes of this Study and Previous Studies

As stated in Section 1, two surveys were conducted in the study area for permanent water traders covering periods 1991-94 and 1994-96. Responses to these surveys were studied by Bjornlund (2000). Several variables considered in those surveys have again been included in the present survey of water traders to reveal any trend over time. The outcomes were compared for common variables and factors in Table 27. Several outcomes of the 1996/97 irrigation farm survey conducted by the water authority, Goulburn- Murray Water (G-MW) in 1997 have also been included (Douglass *et al.*, 1998).

Table 27. Comparison of Outcomes of this Study and Previous Studies for Permanent Water Traders

Factor/ Issue	**Findings/ Outcomes**		
	This study	**Bjornlund (2000)**	**96/97 irrigation farm census by G-MW**
Property area (ha.)	Buyers: 101.3 Sellers: 94.6 Difference: not significant	Buyers: 115.7 Sellers: 83.7 Difference: not significant	
Water entitlement attached (ML)	Buyers: 252 Sellers: 169 Difference: significant	Buyers: 294 Sellers: 199 Difference: not significant	
Groundwater use	More use: buyers, regions 1 and 6, farm types dairy and horticulture		More use: regions 1 and 3, farm type dairy. 72% of all use for dairy
Access to regional drainage	High: regions 1 and 2 Low: regions 5 and 6	High: buyers Low: regions 5 and 6	
Availability of surface drains	High: buyers, regions 1 and 2, dairy	High: buyers	
Reuse of drainage water	Use by 41% of respondents. High: buyers, regions 1	High: buyers	Reuse for 40% of irrigated area
Laser grading of farms	47% of irrigation areas are laser graded. High: buyers, regions 1, 2 and 4	High: buyers	41% of irrigated area is laser graded
Problems of soil degradation	Low: buyers, farm type horticulture	Low: buyers	
Problems of soil salinity	Low: buyers High: region 2	Low: buyers High: region 2 and 4	
Problems of high groundwater table	Low: buyers, regions 5 and 6, farm type horticulture High: region 1	Buyers and sellers: no difference Low: regions 5 and 6 High: region 1	

- As shown in Table 27, outcomes for 8 out of 9 variables/ factors compared between this study and Bjornlund (2000) are similar. Disagreement of outcomes exists only between the water entitlement attached to permanent water buyers and sellers.
- The results from this study and the 1996/97 G-MW farm census are similar.

Part III - Temporary Water Trading

8. Scope of Analysis

This section deals with the analysis of survey responses received from temporary water traders. The survey was limited to randomly selected temporary traders in the 1999/2000 water-year in two irrigation zones: Rochester and Swan Hill. The main purpose of the analysis is the identification of drivers of temporary water trading, differences between permanent and temporary water trading, and variability of price traders in different farm enterprises are willing to pay for water. The analysis covers three main areas:

- Temporary water trading in the study area,
- Factors associated with temporary water trading, and
- Behaviour of temporary water trading price.

The results of the analysis are also compared wherever possible with permanent water trading (Part II), past water records and findings by Douglass *et al*. (1998) with a view to comparing results and differences between permanent and temporary water traders.

9. Temporary Water Trading in the Study Area

9.1 Temporary Water Trading in the Past and Trading Rules

Temporary water trading in the Goulburn-Murray Irrigation Scheme commenced in the 1987/88 water year. Trading has gradually been established and expanded for the past 15 years. The amount of water traded has increased from 17,000 ML in 1987/88 to 204,000 ML in 1999/00. At present the annual volume of water traded is equivalent to 10% of permanent entitlements in the scheme (G-MW, 1995-2000).

Irrigators in the Goulburn-Murray Irrigation Scheme are able to trade water attached to water entitlements or sales water. Water allocated up to 100% of permanent water entitlements in a water-year is denoted as water attached to water entitlements. This water is normally considered as more secure water. Water allocated above 100% permanent entitlement in a water-year is known as sales water. This less secure sales water is allocated to irrigators only if enough water resources are available. In this study, both water attached to water entitlements and sales water are considered together for temporary water trading. Off-quota water, which is available only in flood or excess rainy periods, is not allowed for temporary water trading.

In general Shepparton, Central Goulburn, Rochester, Murray Valley, Kerang-Cohuna and Campaspe District are water importing zones. Alternatively, other irrigation zones including regulated and unregulated rivers are mainly water exporting zones. Two irrigation zones: Rochester and Swan Hill, which were selected for this study, represent a water importing zone (Rochester) and a water exporting zone (Swan Hill). In 1999/00 Rochester recorded a net water import of 10,700 ML while Swan Hill recorded net export of 2,300 ML (G-MW, 2000).

Temporary water trading in the study area is subject to specific and enforced guidelines. These guidelines, which are updated annually, control temporary water transfers between irrigation zones. The trading norms applied to the 1999/00 water year are shown in Table 28 (G-MW, 2000). Private diverters described in Table 28 include both regulated and unregulated diverters.

Geographical location and the ability for water to be physically transferred are the main issues considered in allowing temporary water transfers between zones. In general intra-zonal water transfers and water transfers between zones attached to same water supply system are usually allowed.

9.2 Reasons for Water Purchases on the Temporary Water Market

The survey findings support the general belief that the majority of water buyers on the temporary market within the study area are dairy farmers. They account for 76% of the total number of traders whilst cropping and grazing farmers account for 18%. Purchases by cropping and grazing farmers were mainly to irrigate annual pasture due to cheaper water prices at the end of the water-year. Only a few water buyers were horticultural farmers. It is believed that horticultural farmers have high water availability compared to their water requirement (Douglass *et al*., 1998; Peter Witten, 2000, Pers. Comm.). They are highly risk-averse with regard to security of water supply given the long-term nature of their perennial crops. In general, they

Table 28. Temporary Water Trading Possibilities in 1999/00 Water-year

Water supply system and zones attached		**Trading allowed**	
Water supply system	**Zones attached**	**To**	**From**
1: Greater Goulburn	SP, CG, RO, PH, BO and upper Goulburn private diverters	Zones attached to water supply systems 1, 3, 6 and 7	Zones attached to water supply systems 1, 4 and 5
2: Broken	Private diverters in the Broken River	Private diverters upstream to the Casey's Weir can sell water anywhere in the system. Diverters downstream of the Casey's Weir can only sell to downstream users	
3: Lower Goulburn	Lower Goulburn private diverters	Zones attached to water supply systems 3, 6 and 7	Zones attached to water supply systems 1, 3, 4 and 5
4: Campaspe	CD and Campaspe private diverters	Zones attached to water supply systems 1, 3, 4, 6 and 7	Zones attached to water supply system 4
5: Loddon	Private diverters in the Loddon River	Zones attached to water supply systems 1, 3, 5, 6 and 7	Zones attached to water supply system 5
6: Murray - Hume to Barmah	MV, and private diverters of the Murray River upstream of Barmah and Mitta Mitta River	Zones attached to water supply systems 6 and 9	Zones attached water supply systems 1, 3, 4, 5, 6, and 7
7: Murray - Downstream of Barmah	SH, KECO, private diverters of the Murray River downstream of Barmah and pumping districts of Region 7	Zones attached water supply systems 6 and 7	Zones attached water supply systems 1, 3, 4, 5, and 7
8: Ovens and King	Private diverters of Ovens and King Rivers	Zones attached water supply system 8	Zones attached water supply system 8
9: Kiewa	Private diverters of the Kiewa River	Zones attached water supply system 9	Zones attached water supply systems 6 and 9

purchase water on the permanent market to provide a greater availability and security of supply and sell the excess entitlement on the temporary water market depending on the annual allocation level.

Water buyers within the survey were requested to identify the importance of the following reasons for purchasing water on a scale of 1-5:

1 - water shortage for regular irrigated area due to low rainfall,

2 - anticipation of severe drought,

3 - water shortage for existing irrigated area due to low allocations,

4 - low allocation announcement at the beginning of the water-year,

5 - desire to increase irrigated area of existing crops,

6 - purchase at end of the water-year due to cheaper water prices, and

7 - others.

Figure 16 shows how buyers rate the importance of major reasons in water purchasing.

Some respondents identified more than one reason as important. Therefore, the aggregate percentage in each water use category in Figure 16 is not necessarily equal

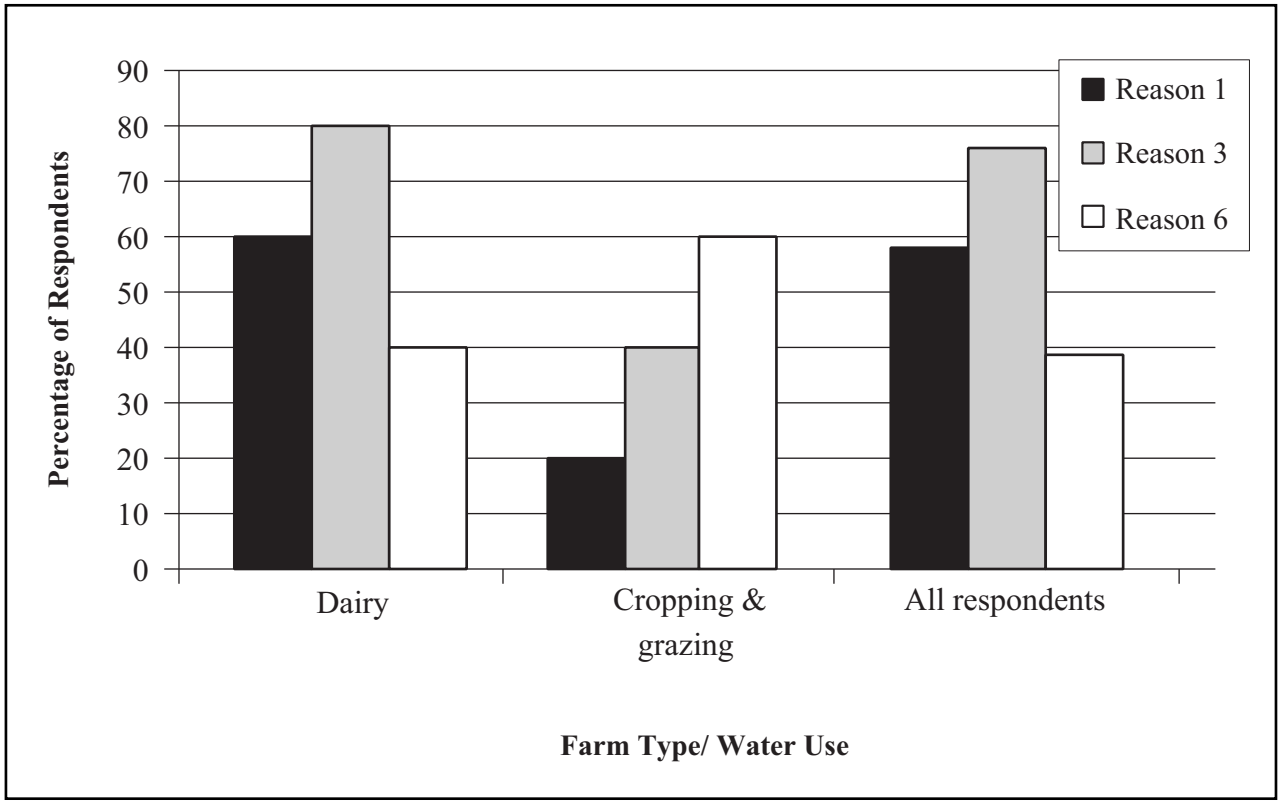

Figure 16. Water Buyers' Reasons for Purchasing Water on the Temporary Market

- ❖ Over 75% of water buyers are dairy farmers.
- ❖ Seasonal shortage was the main reason for purchases on the temporary water market in 1999/00.
- ❖ Cheaper water prices at the end of the water-year are also an important reason for water purchases.
- ❖ Temporary purchases are primarily used to satisfy short-term seasonal needs.

to 100. Very few respondents quoted reasons other than 1, 3 and 6 as important. Figure 16 implies that seasonal shortage is the main reason for purchases on the temporary water market. Higher financial losses compared to the cost of water purchased would have driven such purchases. However, there are many farmers who buy water due to cheaper water prices mainly to irrigate annual pasture at the end of the water year. Increase in irrigated areas is not an important factor in the purchase of additional water. In contrast, temporary purchases are primarily used to satisfy short-term seasonal needs.

9.3 Reasons for Sales of Water on the Temporary Water Market

Past water records in the study area have shown that cropping and grazing farmers have more than sufficient water entitlement in a normal water-year (Douglass *et al.,* 1998; G-MW, 1997). The survey has confirmed those observations given that the majority of water sellers are cropping and grazing farmers. The percentage of water sellers who belong to the dairy, horticultural and cropping and grazing groups are 9, 22 and 67 respectively.

Water sellers were requested to identify the importance of each of following reasons for selling water on 1 - 5 scale:

1 - excess water for present irrigated area,

2 - desire to decrease irrigated area of existing crops,

3 - more attractive price for water than returns from farming,

4 - financial needs, and

5 - others.

Figure 17 shows a summary of how sellers view the major reasons for water sales. Availability of excess water is the primary reason given by water sellers to sell their water. Unlike sellers in the cropping and grazing group, sellers in the dairy or horticultural groups have not indicated a dominant reason for water sales.

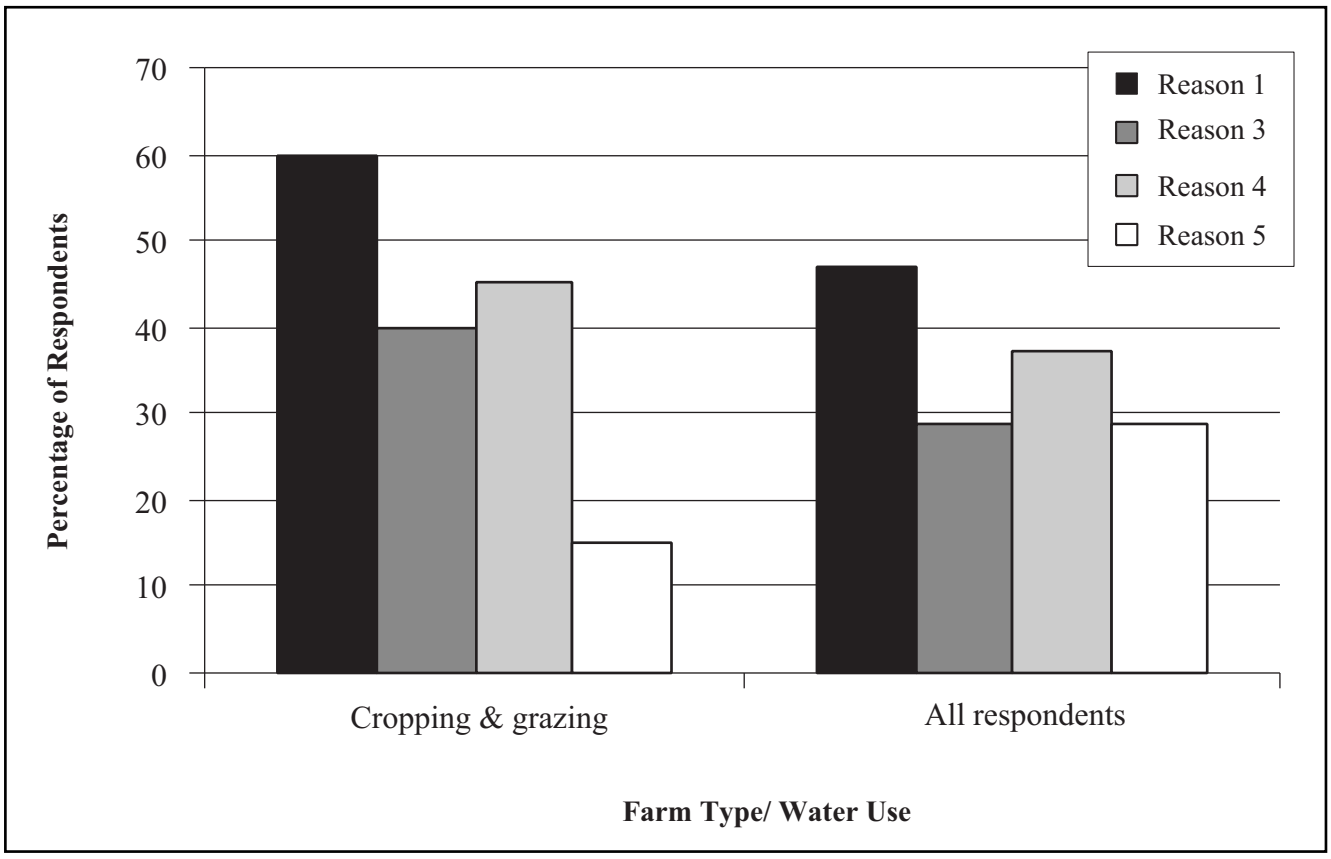

Figure 17. Reasons for Sale of Water on the Temporary Water Market

- ❖ Two-thirds of water sellers are cropping and grazing farmers.
- ❖ Availability of excess water is the primary reason given by water sellers to sell their water.
- ❖ Very few farmers are prepared to reduce the irrigated area in order to sell water.

Very few respondents considered reason 2 as important. There are very few farmers who wish to reduce the irrigated area or normal water use to sell water. On the other hand, around 50% of sellers of permanent water entitlements sell their water to reduce or stop irrigation. This supports the anecdotal observations that permanent transfers are related to long-term structural adjustments of water entitlements while temporary transfers are related to seasonal events.

10. Analysis of Factors Associated with Temporary Water Trading

10.1 Factors Associated with Trading of Temporary Water entitlements

Several factors that are identified as potentially influencing temporary water trading were included in the survey (Bjornlund, 2000; Douglass *et al*., 1998; Earl and Turner, 2000). The analysis of responses to these factors is important to understand trends in temporary water trading and differences between temporary water buyers and sellers. Some factors included in the survey of permanent traders have also been included in the survey of temporary traders. This is only for comparative purpose although several of these factors are known to have negligible influence on temporary water trading. The following factors are included in this section in addition to those stated in Table 11 for permanent trading:

- Water entitlement attached to property,
- Intention to trade water entitlement in future,
- Occurrence of multiple trades within the water year,
- Details of temporary trading (month, price, other transaction costs, quantity), and
- Whether trading was limited because of restrictions imposed by the water authority.

Water price on the temporary market is analysed separately in Section 11. A statistical analysis between temporary water trading and these factors was carried out including an analysis of water buyers against sellers, two-zone analysis and farm type analysis.

10.2 Comparative Analysis of Buyers and Sellers, Zones, and Farm Types

Intra-zonal and Inter-zonal Transfers

Two-thirds of respondents in the survey have traded water within their own zones. There is no significant difference between the two zones surveyed with regard to intra-zonal and inter-zonal trading (Pearson Chi-squared test of significance, and Fisher's exact test of significance are 0.60, and 0.71 respectively).

However, 92% of respondents had no specific reason to trade within or between zones. The respective percentages for buyers and sellers are 82 and 100 respectively whilst the percentages for Rochester and Swan Hill are 85 and 100 respectively.

Limitations on Trading

Only 6% of respondents were unable to trade the amount of water they wanted due to reasons other than high or low prices. The percentages of respondents who were unable to trade freely for buyers and sellers are 3% and 9% respectively (Fisher's exact test of significance = 0.61). The percentages of respondents who were unable to trade freely in Rochester and Swan Hill are 3 and 12 respectively (Fisher's exact test of significance = 0.30). These observations together with observations from the analysis of intra-zonal transfers against inter-zonal transfers show that respondents were largely able to select their trading areas freely.

Property Area and Distribution of Water Entitlements

Property area and water entitlement attached to temporary water traders were surveyed and analysed in order to understand how these factors relate to temporary water trading. Figure 18 and Table 29 compare property area and water entitlements attached to temporary water traders on buyers and sellers, traders' zone and farm type.

The property area is not significantly different in different zones although buyers have significantly larger property areas compared with sellers. Dairy farmers have significantly larger property area but the difference between horticultural and cropping and grazing farmers is not significant (MWU and KS two sample tests of significance: 0.75 and 0.99 respectively). These are not necessarily contradicting observations because the majority of buyers are dairy farmers, and the majority of sellers are cropping and grazing farmers. The difference between permanent water buyers and sellers with regard to property area is not significant because horticultural farmers constitute a substantial proportion of permanent water buyers.

The average water entitlement attached to buyers is higher than that of sellers but the difference is not significant at 0.05 significant level. However, water entitlements attached to temporary water traders in Rochester are significantly higher than that of Swan Hill. The difference between water entitlements attached to dairy farmers and other farmers is high in absolute terms but the difference between horticultural and cropping and grazing farmers is not significant (MWU and KS two sample tests significance: 0.43 and 0.51 respectively).

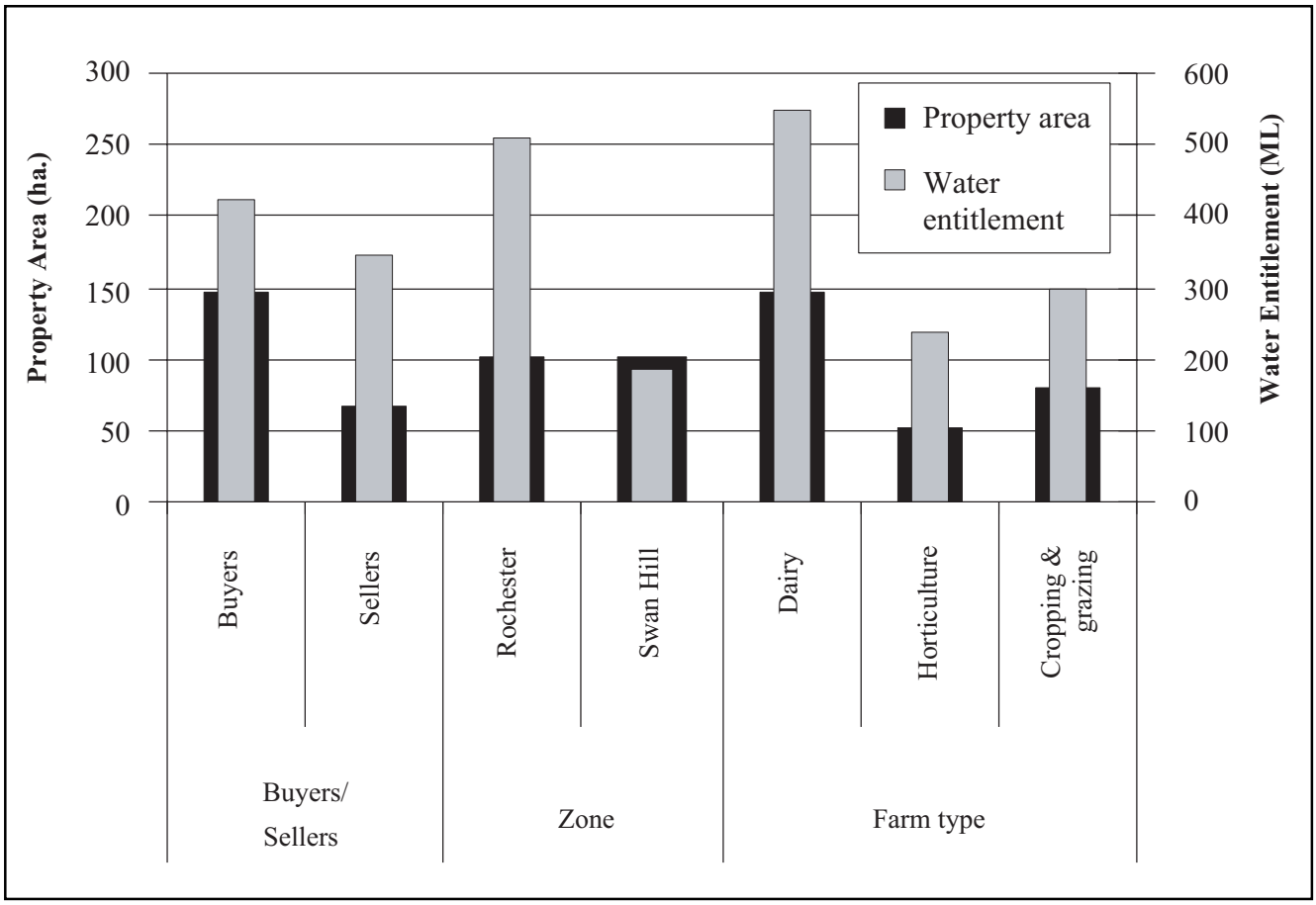

Figure 18. Mean Property Area and Mean Water Entitlements Attached to Respondents

Irrigation Methods

In the survey, temporary water traders were asked to indicate the irrigation method used on the farm. The methods considered are flood irrigation, furrow, overhead sprinklers, drip, centre pivot, under canopy sprinklers, trickle, and others. The same categorization used in the analysis of permanent trading in which the first three methods are traditional or less efficient irrigation methods is again used for temporary water traders.

The proportion of respondents who use flood irrigation, furrow, and overhead sprinklers methods are shown in Table 30. There is hardly any difference in the irrigation method used by buyers and sellers and by farmers in different zones. Pressurized methods appear to be used only by some horticultural farmers irrespective of respondent category.

Table 29. Comparison of Property Area, and Water Entitlements Attached for Respondents

Basis for comparison	**Test**	**Significance of difference**	
		Property area (ha)	**Water entitlements attached (ML)**
Buyers against sellers	MWU	0.01*	0.15
	Two sample KS	0.03*	0.32
	Two sample t-test	0.01*	0.50
Zone basis	MWU	0.20	0.01*
	Two sample KS	0.40	0.03*
	Two sample t-test	0.99	0.01*
Farm type basis	KW	0.02*	0.01*

Note: * denotes that differences are significant at 0.05 significance level
Equality of variances is not assumed for two-sample t-test

Table 30. Percentages of Respondents who Use either Flood, Furrow or Overhead Sprinklers Irrigation Methods

Category of respondents	**Percentage**
Buyers	98
Sellers	91
Rochester	95
Swan Hill	96
All	95

Alternative Water Uses and Water Storage

Alternative water uses and water storage issues were included in the analysis of permanent water trading. Similar issues have also been incorporated into the analysis for temporary trading. These are:

- availability of off-quota water;
- availability of farm dams to store irrigation water; and
- groundwater use for irrigation.

Availability of Off-quota Water: Less than 30% of respondents have made use of this facility. There is hardly any difference between buyers and sellers in relation to the use of off-quota water. Moreover, there is no significant difference between respondents from Rochester and Swan Hill with regard to the use of off-quota water (Pearson Chi-squared test of significance = 0.88). It seems that use of off-quota water is limited to dairy and cropping and grazing farmers.

Availability of Farm Dams to Store Irrigation Water: Temporary traders were asked questions about the availability of farm dams and the summary of responses is shown in Figure 19. There is no significant difference in regard to the availability of farm dams between buyers and sellers (Pearson Chi-squared test of significance: 0.18), respondents from Rochester and Swan Hill (Pearson Chi-squared test of significance: 0.19), and dairy farmers against cropping and grazing farmers (Pearson Chi-squared test of significance: 0.14). However, in absolute terms, a higher percentage of respondents including buyers, Rochester farmers and dairy farmers have farm dams. Hardly any horticultural farmer has a farm dam.

Groundwater Use for Irrigation: The analysis of groundwater use among respondents is shown in Figure 20.

It is important to note that most of the respondents who use groundwater are dairy farmers.

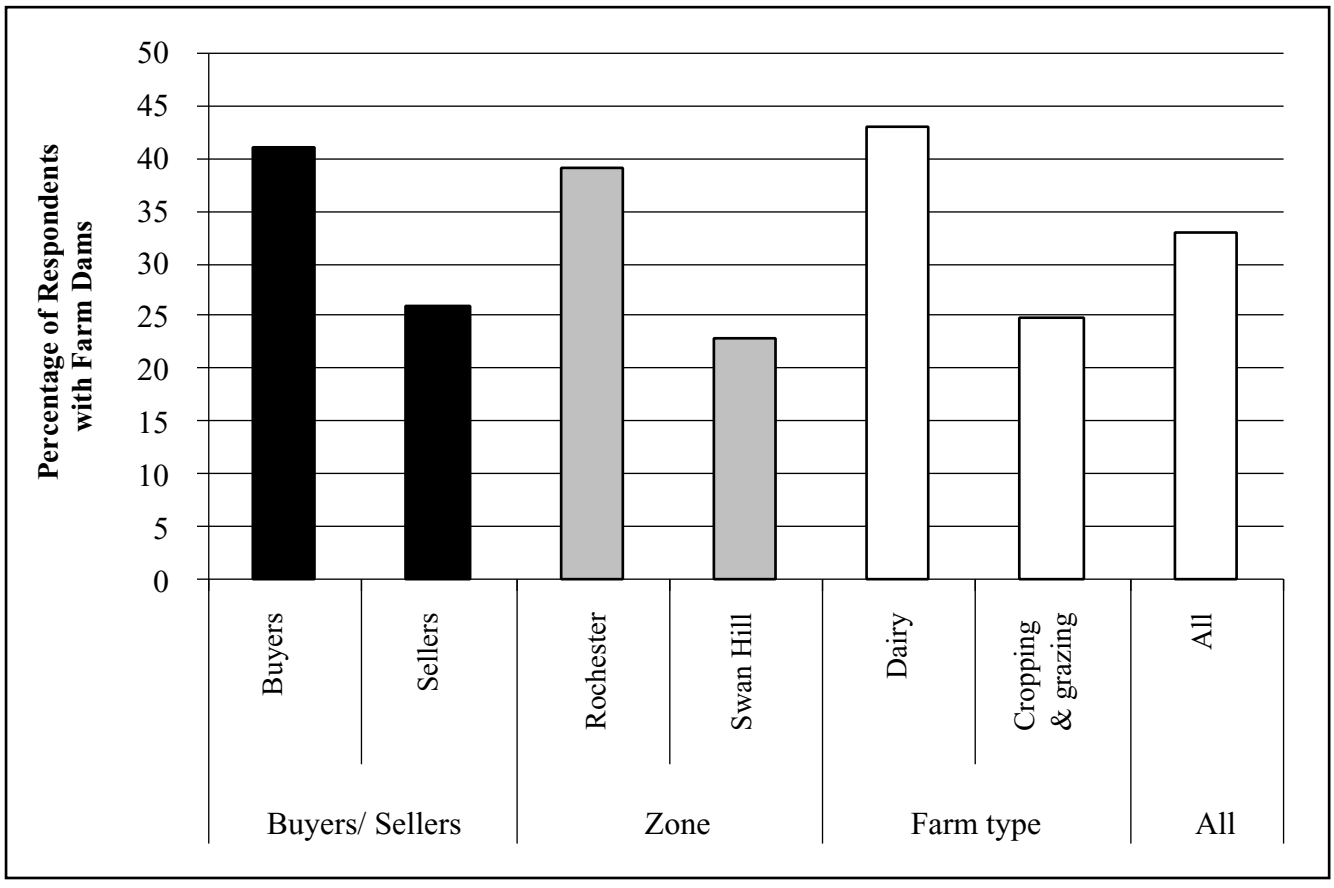

Figure 19. Availability of Farm Dams among Respondents

There is no significant difference between buyers and sellers (Fisher's exact test of significance: 0.66), and Rochester and Swan Hill (Fisher's exact test of significance: 0.64) with regard to groundwater use. However, a relatively higher percentage of respondents among buyers and from Rochester use groundwater.

Analysis of Selected Resource, Economic and Environmental Factors

The same factors considered for permanent trading in Section 7.2 have been included in the analysis of temporary trading. They are:

- access to regional drainage,
- availability of surface drainage facilities,
- reuse of drainage water,
- extent of the farm laser grading,
- problems of market access (transporting products to the market),
- problems of marketing of products (no market, lower prices),
- soil degradation,
- soil salinity, and
- high groundwater table.

All these factors were measured in the survey on a 1-5 ordinal scale. The lowest preference is indicated by 1 and the highest preference is indicated by 5. Mann-Whitney 'U', 2-sample Kolmogorov-Smirnov, and 2-sample t-tests were applied to these variables for buyers against sellers (in both zones and individual zones), geographical zones (Rochester against Swan Hill) and farm types.

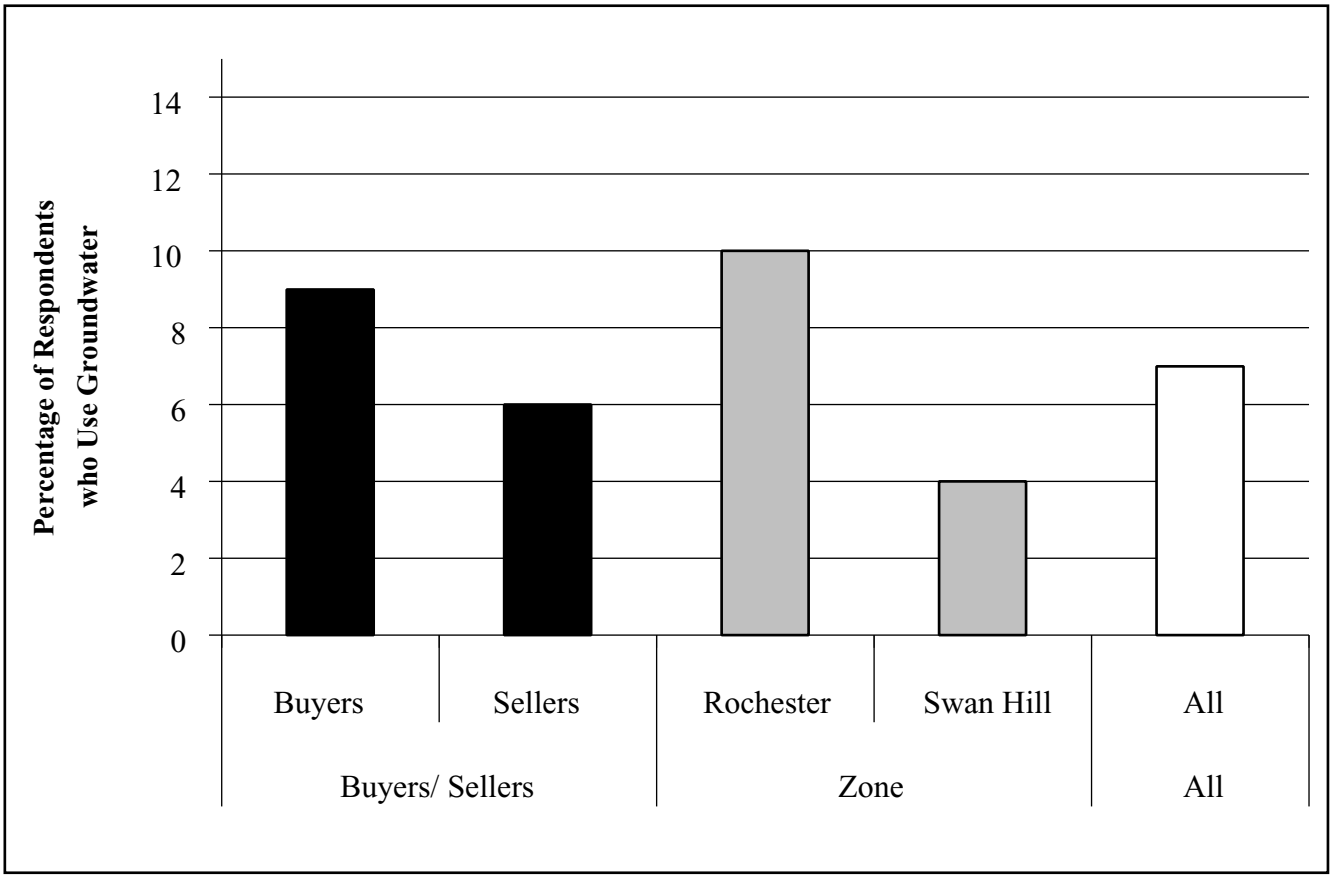

Figure 20. Groundwater Use by Respondents

Access to Regional Drainage: Access to regional drainage depends on availability of regional drainage facilities, limitations in the drainage system and farmer's need for drainage. There is no significant difference between buyers and sellers in either zone or both zones combined together and between the two zones (Table 31). However, dairy farmers perceive that they have greater access to drainage than cropping and grazing farmers.

Availability of Surface Drainage: Data on the availability of on-farm surface drainage facilities were collected and analysed in order to understand the relation between this factor and temporary water trading. There is no significant difference between buyers and sellers (in either zone or both zones together) and between the two zones with regard to availability of surface drainage (Table 32). However, availability of surface drains for dairy farmers is significantly higher than for cropping and grazing farmers.

Reuse of Drainage Water: Survey data related to reuse of irrigation and rainfall run off on farms by temporary water traders were analysed for different categories of farm enterprises and traders. Reuse of drainage water is significantly high among buyers (Table 33) with reuse among dairy farmers being higher than cropping and grazing farmers although the difference is not significant at 0.05 significance level.

Table 31. Comparison of Access to Regional Drainage among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	3.37	0.93	0.99
	Sellers	48	3.29		
Two zones	Rochester	50	3.51	0.39	0.85
	Swan Hill	42	3.04		
Rochester	Buyers	26	3.60	0.84	0.99
	Sellers	24	3.42		
Swan Hill	Buyers	18	2.90	0.84	0.99
	Sellers	24	3.13		
Farm types	Dairy	38	3.76	0.17	0.41
	Horticulture	12	3.43		
Farm types	Dairy	38	3.76	0.05*	0.16
	Cropping and grazing	42	2.77		
Farm types	Horticulture	12	3.43	0.69	0.98
	Cropping and grazing	42	2.77		
All		92	3.32		

Note: *significant at 0.05 significant level
na - not available

Table 32. Comparison of Availability of Surface Drainage among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	43	4.16	0.28	0.95
	Sellers	48	3.76		
Two zones	Rochester	49	4.03	0.80	0.99
	Swan Hill	42	3.85		
Rochester	Buyers	25	4.33	0.16	0.86
	Sellers	24	3.65		
Swan Hill	Buyers	18	3.80	0.84	0.99
	Sellers	24	3.88		
Farm types	Dairy	37	4.57	0.01*	0.09
	Cropping and grazing	42	3.60		
All		91	3.95		

Note: * significant at 0.05 significant level
na - not available
Not enough responses have been received from horticultural farmers

Table 33. Comparison of Reuse of Drainage Water among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	3.81	0.02*	0.03*
	Sellers	49	2.74		
Two zones	Rochester	50	3.41	0.33	0.99
	Swan Hill	43	3.00		
Rochester	Buyers	26	3.86	0.13	0.17
	Sellers	24	2.89		
Swan Hill	Buyers	18	3.70	0.11	0.50
	Sellers	25	2.59		
Farm types	Dairy	39	3.90	0.09	0.45
	Cropping and grazing	42	3.08		
All		93	3.24		

Note: * significant at 0.05 significant level
na - not available
Not enough responses have been received for horticultural farming

These two outcomes are consistent with the fact that the majority of buyers are dairy farmers and the majority of sellers are cropping and grazing farmers.

Extent of the Laser Grading: The extent to which farms have undergone laser grading is one of several factors used in the analysis to test differences between temporary water buyers and sellers. Table 34 compares the extent of laser grading for these two groups. There is no significant difference between any of the categories regarding the use of laser grading.

Problems of Market Access for Farm Products: The severity of problems associated with transport of farm products to the market was tested to compare how temporary water buyers and sellers perceive the problem. Outcomes of the analysis are presented in Table 35. There is no significant difference between buyers and sellers with regard to market access. However, zonal differences have been observed with regard to the problem.

Problems of Marketing Farm Products: Issues like low prices and low demand for products have been grouped under the common label of marketing problems. There is no significant difference between any of the categories compared (Table 36): however, the mean response for respondents among dairy farmers is comparatively high. This reflects the general perception among of dairy farmers of the adverse impacts of the recent deregulation in the dairy industry (Telford *et al.,* 1997; Gleeson, 1998 and Ashton *et al.,* 2000). This issue would have contributed to a high mean response from dairy farmers. However, in the case of permanent water traders the mean response for dairy farmers is lower than that of cropping and grazing farmers. As shown earlier, the majority of dairy farmers who trade permanent water entitlements, are buyers and they seem to be efficient farmers who foresee less future problems.

Table 34. Comparison of Laser Grading of Farms among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	3.39	0.50	0.55
	Sellers	49	3.53		
Two zones	Rochester	50	3.35	0.30	0.59
	Swan Hill	43	3.63		
Rochester	Buyers	26	3.48	0.53	0.94
	Sellers	24	3.21		
Swan Hill	Buyers	18	3.20	0.17	0.50
	Sellers	25	3.88		
Farm types	Dairy	39	3.53	0.89	0.52
	Cropping and grazing	42	3.50		
All		93	3.46		

Note: Significance is tested at 0.05 significance level
na - not available
(Not enough responses have been received for horticultural farming)

Table 35. Comparison of Market Access Problems among Buyers and Sellers, Two Zones and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	1.61	0.92	0.99
	Sellers	48	1.67		
Two zones	Rochester	50	1.38	0.02*	0.16
	Swan Hill	42	2.04		
Rochester	Buyers	26	1.50	0.18	0.84
	Sellers	24	1.24		
Swan Hill	Buyers	18	1.89	0.61	0.99
	Sellers	24	2.13		
Farm types	Dairy	38	1.56	0.64	0.99
	Horticulture	12	1.71		
Farm types	Dairy	38	1.56	0.74	0.99
	Cropping and grazing	42	1.68		
Farm types	Horticulture	12	1.71	0.79	0.99
	Cropping and grazing	42	1.68		
All		92	2.50		

Note: * significant at 0.05 significant level
na - not available

Table 36. Comparison of Problems of Marketing Farm Products among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respond-ents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	2.47	0.98	0.99
	Sellers	48	2.53		
Two zones	Rochester	50	2.45	0.74	0.99
	Swan Hill	42	2.58		
Rochester	Buyers	26	2.52	0.57	0.78
	Sellers	24	2.35		
Swan Hill	Buyers	18	2.33	0.46	0.82
	Sellers	24	2.73		
Farm types	Dairy	38	2.65	0.27	0.82
	Horticulture	12	2.29		
Farm types	Dairy	38	2.65	0.37	0.97
	Cropping and grazing	42	2.37		
Farm types	Horticulture	12	2.29	0.61	0.99
	Cropping and grazing	42	2.37		
All		92	2.50		

Note: Significance is tested at 0.05 significance level
na - not available

Problems of Soil Degradation: The issue of soil degradation was discussed in Section 7.2 for permanent water traders. This issue is analysed in this section in relation to temporary water traders. Table 37 summarizes the results of the analysis.

Respondents from Rochester note fewer soil degradation problems compared to respondents from Swan Hill as shown in Table 37. However, the differences that exist between any of categories in relation to soil degradation are not significant.

Table 37. Comparison of Problems of Soil Degradation among Buyers and Sellers, Two Zones and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	45	2.43	0.61	0.99
	Sellers	48	2.27		
Two zones	Rochester	51	2.20	0.14	0.39
	Swan Hill	42	2.60		
Rochester	Buyers	27	2.26	0.67	0.29
	Sellers	24	2.12		
Swan Hill	Buyers	18	2.89	0.40	0.99
	Sellers	24	2.44		
Farm types	Dairy	38	2.36	0.31	0.68
	Horticulture	12	1.71		
Farm types	Dairy	38	2.36	0.54	0.99
	Cropping and grazing	43	2.54		
Farm types	Horticulture	12	1.71	0.19	0.85
	Cropping and grazing	43	2.54		
All		93	2.35		

Note: Significance is tested at 0.05 significance level
na - not available

Problems Related to Soil Salinity: Due to the severity of soil salinity related problems believed to be faced by a section of water users in the study area (Bjornlund and McKay, 1995), the issue was considered separately in the survey of temporary water traders. Table 38 summarizes results of the analysis of the issue. Specific conclusions cannot be drawn about differences in soil salinity problems between the categories compared except for buyers and sellers of Swan Hill.

Table 38. Comparison of Problems of Soil Salinity among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	2.91	0.32	0.84
	Sellers	48	2.61		
Two zones	Rochester	50	2.72	0.87	0.99
	Swan Hill	42	2.81		
Rochester	Buyers	26	2.70	0.83	0.99
	Sellers	24	2.76		
Swan Hill	Buyers	18	3.40	0.04*	0.39
	Sellers	24	2.44		
Farm types	Dairy	38	2.75	0.21	0.88
	Horticulture	12	2.14		
Farm types	Dairy	38	2.75	0.57	0.99
	Cropping and grazing	42	2.93		
Farm types	Horticulture	12	2.14	0.10	0.85
	Cropping and grazing	42	2.93		
All		92	2.76		

Note: * significant at 0.05 significant level
na - not available

Problems of High Groundwater Table: Problems of high groundwater table were considered as a separate issue in the survey of temporary water traders due to the severity of the problem believed to be existing in several irrigation zones in the study area (Bjornlund and McKay, 1995). Results of the analysis of the issue are summarized in Table 39.

No significant difference exists between zones or buyers and sellers (for both zones together or one zone) with regard to high groundwater table problems. However, significant differences exist between farm types.

Factors Related to Dairy and Grazing Farming

Four factors were included in the survey of temporary water traders: pasture area fertilized, grain use for animal feeding, stocking rate and ratio of annual to perennial pasture. Stocking rate was analysed only for dairy farmers.

Percentage of pasture area fertilised and annual grain use were analysed for temporary water traders in the dairy and cropping and grazing farming groups. Levels of these inputs were analysed for water buyers against sellers, two zones and two farming groups (dairy and cropping and grazing) in order to compare water buyers and sellers. The stocking rate and annual to perennial pasture ratio observed for temporary water traders was compared with that of permanent water traders and findings of previous studies (ABARE, 1997) in order to interpret the results of this study. In addition, results of the analysis of annual to perennial pasture ratio for temporary water traders were used in the analysis of water prices in the temporary water market (Section 11).

Table 39. Comparison of Problems of High Groundwater Table among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean**	**Significance of difference**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	44	3.00	0.28	0.96
	Sellers	48	2.66		
Two zones	Rochester	50	2.79	0.85	0.99
	Swan Hill	42	2.88		
Rochester	Buyers	26	2.91	0.52	0.99
	Sellers	24	2.65		
Swan Hill	Buyers	18	3.20	0.33	0.97
	Sellers	24	2.67		
Farm types	Dairy	38	3.26	0.03*	0.28
	Horticulture	12	2.14		
Farm types	Dairy	38	3.26	0.04*	0.38
	Cropping and grazing	42	2.58		
Farm types	Horticulture	12	2.14	0.36	0.98
	Cropping and grazing	42	2.58		
All		92	2.83		

Note: * significant at 0.05 significant level
na - not available

Area Fertilized and Grain Use: Tables 40 and 41 present a summary of the analysis of fertilized pasture area and grain use. The binomial distribution with normal approximation was used to test percentage of area fertilised. Binomial test values were decided on median value of the percentage of fertilised area in the sample. The MWU test, KS two sample test, and two-sample t-test were applied in the analysis of grain use.

There is a significant difference between buyers and sellers with regard to fertilized pasture area and grain use for animal feeding. This difference is clearly established between dairy farmers and cropping and grazing farmers. As shown earlier, the majority of buyers are dairy farmers and the majority of sellers are cropping and grazing farmers. This outcome is consistent with outcomes already observed in permanent water transfers. The same trend was observed for permanent transfers since permanent purchases are also dominated by dairy farmers.

Table 40. Comparison of Pasture Area Fertilized (for Animal Growers) among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Median percentage**	**Significance of difference based on binomial distribution**
Buyers and sellers	Buyers	30	100	0.02*
	Sellers	24	60	
Two zones	Rochester	35	98	0.46
	Swan Hill	19	95	
Farm types	Dairy	30	100	0.001*
	Cropping and grazing	22	50	
All		54	98	

Note: * significant at 0.05 significant level

Table 41. Comparison of Annual Grain Use for Animal Feeding (for Animal Growers) among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Mean (kg/animal)**	**Significance**	
				MWU test	**Two-sample KS test**
Buyers and sellers	Buyers	31	696	0.01*	0.01*
	Sellers	18	141		
Two zones	Rochester	32	506	0.51	0.86
	Swan Hill	17	465		
Farm types	Dairy	29	761	0.01*	0.01*
	cropping and grazing	18	112		
All		49	492		

Note: * significant at 0.05 significant level

Stocking Rate of Dairy Farmers: The mean stocking rate (head/ha), based on average irrigated area in the last five years for dairy farmers, is 2.30. The stocking rate is 3.12 if only perennial pasture area is considered. The values observed for permanent water traders are 2.29 and 3.35 respectively (Section 7.2).

The difference in stocking rates between temporary and permanent traders is not significant at 0.05 significant level. The MWU, two-sample KS and 2-sample t test of significance values are 0.87, 0.81 and 0.99 respectively when stocking rate is based on total average irrigated area. When the variable is based on perennial pasture area, the difference between the stocking rates is equally not significantly different (significance: 0.49, 0.76 and 0.54). The test results as well as the absolute values observed show that stocking rates for temporary and permanent water traders are very similar. Therefore results observed for temporary traders are entirely consistent with those from the analysis of permanent traders.

Annual Pasture-Perennial Pasture Ratio: The ratio of annual pasture area to perennial pasture area for temporary water traders who belong to the dairy farmers' group was analysed. The analysis was aimed at comparing this ratio with that observed for permanent water traders, and in the 1996/97 irrigation farm census for the study area (Douglass *et al.,* 1998) in order to test consistency of outcomes of this study. In addition, this ratio for temporary traders was used in the analysis of the variability of water price dairy water users are prepared to pay at the temporary water market (Section 11).

The mean annual-perennial pasture ratio observed for temporary water traders is 0.49. The mean ratios observed for permanent water traders and in the 1996/97 irrigation farm census (Douglass *et al*., 1998) are 0.54 and 0.47 respectively. The binomial test with normal curve approximation was applied to examine differences between the ratio observed for temporary and permanent water traders and the 1996/97 farm census. Binomial test values were applied on the median annual-perennial pasture ratio observed for temporary water traders. There is no significant difference between the ratio observed for temporary water traders and permanent water traders (Binomial test of significance: 0.89), and temporary water traders and 1996/97 irrigation farm census (Binomial test of significance: 0.28) at 0.05 level.

Survey responses for temporary water traders show that dairy farmers buy water to irrigate regularly irrigated areas (including perennial pasture and some annual pasture) or annual pasture given cheap water prices at the end of the water-year. Based on these two types of purchases for dairy farmers the annual-perennial pasture ratio was also analysed. Analysis of this ratio on these divisions is useful because the water price that dairy water users are prepared to pay at the temporary water market was also analysed in Section 11 to understand how the variability of purchase water prices. The mean annual-perennial pasture ratios for dairy farmers who buy water to irrigate regularly-irrigated areas and annual pasture area given cheap water prices at end of the water-year are 0.39 and 0.66 respectively.

In the case of temporary water traders in the cropping and grazing group, more than one-third of respondents do not depend on perennial pasture at all for animal feeding. The same observation is made for permanent water traders in the cropping and grazing farming group.

Comparative Analysis of Responses for Grain Use for Animal Feeding, Number of Animals and Pasture Area for Dairy Farming: Number of animals, pasture area and grain feeding are believed to be interrelated variables in animal based enterprises. A regression analysis was performed to identify any relation between annual quantity of grain use, number of animals and pasture area for dairy farmers.

Sample coefficients of determination between grain use and number of animals, extent of perennial pasture area, extent of annual pasture area and extent of total irrigated area are 0.49, 0.32, 0.001, and 0.02 respectively. The multiple coefficient of correlation between grain use (dependent variable), and number of animals and extent of perennial pasture area (independent variables) is 0.51. In a step-wise regression, none of independent variables qualifies to be included when the other independent variable is present in the relation. This indicates that none of independent variables has strong relation with grain use. However, sample coefficients of determination

between number of animals and perennial pasture area for temporary traders is 0.78. This shows that grain use has no strong relation with related variables compared to the relation between number of animals and extent of perennial pasture area. This suggests that although respondents use grain for supplementary feeding they are not prepared to use grain feeding to replace pasture area.

Restrictions in Water Application Rate

Temporary water traders were asked several questions regarding the impact of restrictions in water application rate on their operation. These questions were included in the survey in order to analyse how temporary water buyers and sellers are affected by the issue, and to compare consistency of results of the analysis for permanent and temporary traders.

There is a significant difference between buyers and sellers in this regard. Impacts of restrictions in water application rate on respondents are compared in Table 42.

There are significant differences of restrictions on application rates between buyers and sellers and between farm types. A greater number of dairy farmers compared to other farm types are restricted by application rates. The same situation was observed for dairy farmers in the analysis of responses from permanent traders. However, the difference between buyers and sellers for permanent trading was not significant because a significant proportion of buyers belong to the horticultural farming group (Table 23). Because water consumption by horticultural farmers is low compare to that of dairy farmers, horticultural farmers feel less restricted than dairy farmers (Douglass *et al*., 1998).

Table 42. Comparison of Application Rate Restrictions among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of respondents**	**Percentage of respondents restricted**	**Pearson Chi-squared test**
Buyers and sellers	Buyers	32	45	0.02*
	Sellers	34	18	
Two zones	Rochester	39	36	0.32
	Swan Hill	27	24	
Farm types	Dairy	27	59	0.01*
	Cropping and grazing	27	4	
	Dairy	27	59	0.04*
	Horticulture	12	20	
All		66	31	

Note: * significant at 0.05 significant level

Soil Types

Respondents were also asked to indicate the predominant type of soil in their properties. Table 43 shows the comparison of soil types applicable to different categories of temporary water traders.

As explained earlier in the analysis of responses for permanent water traders (Section 7.2), soils have been grouped into two types: extreme soil group that include sandy soils and clay soils, and loam soil group that include loam and sandy loam soils. As expected due to the spatial distribution of soils in the study area, there is a significant difference between the two zones with respect to soil types; however, there are no differences between buyers and sellers or between farm types.

Table 43. Comparison of Soil Types among Buyers and Sellers, Two Zones, and Farm Types

Basis for comparison		**Number of responses**	**Percentage of respondents who have farms on loam soils**	**Pearson Chi-squared test significance**
Buyers and sellers	Buyers	34	53	0.72
	Sellers	37	49	
Two zones	Rochester	44	61	0.02*
	Swan Hill	27	33	
Farm types	Dairy	30	53	1.00
	Cropping and grazing	30	53	
	Dairy	30	53	0.71
	Horticulture	10	60	
All		71	51	

Note: * significant at 0.05 significant level

- Temporary water traders have no specific reason to trade from/ to a, particular area.
- Most traders have not observed limitations on trading other than too low or too high prices.
- There is a significant difference in the size of property area between buyers and sellers on the temporary water market.
- There is no significant difference in the size of permanent water entitlements attached to properties of temporary water buyers and sellers.
- There is hardly any difference in the irrigation method used by temporary water buyers and sellers.
- There is no significant difference between temporary water buyers and sellers with regard to alternative water sources and storage facilities.
- Out of nine selected resource, economic and environmental factors, only reuse of drainage water significantly differs between temporary buyers and sellers. No factor other than problems of market access differs between the two zones: Rochester and Swan Hill. Availability of surface drainage and problems of high groundwater table differ according to farm types.
- Dairy farmers maintain consistent stocking rate and annual pasture-perennial pasture ratio.
- The number of animals owned by dairy farmers is highly correlated to the extent of perennial pasture.
- Two-thirds of the pasture area of dairy farmers is perennial pasture. The annual-perennial pasture ratio of dairy farmers and the reason for water purchase on the temporary water market are related.
- There are significant differences in restrictions to application rates between temporary water buyers and sellers and between dairy and other farm types. Predominance of dairy farmers among buyers would have influenced the difference between buyers and sellers.
- Temporary buyers or sellers are not restricted to particular soil types on the farm.

10.3 Summary of Analysis of Factors Associated with Temporary Water Trading

This section summarises the results of the analysis carried out in section 10.2. The analysis centres on the comparison of the main variables based on two criteria: water buyers and sellers and between Swan Hill and Rochester areas. Table 44 shows the summary of outcomes.

Comparison of Water Buyers and Sellers

Several factors used to analyse permanent water transfers were also used in this section to compare temporary water trading. Table 44 shows there is no difference between temporary water buyers and sellers except for property area, reuse of drainage water, fertilised pasture area, grain use for animal feeding and application rate restrictions. Except for reuse of drainage water, differences in other four factors coincide with differences among farm types. There is no evidence from these results that temporary buyers can be distinguished from temporary sellers as a better section of farmers in terms of general efficiency or use of advanced farm technology. Conversely, the majority of permanent water buyers could be identified as comparatively more efficient and advanced users of farm technology.

Comparison of Two Zones

The analysis across the two zones included in the survey, Rochester and Swan Hill, shows that only spatially distributed factors considered in the analysis such as soil type and problems of market access are different between the two zones. Although not significantly different, respondents felt that there are less soil degradation problems in Rochester than in Swan Hill. Rochester, on the other hand, has significantly higher water entitlements due to significant differences in farm types. Over 50% of respondents in Rochester are dairy farmers. On the other hand, over 70% in Swan Hill are cropping and grazing farmers.

- ❖ Water buyers at the temporary water market cannot be distinguished from sellers as a better section of farmers in terms of general efficiency or use of advanced farm technology.

Table 44. Summary of Analysis of Factors Associated with Temporary Water Trading

Factor/issue	Significant difference between:					Remarks
	Buyers and sellers	RO and SH	Farm type			
			D - H	D - CGR	H - CGR	
Internal against external trading	No	No	na	na	na	
Reason to trade	No	No	na	na	na	
with particular area Impact of trading rules on trading	No	No	na	na	na	
Property area	Yes	No	Yes	Yes	No	Buyers/dairy - high
Water entitlement attached	No	Yes	Yes	Yes	No	Rochester/dairy - high
Irrigation method	No	No	Yes	No	Yes	More horticulture-advanced methods
Availability of off-quota water	No	No	na	na	na	
Availability of farm dams	No	No	na	No	na	
Groundwater use	No	No	na	na	na	
Access to regional drainage	No	No	No	No	No	
Availability of surface drains	No	No	na	Yes	na	Dairy - high
Reuse of drainage water	Yes	No	na	No	na	Buyers - high
Laser grading of farms	No	No	na	No	na	
Problems of market access	No	Yes	No	No	No	Rochester - low
Problems of marketing products	No	No	No	No	No	
Problems of soil degradation	No	No	No	No	No	
Problems of soil salinity	No	No	No	No	No	
Problems of high groundwater table	No	No	Yes	Yes	No	Dairy - high
Pasture area fertilized	Yes	No	na	Yes	na	Buyers/ dairy - high
Grain use for animal feeding	Yes	No	na	Yes	No	Buyers/ dairy - high
Stocking rate of dairy farmers	na	na	na	na	na	2.30 head/ha. for dairy
Annual-perennial pasture area ratio	na	na	na	na	na	0.49 for dairy
Application rate restrictions	Yes	No	Yes	Yes	No	Buyers/ dairy - high
Soil type	No	Yes	No	No	No	More in Rochester - loam soils

Note: na - not applicable, D - Dairy, H- Horticulture, CGR - Cropping and Grazing
RO - Rochester, SH - Swan Hill

11. Variability of Temporary Water Price

11.1 Temporary Water Price Variability in the Past

Price of water is a decisive factor in temporary trading. The analysis of water price presented in this section is based on data obtained from survey responses and past water records. Figure 21 shows the variability of temporary water trading price in Rochester for the water-years 1998/1999 - 2000/2001. Water prices are those agreed by buyers and sellers in the Northern Victorian Water Exchange (G-MW, 1999a - 2001). The Northern Victorian Water Exchange has been established by the water authority to facilitate temporary water trading. For Rochester, the analysis includes three years characterised by low initial allocations and final allocation of 100%. There are however some differences in climate and the distribution of allocations. The general price variability shown in Figure 21 is also applicable to several other trading zones.

Clearly, there are three separate segments of price variation that can be identified during the year. Segment 'A' corresponds with unstable price behaviour at the beginning of the water-year; segment 'B' is a relatively more stable period in the middle of the water year; and segment 'C' shows a declining price nearing the end of the water-year.

Segment 'A' water prices are highly unpredictable. In a dry water-year with low initial allocations and low rainfall, prices are very high, although they subsequently decrease as increased allocations are announced. There are few sellers in this period and farmers with high value crops, who face a shortage of water, tend to drive prices up. This is evident in a relatively dry year like 1998/1999. On the other hand, in a wet water-year with low initial allocations and high and/or well distributed rainfall at the beginning of the season, prices begin low and later stabilize over the following several weeks. This situation was observed in 1999/2000. The year commenced with early rainfall and 35% initial water allocations in most of irrigation zones (G-MW, 2000). Despite low allocations, demand for irrigation water remained low resulting in low water prices at the beginning of the season.

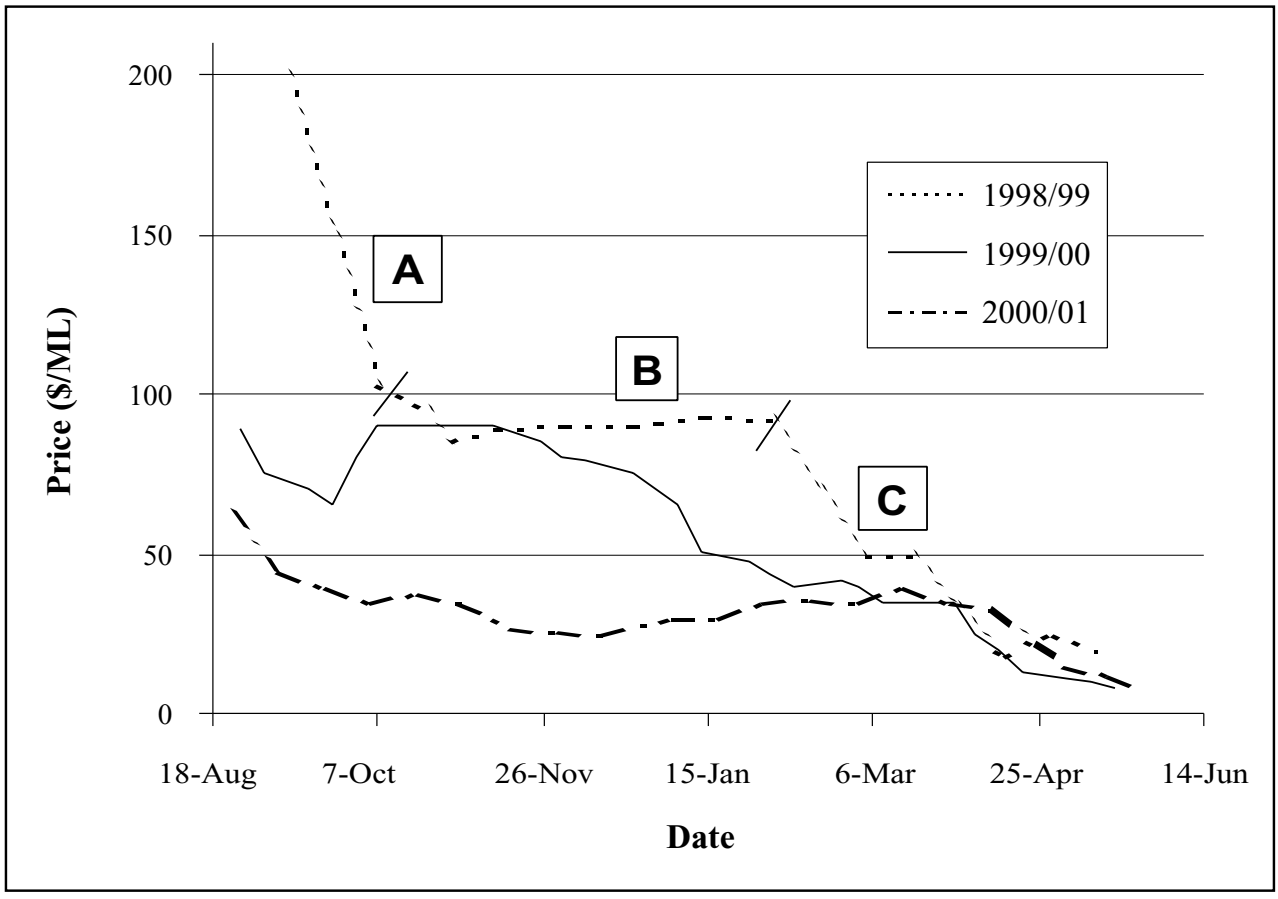

Figure 21. Temporary Water Price in Rochester for 1998/99 to 2000/01 Water -Years

Segment 'B' trend comprises the middle of the water-year when allocations remain constant or increase slowly and prices tend to remain stable. The price relations observed in Figure 21 for 1998/1999 and 1999/2000 illustrate this trend. During this period, sellers still do not have a proper estimation of the excess of water available because final allocations were not yet known. However, there is still demand for water especially from high value farmers whose water entitlements do not yield enough water at the time.

Segment "C' is observed at the end of the water-year. At this time, most potential traders have made a more accurate estimation of their water availability and demand. In general, there tends to be excess water available because a large number of cropping and grazing farmers hold water entitlements that under normal circumstance yield more than sufficient water for their irrigated areas as evidenced by their water availability (Douglass *et al*., 1998). Because of the higher risk associated with water shortage, horticultural farmers maintain a high level of water availability. In most years, excess water from them also becomes available at the end of the water-year. Because of all these factors operating late in the season, supply of water to the market exceeds the demand and water prices tend to decrease rather rapidly. The survey responses in this study confirm the assertion that water purchases at end of the water-year due to these low water prices normally fall into two categories: purchases to satisfy the requirement of crop areas already under irrigation and irrigation of annual pasture. Furthermore, there are farmers who do not sell their excess water due to low prices, and instead opt for irrigating their own annual pasture. These areas would not have been irrigated if water prices were higher.

Water prices in Segments A and B of 2000/01 water-years were lower than those in the previous two years. Segment B with low water prices was very long in this year. Because of the long period of low water prices, the initial period of Segment C continues with the declining trend of Segment B. Often availability of higher initial allocations and evenly distributed rainfall can result in this type of variability. In contrast to the previous two water years, water allocation increased rapidly and reached 100% at end of October in the 2000/01 water-year. Well-distributed spring rainfall was also a contributing factor. It is also possible that water price variability in past years could be another reason contributing to water trading decisions made by farmers.

From the past several years, water users know that excess water is available in general and water prices decline towards the end of the year. This induces a large proportion of water transfers to take place in this part of the season. This was the case in the 1998/1999 and again in 1999/2000 water years. The percentage of trades that took place from mid-February to end of the water-year was similar in 1998/1999 and 1999/2000. In view of this experience it is possible that buyers are not prepared to pay higher prices during the early and mid part of the year, but rather wait until the late part of the season to carry out any purchases.

A summary of water trading for Rochester for 1998/1999 to 2000/2001 water-years and Swan Hill for the 1999/2000 water-year is shown in Table 45. Data for this analysis were obtained from the Northern Victorian Water Exchange. The duration of the pricing segments is slightly different for each year because of climatic variability and sequence of allocation announcements.

Lower prices were observed in Swan Hill compared to Rochester in Segments A and B during the 1999/2000 water-year. Swan Hill had higher allocations from the beginning of the water-year leading to 190% allocation at the end of the season. Moreover, Swan Hill has a higher percentage of the area under cropping and grazing farming with higher water availability and low percentage of area under dairy farming with higher water use (Douglass *et al*., 1998). Water sellers in Swan Hill are not able to sell their water to Rochester due to system limitations although Rochester sellers can sell their water to Swan Hill. These reasons could have contributed to the price differences observed.

Water prices for Segment 'C', and results from the analysis of purchase water price shown in Table 46 indicate that the behaviour of water price in both zones is similar when there is excess water.

Table 45. Temporary Water Prices in the Rochester and Swan Hill Trading Zones

Segment*	Description	Rochester			Swan Hill
		1998/1999	1999/2000	2000/2001	1999/2000
A	Period	Before mid-October	Before mid-October	Before mid-October	Before mid-October
	Price range ($/ML)	85-200	66-90	38-63	25-45
	Average price ($/ML)	124	77	41	42
	Allocation (%)	40-90	35-55	45-80	100-110
	% of total trade	10	10	10	5
B	Period	mid-October-mid-February	mid-October-early-January	mid-October-early-April	mid-October-end-January
	Price range ($/ML)	85-93	75-90	20-40	50-60
	Average price ($/ML)	91	86	33	52
	Allocation (%)	90-100	70-90	95-100	110-120
	% of total trade	30	10	85	15
C	Period	After mid-February	After early January	After early April	After end-January
	Price range ($/ML)	18-71	8-65	8-33	11-50
	Average price ($/ML)	40	37	18	38
	Allocation (%)	100	100	100	130-190
	% of total trade	60	80	5	80
Average price for the water-year ($/ML)		66	55	34	45

Note: * segments - refer Figure 21

Table 46. Purchase Price Analysis for Dairy Farmers

Description	Mean price ($/ML)		Mean of the maximum price respondents are prepared to pay ($/ML)
	From water records	Survey respondents	
Segment 'B'- Rochester	85.77	83.80	96.40
Segment 'C'- for all purposes in Rochester	37.28	34.82	41.78
Segment 'C'- for all purposes in Rochester and Swan Hill	37.45	33.37	40.27
Segment 'C'- irrigation for regular crops in Rochester	na	36.35	44.84
Segment 'C'- irrigation for regular crops in Rochester and Swan Hill	na	35.15	43.26
Segment 'C'- annual pasture irrigation due to cheaper water prices in Rochester	na	26.08	33.40

Note: segments correspond to Figure 21

- ❖ Water prices on the temporary market in the recent past were variable at beginning of the water-year, more stable in the middle of the year, and declining towards the end of the water-year.
- ❖ Farmers' memory of water price variations seems to be an important factor that influences water price.

11.2 Analysis of Water Price

Purchase Water Price

Survey respondents were requested to indicate the price they paid for water on the temporary market. They were also requested to indicate the percentage of water price increase at which they would have changed their decision to buy water if the price of water had been higher than the price they paid at the time they bought water, and whether they would have changed their decision to purchase water if prices of farm products were lower by between 5% and 50%.

Based on the survey responses, the maximum price buyers are willing to pay for water was calculated. Purchases have been divided into the following categories for dairy farming:

- purchases to meet requirements of crop areas regularly under irrigation, and
- purchases for irrigation of annual pasture because of cheaper water prices at the end of the water-year.

The maximum prices that farmers are willing to pay have been analysed under conditions normally prevailing in a water-year in the study area. Extreme conditions such as extremely wet or dry year, very low or high commodity prices could result different price relations.

Table 46 contains statistics of the maximum prices that dairy farmers are prepared to pay for water. The price variability related to Segment 'B' and purchases due to cheaper water prices were analysed only for Rochester because not enough responses were available for Swan Hill. Mean prices from water records stated in Table 46 were calculated from water trading data obtained from the Northern Victorian Water Exchange. They are applicable to all water buyers in the study area.

There are no large discrepancies between mean water prices from water records and the responses of the survey. The average maximum prices that buyers are prepared to pay in Rochester, and Rochester and Swan Hill together are quite similar for two cases considered: purchases for existing irrigated area and purchases for all purposes. This observation, together with details shown in Table 45 for Segment 'C', suggests that responses in both zones can be combined together to analyse the behaviour of the maximum price that dairy farmers are willing to pay.

There is a large difference between the maximum price dairy farmers are willing to pay for their regularly irrigated area and purchase due to cheaper water prices at end of the water- year. Therefore, in the analysis of maximum price variability, it is important to analyse these two types of purchases separately.

The number of respondents that bought water and belong to the cropping and grazing group is limited and almost all of them bought water for annual pasture irrigation due to cheaper water prices at the end of the water year (Segment C). The price range is \$15/ML-\$23/ML and the mean maximum price farmers are prepared to pay is \$19.38/ML. An insufficient number of responses were received from horticultural farmers to carry out a similar analysis for this group.

The maximum price that dairy and cropping and grazing farmers are prepared to pay is shown in Figures 22 and 23. These are based on responses from temporary water buyers in the survey. Figure 22 presents the price relations with respect to percentage of number of water buyers while Figure 23 is based on volume of water purchased developed from responses in Segment C of the water-year. It must be noted from Table 45 that Segment C usually accounts for most of the water traded in a water-year.

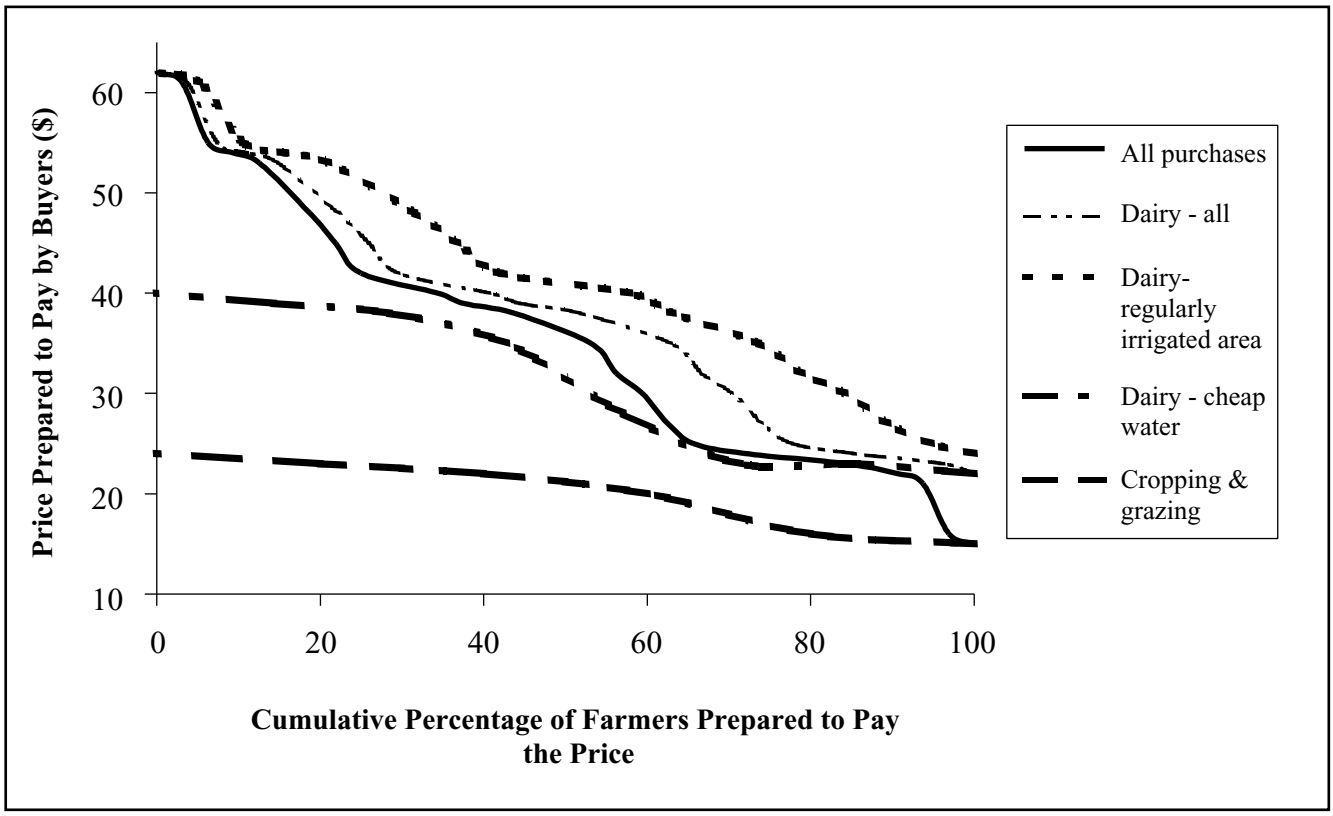

Figure 22. Maximum Water Price Dairy and Cropping and Grazing Farmers are Prepared to Pay

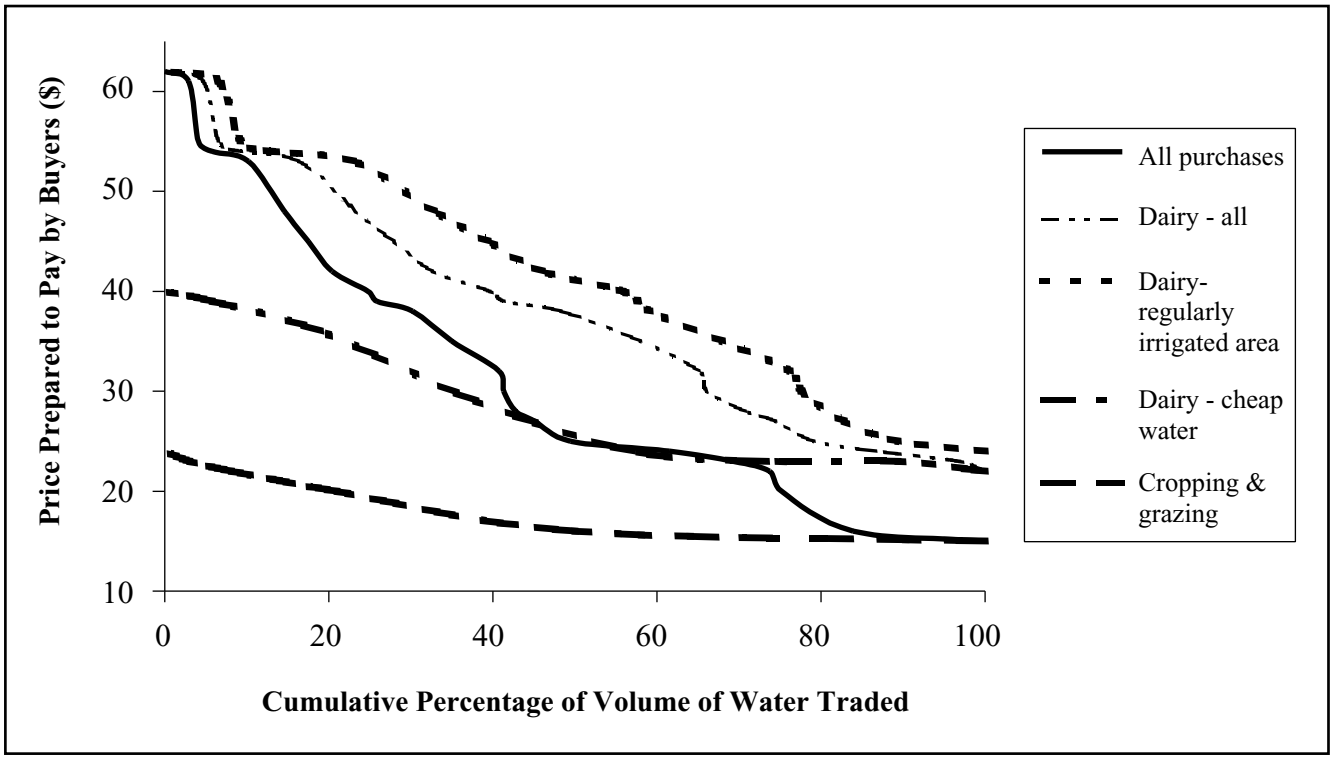

Figure 23. Variability of Maximum Water Price Dairy and Cropping and Grazing Prepared to Pay by Farmers Against Volume Purchased

Price relations for water buyers in the dairy farming group were developed separately for:

- purchases for requirements of regularly irrigated area, and
- purchases due to cheaper water prices at end of the year.

Purchases due to cheaper water prices at end of the year are mainly made to irrigate annual pasture in autumn.

All water buyers in the cropping and grazing group have purchased water due to cheaper water prices to irrigate annual pasture in autumn. Therefore the price-demand relation was developed based on trades in Segment 'C'.

It is important to note that dairy farmers who purchase water to irrigate their regularly irrigated area maintain mean annual to perennial pasture ratio of 0.39. They mainly depend on perennial pasture for animal feeding. On the other hand, dairy farmers who purchase water due to cheaper water prices at the end of the year are more dependent on annual pasture. They buy water mainly to irrigate annual pasture in autumn and their mean annual-perennial to pasture ratio is 0.66. The mean annual to perennial pasture ratio observed for all water traders in the dairy farmers group is 0.49.

Participants in this survey were also requested to respond whether they would change their decision to purchase water if prices of farm products were lower by between 5 and 50%. Responses to this question in the preceding water price analysis show that there are few buyers willing to purchase water if prices of farm products were lower by 50% or price of water was 50% higher.

Sales Water Price

Water sellers were ask to indicate the percentage of water price decrease at which they would have changed their decision to sell water if the price of water had been lower than the price they received at the time they sold water, and their intention about selling water if prices of farm products were high by between 5% and 50%. The summary of responses is shown in Table 47.

Table 47 shows that the decision to sell water is not sensitive to prices of farm products. The majority of sellers (67%) sold water because excess water available and they are not able to increase their irrigated area.

According to Table 47 the majority of sellers preferred to sell water even if the water price was low. However, some sellers would have changed their decision to sell water if price was low. For instance, 35% of sellers who sold water due to excess water in the cropping and grazing group would not have sold their water if the price were 50% lower. Some cropping and grazing farmers who sold water indicated that they would use the water to irrigate annual pasture in autumn. Annual pastures would not have been irrigated if the price of water were higher. It is also apparent from Table 47 that the response is more sensitive to changes in water price than to changes in commodity prices.

Table 47. Sellers' Response Assuming Prices of Farm Products and Water are Changed

Condition	**Reason for water sales**	**Farm type**	**Percentage of respondents who would continue to sell**
Prices of farm products were higher by 50%	All reasons	Horticulture	80
		Cropping and grazing	68
	Excess water	Horticulture	100
		Cropping and grazing	85
Price of water were lower by 50%	All reasons	Horticulture	40
		Cropping and grazing	65
	Excess water	Horticulture	67
		Cropping and grazing	65

Note: not enough responses received from dairy farmers.

- The maximum price that buyers are willing to pay for water depends on water uses.
- Water prices and commodity prices highly influence farmer's decision to purchase water.
- A farmer's decision to sell water is more sensitive to water price than commodity price.

Part IV - Security Aspirations

12. Desired Water Security of Farmers

12.1 Defining Water Security

Water security in an irrigation system can be expressed in several ways. If water availability is higher than water requirement in all seasons, security can be considered as 100%. On this basis, water security depends on the annual allocation, water availability (Entitlement available per unit crop area), crop type and climate factors.

Water availability can be considered as an indicator of water security. According to past data in the study area, there is little difference in allocation between different regions. Given that allocations and climatic factors are beyond the control of water users, the main alternative available to farmers with pre-defined farm types to change their security is to change their water availability.

As shown in Section 6, two major reasons for purchasing water entitlements are increasing application rates for existing crops and proofing existing crops against possible droughts. A major reason for selling water entitlements is excess water available. This study as well as previous studies (Bjornlund and McKay, 1995) show that about 50% of buyers and 40% of sellers trade their water entitlements due to these reasons. It is therefore hypothesised that both buyers and sellers aim to achieve a similar level of water availability as a security measure by transferring their water entitlements. This desired water availability in terms of water entitlement per unit area was considered a variable in this study.

12.2 Study of Desired Water Availability

The survey conducted for this study collected data required to analyse the desired water security in terms of water availability for permanent and temporary water traders.

The desired water availability of permanent water traders is analysed for traders who purchased or sold water in relation to three farm types: dairy, horticulture, and cropping and grazing. The desired water availability based on water trades for security reasons (trades due to shortage and excess of water), and expansion or reduction of irrigated area was compared for the three farm types wherever possible. In addition, an analysis was also conducted of how farmers react in relation to their desired water availability if the price of farming commodities changes.

One can argue that an analysis based only on permanent water trading is not representative of all farmers. It can also be argued that permanent water entitlement buyers are a better section of farmers (efficient, progressive) than sellers. It is therefore also necessary to analyse security aspirations using farmers who have not transferred their water entitlements.

The survey of temporary water traders in Rochester and Swan Hill provides an independent source of data to test and compare outcomes from the analysis of desired water availability of permanent water traders. These temporary water traders belong to two zones of the study area whilst permanent water traders belong to the entire study area. The temporary water traders did not trade permanent water entitlements in the 1999/2000 water year during which permanent water trading took place.

Irrigated areas of dairy farms consist of perennial pasture and annual pasture. As shown in Parts II and III, and also by ABARE (1997), dairy farmers in northern Victoria are highly dependent on perennial pasture. Therefore, security analysis for dairy farmers was carried out on the basis of both the total average irrigated area and the average perennial pasture area.

12.3 Data

In the survey of permanent water traders, questions were formulated in a way that enables the calculation of the desired security in terms of water availability (water entitlement per unit area) for individual respondents. The questionnaire asked several questions related to water transfers:

- reasons for transfers,
- water entitlement before the transfer,
- water entitlement transferred,
- further water entitlement intended to be transferred in future without changing present average irrigated area,
- farm type,

- irrigated areas in the 1999/00 season and average for the last five water-years,
- property area,
- total irrigable area within the property, and
- whether the decision about water transfers would have changed if prices of farm products had been different at the time of the transfer.

Temporary water traders were asked to state:

- their farm type, irrigated area in the 1999/00 season and average own the last five water-years,
- property area, maximum possible irrigated area, and
- present water entitlement and quantity of water entitlement they would wish to trade in future without changing their present average irrigated area.

These data enabled the analysis of the desired water availability for different farm types and comparison with that of permanent water traders.

Present water entitlements and details of property area for both permanent and temporary traders, and water entitlements traded for permanent water traders were crosschecked with records of the water authority (Goulburn -Murray Water).

13. Analysis of Desired Water Availability

The desired water availability of a respondent who belong to a particular farm type is calculated by dividing desired water entitlement by the average irrigated area for the last five years provided this has not changed due to permanent water trading. Three farm types (dairy, horticulture, and cropping and grazing) were considered in the analysis.

In the case of expansions and reductions of irrigated area by permanent trades, the increase or decrease in irrigated area was also taken into account in the calculations.

The desired water entitlement is defined as the sum of an irrigator's present water entitlement (after water transfer in case of permanent trade) and any water entitlement the irrigator wishes to buy or sell for the present irrigated area but has not been able to do so for various reasons.

Desired water entitlement W_{df} (ML) of an irrigator who belongs to farm type f is defined as:

$$W_{df} = W_{pf} + W_{mf} \quad (1)$$

where:

W_{pf} = present water entitlement available for farm type f (water entitlement available before the transfer plus water entitlement bought in case of permanent water traders)

W_{mf} = additional water entitlement intended to be traded in future without changing present irrigated area (negative if selling)

The irrigated area I_a (ha) for calculation of desired water availability is:

$$I_a = I_{av} + I_c \quad (2)$$

where:

I_{av} = average irrigated area (before water transfer in case of permanent water trading)

I_c = change of irrigated area due to the transfer (only for expansion or reduction due to permanent water trading, negative for reductions)

The irrigated area is the total area under perennial pasture and annual pasture or area under perennial pasture in case of dairy farming.

Then the desired water availability (ML/ha) is defined as:

$$w_{af} = W_{df} / I_a \quad (3)$$

where w_{af} = desired water availability

13.1 Security Aspirations of Permanent Water Traders

Dairy Farming

Buyers of Water Entitlements: The key statistics of desired water availability for dairy farming buyers are presented in Table 48 together with purchases made for two reasons: security and expansions. The statistical distributions of desired water availability based on two cropping scenarios are symmetric and normal as proven by the SW test at 0.05 significance level.

The means of desired availability for purchases made for security reasons and those made for expansions based on total irrigated area are 3.78 ML/ha. and 4.01 ML/ha. In order to test whether farmers are trying to achieve a different level of security depending on the reasons for purchasing water, the desired water availability for purchases made for security reasons and those made for expansions were compared by testing the equality of means and distributions. The MWU significance test for equality of means and 2-sample KS test significance for equality of distributions are 0.74 and 0.98 respectively showing that the means are not significantly different. If only the perennial pasture area is considered as the indicator of irrigated area, the significance values are 0.56 and 0.31 respectively. These results indicate that farmers try to achieve the same water entitlement per unit area irrespective of the reason for purchase.

Sellers of Water Entitlements: Since there are a small number of dairy farmers who sell water entitlements, the sample size available from responses to analyse security issues for sales is too small to be statistically analysed. Furthermore, all available responses are related to reductions in irrigated areas. Therefore statistical tests have not been carried out for sales.

Horticultural Farming

The means of desired water availability for purchases for security reasons and expansions are 3.01 ML/ha. and 1.54 ML/ha. Notwithstanding that the absolute difference between means appear to be high (1.48 ML/ha), they are not significantly different based on the MWU and 2-sample KS tests (Significance values: 0.13 and 0.48 respectively).

Table 48. Descriptive Statistics of Desired Water Availability for Dairy Farming - Buyers, who wish to Increase Water Entitlement per Unit Area (ML/ha)

Description	**Statistic**	
	Based on total irrigated area	**Based on only perennial pasture area**
Mean (ML/ha)	3.86	5.69
Standard error of the mean	0.41	0.50
Median	3.51	5.83
Standard deviation	1.72	2.12
Shapiro-Wilk test significance for normality	0.76	0.90

As shown in the following section, the level of water availability achieved by buyers who purchase water entitlements for expansions of irrigated horticulture is very similar to that achieved by cropping and grazing farmers. Cropping and grazing farmers are highly dependent on annual pasture and are considered to take higher risk on water security than other farmers (Bjornlund, 2000). Horticultural farmers are normally considered as water users taking low risk due to the nature of their crops. Therefore, water availability achieved for expansions of horticultural farming appears not to be representative of actual water needs.

On the other hand, farmers who buy water entitlements for security reasons and who sell water entitlements due to excess water can be considered to have a better estimation of water requirement of their crops compared to farmers who try to expand into new lands. The mean desired water availability for water entitlement sellers is 3.19 ML/ha, which is almost similar to the mean desired water availability achieved by buyers who purchased water entitlements for security reasons. The MWU test and 2-sample KS test of significance for the difference between means and distributions of desired security of buyers for security reasons and water entitlement sellers are 0.39 and 0.99 respectively. This shows that buyers who purchase water entitlements for security reasons and sellers of water entitlements reach the same level of water availability. Because of this similarity, the descriptive statistics of water availability are shown in Table 49 for both categories together. The mean desired water availability for both categories together, shown in Table 49 is almost similar to that of individual categories considered. Because of these similarities, statistics of both categories together were used with statistics from the analysis of temporary water trading to verify desired water availability of horticultural farmers (Section 13.3).

Cropping and Grazing Farming

Buyers of Water Entitlements: Nearly all cropping and grazing farmers have purchased water entitlements for security requirements. Descriptive statistics of desired water availability are presented in Table 50.

Table 49. Descriptive Statistics for Desired Water Availability for Horticultural Farmers (Water Entitlements Buyers for Security Reasons and Sellers combined)

Description	Statistic
Mean (ML/ha)	3.08
Standard error of the mean	0.29
Median	2.79
Standard deviation	1.24
Shapiro-Wilk test significance for normality	0.29

Note: Desired water availability is measured in terms of water entitlements per unit area in ML/ha

Table 50. Descriptive Statistics for Desired Water Availability for Cropping and Grazing Farming Buyers

Statistic	Purchased for security reasons
Mean (ML/ha)	1.87
Standard error of the mean	0.24
Median	1.99
Standard deviation	0.67
Shapiro-Wilk test significance for normality	0.31

Sellers of Water Entitlements: The majority of sellers of water entitlements in the study area are in the cropping and grazing farming group. Table 51 presents descriptive statistics of desired water availability for sellers of water entitlements that belong to this group. It includes three categories: sales due to excess water, sales due to reduction in irrigated area and all sales. The normality test verifies that the desired water availability is normally distributed.

The desired water availability achieved after the sale of water entitlements due to excess water and reductions of irrigated areas was analysed using two-sample t-test. The significance test indicates that the two means are not significantly different. This result confirms that it is appropriate to consider both samples of sellers due to excess water and to area reductions together for the calculations of security of cropping and grazing farmers who sold water entitlements.

Buyers of Water Entitlements Against Sellers: The mean value of water availability desired by CG buyers (for all reasons) and sellers are 1.87 ML/ha and 1.47 ML/ha respectively. A comparison of buyers and sellers shows that the mean value of water availability of sellers is 0.41 ML/ha less than that of buyers. However, the two-sample t-test shows that the means are not significantly different at 0.05 level (test significance for equality of means: 0.22). This higher-risk taking attitude of cropping and grazing sellers who are prepared to reduce their water entitlements drastically has already been observed in previous studies (Bjornlund, 2000).

Table 51. Descriptive Statistics of Desired Water Availability for Cropping and Grazing Sellers

Statistic	**Category**		
	Sales due to excess water	**Sales due to area reduction**	**All sales**
Mean (ML/ha)	1.48	1.45	1.47
Standard error of the mean	0.12	0.10	0.08
Median	1.28	1.53	1.36
Standard deviation	0.52	0.33	0.44
Shapiro-Wilk test significance for normality	0.09	0.71	0.27
Significance of 2-sample t - test for equality of means	0.91		

Note: significance is tested at 0.05 level

Security Aspirations and Change of Prices of Farm Products

One aim of the survey of permanent water traders was to determine whether there would be a change in the level of water availability desired by traders if prices of farming products change. Permanent water traders were requested to outline their behaviour in buying and selling water entitlements if the price of farm products were different at the time of the transactions assuming they remain in the same type of farming enterprise. Respondents were asked to respond to five scenarios of price change for selling and buying water entitlements. In the case of buying water entitlements the five scenarios are: 0%, 5%, 10%, 20% and 50% reduction in product price. In the case of selling, the same percentages of price increases were considered.

Relation between Desired Water Availability and Price Reduction: The behaviour of desired water availability for water buyers when prices of farm products are reduced is shown in Figure 24 for dairy, horticultural and cropping and grazing farming. Purchases for two reasons: security and expansions were considered for dairy, and only purchases for security reasons were considered for horticultural and cropping and grazing farming.

The overall trend shows a reduction in the level of water availability desired by farmers when prices of farm products drop. Compared with cropping and grazing farming, dairy and horticultural farmers are more responsive to price reductions. Moreover, most respondents indicated that they would give up farming if prices fall by more than 20 % in the long-term.

Relation between Desired Water Availability and Price Increases: As described earlier, insufficient data are available to carry out a sensitivity analysis of desired water availability for dairy and horticultural sellers. Therefore, this analysis is limited to cropping and grazing sellers.

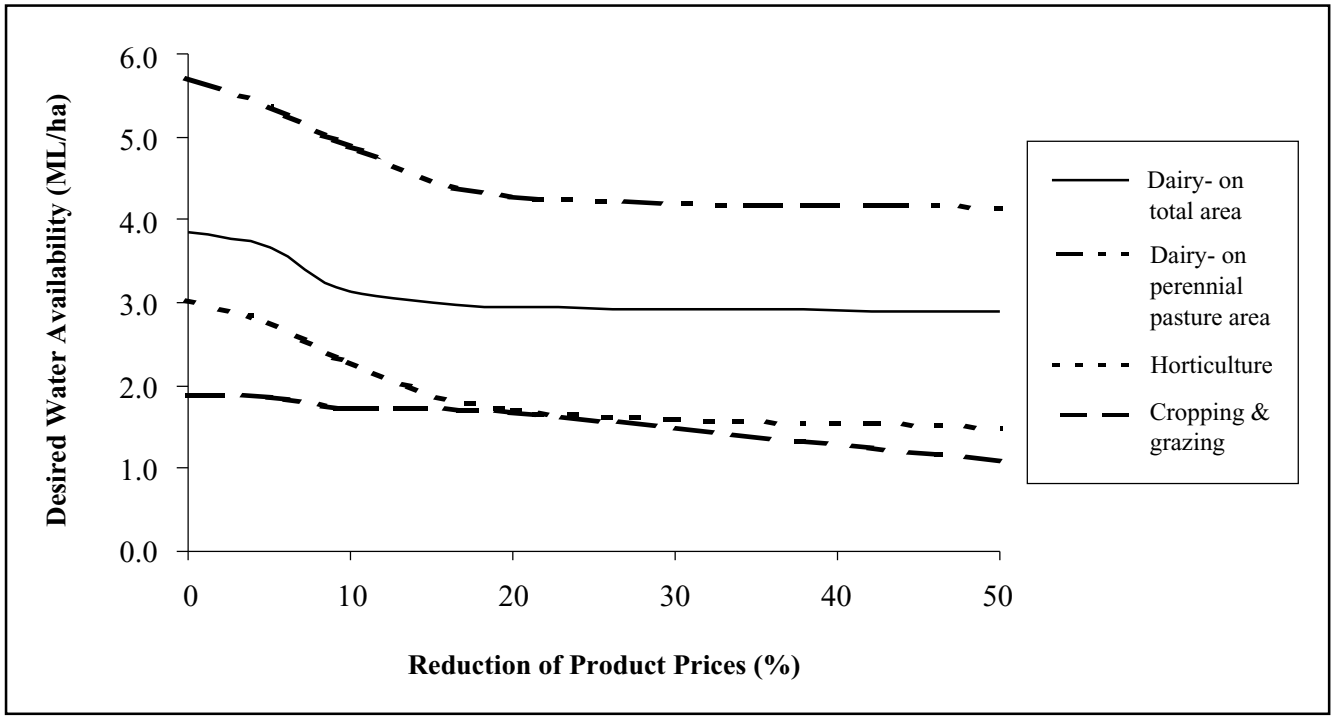

Figure 24. Sensitivity of Desired Water Availability to Reduction of Farm Product Prices

The variability of the desired water availability for cropping and grazing sellers of water entitlements because of either excess water or reduction of irrigated area when prices of farm products increase is shown in Figure 25.

It appears that sellers have opted for higher water availability by retaining their water entitlements if prices of farm products were higher. However, most of the respondents who opted for retaining their water entitlements (generally more than 10%), noted that by retaining the additional water entitlements their water availability would be excessive for the existing irrigated area.

The analysis shows that the mean desired water availability at 10% price increase is 1.82 ML/ha for cropping and grazing sellers. This value is similar to the mean desired water availability for farmers who bought water entitlements for security reasons (1.87 ML/ha). These values are not statistically different at 0.05 level of significance (One-sample t test, MWU test and 2-sample KS test of significance: 0.77, 0.57 and 0.49 respectively). This suggests that water availability desired by buyers (with no commodity price change) represents the actual security aspirations of cropping and grazing farmers. Because water sellers would consider retaining their water availability if commodity price increases (1.82 ML/ha), this implies that sellers are then prepared to take a higher risk than buyers by selling water entitlements, which would result in a lower water availability (1.47 ML/ ha).

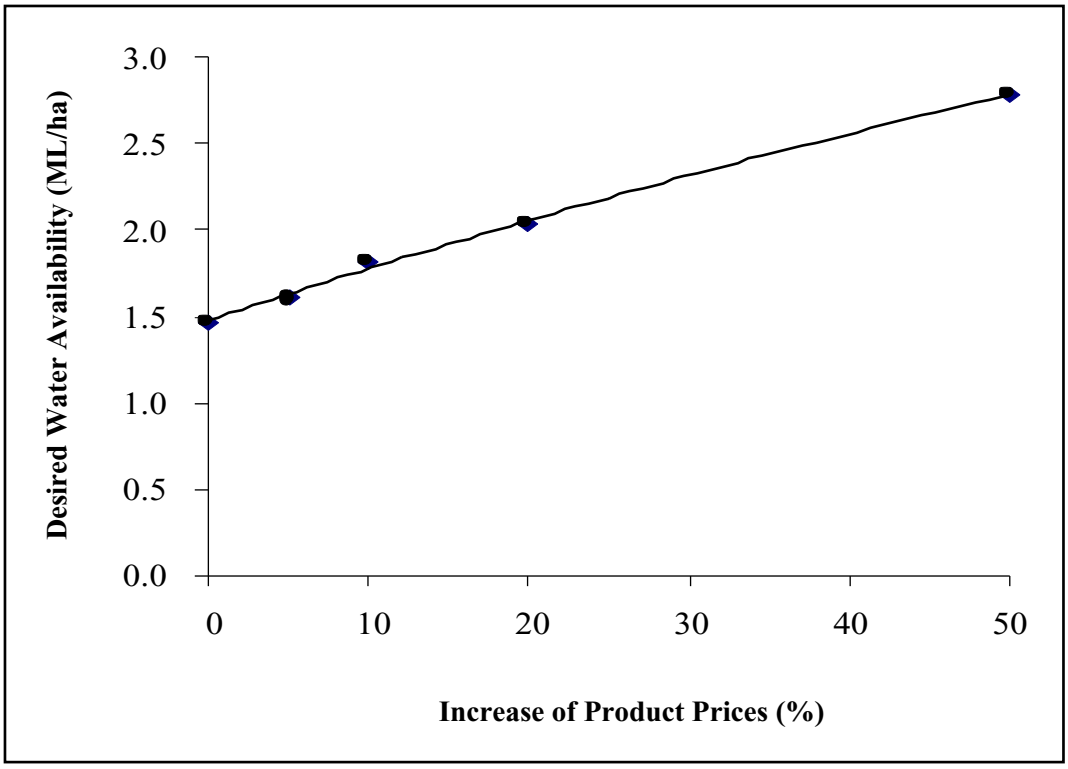

Figure 25. Variability of Mean Water Entitlement per Unit Area for Cropping and Grazing Sellers when Prices of Farm Products Increase

- There is no significant difference in the level of water availability between dairy farmers who purchased water entitlements to increase security and those who purchase for expansions.
- There is no significant difference in the level of water availability achieved by water buyers who purchased water entitlements to increase security and horticultural water sellers.
- Whilst cropping and grazing water buyers have achieved a level of water availability of 1.87 ML/ha, water sellers have seen their water availability drastically reduced. Water sellers would have retained their water entitlement to a level similar to that of water buyers if prices of farm products were higher.
- The desired level of water availability of buyers and sellers of water entitlements is sensitive to prices of farm products.

13.2 Water Availability Desired by Temporary Water Traders

The issue of security aspirations was analysed with respect to permanent water transfers in Section 13.1. This analysis, however, needs to be expanded by considering an independent set of data collected in this survey from temporary traders in Rochester and Swan Hill.

Table 52 shows the main descriptive statistics for individual desired water availability levels according to farm types.

As indicated in Section 10.2, two-thirds of the irrigated area of dairy farmers consists of perennial pasture. Therefore descriptive statistics of water availability of dairy farmers are based on both total irrigated area (includes perennial pasture and annual pasture) and perennial pasture area.

13.3 Comparative Analysis of Security Aspirations between Permanent and Temporary Water Traders

The previous analysis is restricted to either permanent or temporary water traders. It is worthy, however, to compare the security aspirations pursued by temporary and permanent traders combined together. The comparative analysis of desired water availability achieved by temporary water traders and permanent water traders is summarised in Table 53.

The analysis in Table 53 of permanent transfers for dairy farmers is based on data related to permanent water buyers who bought water entitlements for either security reasons or expansion. As indicated above, the analysis for horticultural farmers is based on the aggregate data from permanent water sellers and permanent water buyers who bought water entitlements for security reasons. It was also shown above that cropping and grazing water sellers may have reduced their water entitlements excessively and that water availability desired by cropping and grazing water buyers is more representative of actual needs of cropping and grazing farmers. Therefore the analysis of permanent transfers for cropping and grazing farmers in Table 53 is based on data related only to permanent water entitlement buyers.

Dairy Farming

The conjunctive analysis (Table 53) shows that there is no significant difference between permanent traders and temporary traders with regard to water entitlement per unit area. The mean values are nearly the same when only perennial pasture area is considered as irrigated area. The mean water entitlement per unit area

Table 52. Descriptive Statistics of Desired Water Availability for Temporary Water Traders according to Farm Types

Statistic	**Farm type**			
	Dairy- based on		**Horticulture**	**Cropping and Grazing**
	Total irrigated area	**Irrigated perennial pasture area**		
Mean (ML/ha)	3.72	5.71	3.14	1.92
Std. error of the mean	0.25	0.29	0.27	0.15
Median	4.06	5.40	2.83	1.91
Standard deviation	1.57	1.84	0.95	0.96
Shapiro-Wilk test significance for normality	0.10	0.40	0.31	0.75

Table 53. Comparison of Water Entitlement per Unit Area of Permanent and Temporary Water Traders

Farm type	**Mean Water entitlement per unit area (ML/ha)**			**Test of significance for the difference of water entitlement per unit area for temporary and permanent transfers**	
	Permanent transfers	**Temporary transfers**	**Both transfers together**	**Significance**	**Test**
Dairy - based on total irrigated area	3.86	3.72	3.77	0.93	MWU
				0.97	2-sample KS
				0.79	2-sample ‘t’
Dairy - based on perennial pasture area	5.69	5.71	5.70	0.89	MWU
				0.99	2-sample KS
				0.99	2-sample ‘t’
Horticulture	3.08	3.14	3.10	0.66	MWU
				0.80	2-sample KS
				0.89	1-sample ‘t’
Cropping and grazing	1.87	1.92	1.91	0.99	MWU
				0.90	2-sample KS
				0.81	1-sample ‘t’

Note: significance is tested at 0.05 level

❖ Temporary water traders are also interested of achieving desired water availability.

based on total irrigated area yields almost similar ratios for both permanent and temporary trading to that based only on perennial pasture area. This is consistent with the similarities observed in annual pasture to perennial pasture ratio for both permanent and temporary water traders belong to dairy farming.

Horticultural Farming

Horticultural farmers have a desire to achieve a unique level of water entitlement per unit area. As revealed in Table 53, there is no significant difference between permanent traders and temporary traders in this regard.

Cropping and Grazing

Table 53 shows that mean values of water entitlement per unit area are almost identical for temporary and permanent water traders.

13.4 Outcomes of the Analysis of Water Security Aspirations

The study of water security aspirations in this section is focused on whether farmers are trying to achieve a particular level of security by transferring (buying or selling) their water entitlements. Water availability is used as an indicator of desired security. The desired water availability of permanent water traders was analysed for:

- purchases of water entitlements,
- sales of water entitlements, and
- combination of purchases and sales of water entitlements.

The analysis comprises three types of farming enterprises: dairy, horticulture, and cropping and grazing. In addition, the sensitivity of farmers reactions to desired security as a result of changes in price of farming products was also analysed. Due to the strong relation between dairy farming and perennial pasture, calculations were based on total cropping area and area planted to perennial pasture as indicators of irrigated area. Independent data from the survey of temporary water traders in Rochester and Swan Hill zones were used to test and compare the outcomes from the analysis of permanent water traders.

- ❖ The level of water availability achieved by permanent and temporary water traders is very similar for all three farm types: dairy, horticulture and cropping and grazing.
- ❖ Water traders have a desire to achieve a particular level of water availability. This value is unique for each farm type:
  - dairy based on total irrigated area: 3.77 ML/ha
  - dairy based on perennial pasture are: 5.70 ML/ha
  - horticulture: 3.10 ML/ha
  - cropping and grazing: 1.91 ML/ha.

Conclusions

The survey of permanent and temporary water traders found several distinct results for these two groups of traders. It also provided information to derive quantitative functions describing the security aspirations of farmers in relation to price of farming commodities, water price trends, and willingness to pay for water by different farming enterprises.

Permanent water trading

The history of water entitlement trading shows that regions 1 and 7 (Shepparton, Central Goulburn and Rochester zones, Campaspe district, and small pumping districts) are major destinations for water purchases, accounting for more than 50% on water purchases from other zones. Over 50% of lands in these regions are now under high value cropping. Zones that depend on less than 50% of external transfers are predominantly water selling areas in which more than 50% of the land is under cropping and grazing enterprises.

Permanent water buyers are, in general, more efficient farmers who produce high value crops and have established their farms on lands with less environmental problems (soil salinity, soil degradation, soil type, high groundwater table). These buyers are found in all regions of the study area although the majority are in region 1.

Despite a reduction in the purchase of permanent entitlements to satisfy the needs of existing areas under irrigation in the last 10 years, this survey shows that more than 40% of water entitlements have been purchased to satisfy the needs of existing irrigated areas. Reductions in this type of trade can be ascribed to lower demand from dairy farming resulting from continuous acquisition of water entitlements in the last 10 years.

Water purchases for the purpose of expansion of existing enterprises has increased slightly over the last 5 years to about 50%.

Horticultural and dairy farmers account for more than 80% of water entitlements bought for two major reasons: use in existing areas and expansion of irrigated area. Purchases for non-irrigation uses have also increased over the last five years.

Water sellers are primarily cropping and grazing farmers who have established their farms on clay/sandy soils in regions 2 and 4 and excess diversion licence holders in regions 5 and 6. There has been no substantial change during the last 10 years in this regard and they still contribute 80% of the water entitlements sold.

Regions 2, 4, 5 and 6 account for most of the water entitlements sold. Farmers responses indicate that water entitlements have been sold mainly due to reductions in cropping and grazing irrigated areas in region 2, excess water entitlements in region 4 and excess diversion licences in unregulated rivers in region 6. Around 50% of water entitlements sold on the permanent market were sourced from the activation of sleeper and dozer licences, while reduction of irrigation area and other non-irrigation uses provided the remaining 50%.

In addition to more traditional water trade drivers such as security, expansions, price efficiency, environmental problems and relaxation of water trade rules, external buyers now represents a large proportion of water purchases.

The analyses of water entitlements after trade shows that permanent water traders have a desire to achieve a particular level of water availability measured as entitlement per unit area. This is a unique level for each farm type to which both buyers and sellers converge after trading permanent water entitlements. Mean water availability for dairy farmers is 3.77 ML/ha based on total irrigated area, 5.70 ML/ha for dairy farmers based on perennial pasture area, 3.1 ML/ha for horticulture farmers and 1.91 ML/ha for CG farmers.

Temporary water trading

In contrast to permanent water transfers, seasonal water excesses and shortages are the main drivers for temporary water trading. Temporary water buyers cannot be distinguished from temporary water sellers in terms of adoption of technology and efficiency.

Over 75% of water buyers are dairy farmers who gave seasonal water shortages as the major reason for purchasing water on the temporary market. There are also many farmers who buy water due to cheaper water prices mainly to irrigate annual pasture. As expected, temporary buyers do not purchase water to increase their irrigated area.

About two-third of water sellers are cropping and grazing farmers. These farmers are selling mainly excess water entitlements. Farmers have not reduced their regular irrigated area after selling water. Decisions by these farmers to sell water are not highly sensitive to prices of water or farm products.

Three distinct price-demand behaviours during the water-year can be observed in past years. At the beginning of the year, the price is unstable depending on the level allocation announcement and weather followed by a more stable price at the mid-year and declining price towards the end of the water year.

Temporary water traders responding to the survey indicated that there is a maximum price that they are prepared to pay for water according to each particular farm type. There is hardly any buyers in the dairy, horticulture, and cropping and grazing farming groups who are willing to purchase water if prices of farm products fall by 50%, and the price of water rise by 50%.

In general, the findings concerning stocking rate for dairy farmers, annual pasture perennial pasture ratio, pasture area fertilized and grain use, and water availability desired by farmers are consistent for permanent and temporary water traders.

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Appendix 1

Glossary and Abbreviations

Allocation

The announced percentage of water entitlement that can be used in a particular season. This is normally known as seasonal water allocation and is computed based on available in-storage volume plus 1/100 year inflows.

Water Application rate

Quantity of water used per unit area of land measured in mega litre per hectare.

Cap

Limit placed on the abstraction of water from streams and storages in the Murray-Darling Basin.

Cropping farming

Farm type for which main crops are winter and/or summer grain (wheat, barley, oat etc.).

Dairy farming

Farm type for which the main production is milk or milk related products. Milking cows are predominant animal category. Crops are perennial and annual pasture.

Diversion licence

A right under the relevant water act to divert water from streams and storages in the study area.

Grazing farming

Farm enterprise for which cattle and sheep are the main products. Crops are annual and perennial pasture.

Horticultural farming

Farm enterprise for which fruits and vegetables (grapevine, citrus, stone fruit etc.) are the main crops. Crops can be annual or perennial.

Mega Litre (million cubic litres)

1000 cubic meters.

Off-allocation (off-quota)

Access to rain-rejection, flood and other "excess" flows in the river that is granted to downstream users in excess of their permanent water entitlement.

Sleeper licence

Licences, which have been issued but do not have history of water usage.

Dozer licence

Licences, which have been issued but are underused.

Water entitlement

Right to water held by water users and specified in mega litres (ML). In the Goulburn- Murray Irrigation Scheme, permanent water entitlements are known as water rights.

Water transfers on substitution

In water transfers on substitution, to allow transfer of a particular volume of water entitlements from Zone A to Zone B, requires the same volume to be transferred from Zone B to Zone A.

Abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
CGR	Cropping and Grazing
GMIS	Goulburn-Murray Irrigation Scheme
G-MW	Goulburn-Murray Water
ha	Hectare
HO	Horticulture
KS	Kolmogorov-Smirnov
KW	Kruskal-Wallis
ML	Mega litre
MWU	Mann-Whitney 'U'
na	Not applicable/ not available
NSW	New South Wales (in Australia)
SW	Shapiro-Wilk
$	Australian Dollar

Abbreviations - Irrigation Zones

BO	Boort
CD	Campaspe Irrigation District
CG	Central Goulburn
KECO	Kerang and Cohuna
MV	Murray Valley
PH	Pyramid Hill
RO	Rochester
RR	Regulated Rivers
SH	Swan Hill
SP	Shepparton
UR	Unregulated Rivers

Appendix 2

Survey Questionnaires

A2.1 Permanent Water Entitlement Purchasing

No.

Questionnaire for Permanent Water Rights Purchasing

- *This form is designed to obtain data on purchasing water rights in the 1999/2000 season.*
- *Please **tick** or **enter** the response you think most appropriate for each relevant question. If you are not involved in irrigated farming, please complete only first 5 questions, and comments (if any) at the last page.*
- *Notations: **ML** - Mega Litre, **$** - Australian Dollar*

Water Trading

1 **How important was each of following reasons for buying water rights?** *Please **tick** the rating appropriate for you.*

Rating: 1 – not important 5 – very important

Increase application of water for existing irrigated area	1	2	3	4	5
Secure existing crops from possible droughts	1	2	3	4	5
Wanted to increase irrigated area of existing crop	1	2	3	4	5
Wanted to start growing new irrigated crops	1	2	3	4	5
Domestic/industry uses (not for irrigating crops)	1	2	3	4	5
Other (please state)	1	2	3	4	5

2 **What were your water rights <u>prior</u> to buying (***if you had***)?** ☐ ML

3 **Please provide details of water rights bought in (***for all **water right** purchases during the season if more than once***).**

(a) For which farm type/ purpose did you buy water rights?
◯ Dairy ◯ Horticulture
◯ Cropping (grains) ◯ Grazing only
◯ Cropping and grazing ◯ Others

(b) What is the amount bought? ☐ ML

(c) When did you buy? ☐ Month ☐ year

(d) What was the agreed price for water? $ ☐ per ML

(e) What was the total cost of the purchase? $ ☐

(f) What was the buyer's age at the time of the transaction? ☐ years

4 (a) Please write the name of the irrigation area from which you bought water rights. .....

(b) Did you have specific reasons for buying water rights from the above area? ◯ Yes ◯ No → **go to question 5**

(c) If yes, briefly state what are they? .....

5 (a) Do you think you need more permanent water rights for your present irrigated area/ need? ◯ Yes ◯ No → **go to question 6**

(b) If yes, how much additional is required? ☐ ML

(c) What is the reason for not buying these additional water rights so far (*briefly*)? .....
.....

6 (a) Are you involved in irrigated farming? ◯ Yes ◯ No → **go to the last page, write comments, and finish**

(b) Have you increased your area irrigated due to this water right purchase? ◯ Yes ◯ No → **go to question 7**

(c) If yes, what is the increase in area in acre / hectare? (*only for relevant farm types)*

☐	Dairy	☐	Horticulture
☐	Cropping (grains)	☐	Grazing
☐	Mix	☐	Others

Is this area in acre or hectare? ◯ acre ◯ hectare

7 If prices for your products had been lower than the prevailing prices, at the time you bought water rights (by the percentages shown below), what would have been your decision about buying water rights?

If prices were lower by	**Your decision to buy water rights**		
5%	◯ buy	◯ not buy	◯ sell available rights
10%	◯ buy	◯ not buy	◯ sell available rights
20%	◯ buy	◯ not buy	◯ sell available rights
50%	◯ buy	◯ not buy	◯ sell available rights

Farm Characteristics

8 **What is your total property area?** (*please **enter** in the appropriate box*) ☐ hectares **or** ☐ acres

9 **What is the maximum area that can be irrigated from your total property area?** ☐ hectares **or** ☐ acres

10 **What farm type best describes your property?** (*please **tick** one oval*)

- ◯ Dairy
- ◯ Cropping (grains)
- ◯ Cropping and grazing
- ◯ Horticulture
- ◯ Grazing only
- ◯ Others

11 (a) **What is the unit you use to measure area?** ◯ hectare ◯ acre

(b) **Please enter your irrigated areas in <u>above unit</u>** (*in the appropriate categories below*).

Crop	Average irrigated area **before** July 1999	Irrigated area in 1999/2000
Perennial pasture (dairy)		
Perennial pasture (cattle)		
Perennial pasture (sheep)		
Annual pasture (dairy)		
Annual pasture (cattle)		
Annual pasture (sheep)		
Perennial horticulture crops		
Annual horticulture crops		
Cropping (grains)		
Others (please state)		

12 **What were your marketable products in 1999/2000 season?** (*e.g. wheat, milk*) ....

13 (a) What are the irrigation methods used by you?

- ◯ flood irrigation
- ◯ drip irrigation
- ◯ under canopy sprinklers
- ◯ overhead sprinklers
- ◯ furrow
- ◯ centre pivot
- ◯ trickle
- ◯ Other(specify)

(b) What was your water use in 1999/2000 season?

for crops ☐ ML
for other uses ☐ ML

Other Issues

14 (a) Do you see purchasing water on the temporary water market as an alternative to purchasing permanent water rights? ◯ Yes ◯ No

(b) Do you depend on purchasing water on the temporary water market? ◯ Yes ◯ No → **go to question 15**

(c) If you had bought, how much (*average for the last 5 seasons*) **water have you obtained from the temporary water market?** ☐ ML per season

15 (a) Do you depend on off- quota water? ◯ Yes ◯ No → **go to question 16**

(b) If yes, how much (*average for last 5 seasons*) **off-quota water have you used?** ☐ ML per season

16 (a) Do you have farm dams to store water for irrigation? ◯ Yes ◯ No → **go to question 17**

(b) If yes, what is the total capacity? ☐ ML

17 (a) Do you use ground water for irrigation? ◯ Yes ◯ No → **go to question 18**

(b) If yes, what is the average use? ☐ ML per season

18 Please rank (***tick*** *the rating that applies to your property*) **the following issues from <u>1 – lowest level</u> to <u>5 – highest level</u>.**

Issue	How to measure	Your position				
Access to regional drainage	1 – no access, 5 – full access is possible and allowed	1	2	3	4	5
Surface drains existing on your farm	1 – no surface drains 5 – drains cover whole farm	1	2	3	4	5
Reuse of drainage water	1 – no reuse 5 – maximum reuse possible	1	2	3	4	5
Laser grading	1 – no laser grading 5 –100% laser graded	1	2	3	4	5

19 **If your farm type does not involve animals,** → **go to question 20**

If the farm type involves animals;

(a) how many heads do you have? ☐ Milking cows ☐ Sheep ☐ Cattle (beef) ☐ Others (specify)

(b) What is the percentage of area of pasture fertilized? ☐

(c) Do you feed supplements such as grains etc.? ◯ Yes ◯ No → **go to question 20**

(d) How much grain was used per animal (*average for the last 5 years***)?** ☐ Kg per year

20 (a) Is there any restriction on the water application you can make ? ◯ Yes ◯ No → **go to question 21**

(b) If yes, what is the application rate allowed? (*in the appropriate box*) ☐ ML per acre **or** ☐ ML per hectare

21 **What is the soil type in your irrigated area?** (*if more than one, please indicate approximate %*) ◯ Sandy soils ◯ Sandy loam soils ◯ Loam soils ◯ Clay soils

22 **How do you perceive the following problems in general or on your property?** *Please **tick** the appropriate rating.*

	No problem				Very severe
Poor rainfall distribution (month to month, and year to year)	1	2	3	4	5
Market access (transport of products) problems	1	2	3	4	5
Problems of marketing of products (low prices, low demand etc.)	1	2	3	4	5
Soil degradation problems	1	2	3	4	5
Soil salinity problems	1	2	3	4	5
High ground water table problems	1	2	3	4	5

Your comments:

Thank you very much for your cooperation

A2.2 Sale of Permanent Water Entitlements

No.

Questionnaire for Permanent Water Rights Selling

- *This form is designed to obtain data on selling water rights in the 1999/2000 season.*
- *Please **tick** or **enter** the response you think most appropriate for each relevant question. If you are not involved in irrigated farming, please complete only first 5 questions, and comments (if any) at the last page.*
- *Notations: **ML** - Mega Litre, **$** - Australian Dollar*

Water Trading

1 How important was each of following reasons for selling your water rights? *Please **tick** the rating appropriate for you.*

Rating: 1 – not important 5 – very important

You have more water than you need	1	2	3	4	5
You have reduced irrigated area	1	2	3	4	5
You have stopped irrigated farming (but still own the land)	1	2	3	4	5
You have retired from irrigated farming (and the land is irrigated by somebody else)	1	2	3	4	5
You have interest in doing other businesses	1	2	3	4	5
You wanted money for other purposes	1	2	3	4	5
Other (please state)	1	2	3	4	5

2 What were your water rights <u>prior</u> to selling? ☐ ML

3 Please provide details of water rights sold (*for all **water right** sales during the season if more than once***).**

(a) From which farm types/ uses did you sell water rights?
◯ Dairy ◯ Horticulture
◯ Cropping (grains) ◯ Grazing only
◯ Cropping and grazing ◯ Others

(b) What was the amount sold? ☐ ML

(c) When did you sell? ☐ Month ☐ year

(d) What was the agreed price for water? $ ☐ per ML

(e) In how many seasons, out of <u>5</u> seasons prior to this sale, did you use the water attached to water rights sold, for your farming/ uses?
◯ 0 ◯ 1 ◯ 2
◯ 3 ◯ 4 ◯ 5

(f) What was the seller's age at the time of the transaction? ☐ years

4 (a) Please write the name of the irrigation area to which you sold your water rights. .....

(b) Did you have specific reasons for selling water rights to the above area? ◯ Yes ◯ No → **go to question 5**

(c) If yes, briefly state what are they? .....

5 (a) Do you expect to sell more water rights in the future without reducing the present irrigated area/ business (*if you still have water rights*)? ◯ Yes ◯ No → **go to question 6**

(b) If yes, what is the approximate volume you would consider selling? ☐ ML

(c) In how many seasons, out of the last 5, did you use the water attached to those water rights that you are now considering selling? ◯ 0 ◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5

6 (a) Are you involved in irrigated farming? ◯ Yes ◯ No → **go to the last page, write comments, and finish**

(b) Is the reason for selling water rights reducing irrigated area or stopping irrigated farming? ◯ Yes ◯ No → **go to question 7**

(c) What is the main reason for this reduction/ stopping (*briefly*)?

.....

(d) What was the area taken out of irrigation in relevant farm types in acre / hectare?

☐ Dairy ☐ Cropping (grains) ☐ Mix ☐ Horticulture ☐ Grazing ☐ Others

Is this area in acre or hectare? ◯ acre ◯ hectare

7 (a) Is the reason for selling water rights excess water? ◯ Yes ◯ No → **go to question 8**

(b) If yes, was there sufficient land available to expand your irrigated farming, if you desired? ◯ Yes ◯ No → **go to question 8**

(c) If yes, what is the reason for not expanding the farm with available excess water?

◯ Farming is not profitable
◯ Financial difficulties
◯ Others

8 (a) If prices for your products had been higher than the prevailing prices, at the time you sold water rights (by the percentages shown below), what would have been your decision about selling water rights?

If prices were higher by	Your decision to sell water rights		
5%	◯ sell	◯ not sell	◯ buy more water rights
10%	◯ sell	◯ not sell	◯ buy more water rights
20%	◯ sell	◯ not sell	◯ buy more water rights
50%	◯ sell	◯ not sell	◯ buy more water rights

(b) If you had changed your decision above to sell water rights, would retained water rights be excess to present irrigated area? ◯ Yes ◯ No

<u>Questions 9 - 23</u> are similar to questions 8 - 22 in A2.1 (Permanent Water Entitlement Purchasing)

Your comments:

Thank you very much for your cooperation

A2.3 Purchasing Water on the Temporary Water market

No.

Questionnaire on Purchasing Water on the Temporary Water Market

- *This form is designed to obtain data on purchasing water on the temporary water market in the 1999/2000 season.*
- *Please **tick** or **enter** the response you think most appropriate for each relevant question. If you are not involved in irrigated farming, please complete only first 6 questions, and comments (if any) at the last page.*
- *Notations: **ML** - Mega Litre, **$** - Australian Dollar*

Water Trading

1 **How important was each of following reasons for buying water?** *Please **tick** the rating appropriate for you.*

Rating: 1 – not important 5 – very important

Water shortage for regular irrigated area due to low rainfall	1	2	3	4	5
Anticipation of severe drought	1	2	3	4	5
Water shortage for regular irrigated area due to low allocations	1	2	3	4	5
Low allocation announcement at the beginning of the season	1	2	3	4	5
Desire to increase irrigated area of existing crop	1	2	3	4	5
Buying at end of the season due to cheap water prices	1	2	3	4	5
Other uses (please state)	1	2	3	4	5

2 **(a) What was the water right attached to your property at the time water was bought in the temporary market (***if you had***)?** ☐ ML

(b) How much additional water right you think you need to buy/ can sell without changing present irrigated area/ water use? ☐ ML-buying ☐ ML-selling

(c) What was your allocation <u>announced</u> <u>at the time</u> you bought water (*if relevant***)?** ☐ %

3 **Please provide the following details about purchasing water in the temporary water market (***for all purchases during the season if more than once***).**

(a) For which farm types/ uses did you buy water?

◯ Dairy ◯ Horticulture
◯ Cropping (grains) ◯ Grazing only
◯ Cropping and grazing ◯ Others

(b) Please enter details of transactions.

	Amount (ML)	Date of transaction	Price paid ($ per ML)	Other costs ($)
1st purchase				
If 2nd purchase				
If 3rd purchase				

4 (a) Please write the name of the irrigation area from which you bought water. .....

(b) Did you have specific reasons for buying water from the above area? ◯ Yes ◯ No ⟶ **go to question 5**

(c) If yes, briefly state what are they? .....

5 (a) Were you unable to purchase more water due to restrictions such as rules and regulations, high water price, unavailability of water etc.? ◯ Yes ◯ No ⟶ **go to question 6**

(b) If yes, how much more water would you have bought if those limitations were not there? ☐ ML

(c) Please specify limitations (briefly). .....
.....

6 If the price of water had been higher than the price you paid, at the time you bought water, what is the percentage of price increase at which you would have changed your decision to buy water?

	You would have changed the decision to buy water if price of water had been higher by
1st purchase	☐ %
If 2nd purchase	☐ %
If 3rd purchase	☐ %

- **If you are not involved in irrigated farming, please write comments at the last page, and finish.**

7 If prices for your products had been lower than the prevailing prices, at the time you bought water (by the percentages shown below), what would have been your decision about buying water?

If prices were lower by	**Your decision to buy water**		
5%	◯ buy	◯ not buy	◯ sell available water
10%	◯ buy	◯ not buy	◯ sell available water
20%	◯ buy	◯ not buy	◯ sell available water
50%	◯ buy	◯ not buy	◯ sell available water

8 (a) Have you increased your area irrigated due to this water purchase? ◯ Yes ◯ No ⟶ **go to question 9**

(b) If yes, what is the increase in area in acre / hectare? (*only for farm types relevant to you*)

☐	Dairy	☐	Horticulture
☐	Cropping (grains)	☐	Grazing
☐	Mix	☐	Others

Is this area in acre or hectare? ◯ acre ◯ hectare

Questions 9 - 14 are similar to questions 8 - 13 in A2.1 (Permanent Water Entitlement Purchasing)

Questions 15 - 22 are similar to questions 15 - 22 in A2.1 (Permanent Water Entitlement Purchasing)

Your comments:

Thank you very much for your cooperation

A2.4 Sale of Water on the Temporary Water market

No.

Questionnaire on Selling Water on the Temporary Water Market

- *This form is designed to obtain data on selling water on the temporary water market in the 1999/2000 season.*
- *Please **tick** or **enter** the response you think most appropriate for each relevant question. If you are not involved in irrigated farming, please complete only first 7 questions, and comments (if any) at the last page.*
- *Notations: **ML** - Mega Litre, **$** - Australian Dollar*

Water Trading

1 How important were each of following reasons for selling water? *Please **tick** the rating appropriate for you.*

Rating: 1 – not important 5 – very important

Excess water for present irrigated area	1	2	3	4	5
Desire to decrease irrigated area of existing crop	1	2	3	4	5
More attractive price for water than returns from farming	1	2	3	4	5
Financial needs	1	2	3	4	5
Other uses (please state)	1	2	3	4	5

2 (a) What was the water right attached to your property at the time water was sold in the temporary market?

☐ ML

(b) How much additional water right you think you need to buy/ can sell without changing present irrigated area/ water use?

☐ ML-buying
☐ ML-selling

3 Please provide the following details about selling water in the temporary water market (*for all sales during the season if more than once***).**

(a) From which farm types/uses did you sell water?

◯ Dairy ◯ Horticulture
◯ Cropping (grains) ◯ Grazing only
◯ Cropping and grazing ◯ Others

(b) Please enter details of transactions.

	Amount (ML)	Date of transaction	Price received ($ per ML)	Other costs ($)
1st sale				
If 2nd sale				
If 3rd sale				

4 (a) Please write the name of the irrigation area to which you sold water.

……

(b) Did you have specific reasons for selling water to the above area?

◯ Yes ◯ No ⟶ **go to question 5**

(c) If yes, briefly state what are they?

……

5 Did you sell water attached to water rights or sales water?

◯ water rights ◯ sales water

6 (a) Were you unable to sell more water due to restrictions such as rules and regulations, low water price etc.?

◯ Yes ◯ No ⟶ **go to question 7**

(b) If yes, how much more water would you have sold if those limitations were not there?

☐ ML

(c) Please specify limitations (briefly).

……
……

7 **If the <u>price of water</u> had been lower than the price you received, at the time you sold water, what is the percentage of price decrease at which you would have changed your decision to sell water?**

	You would have changed the decision to sell water if price of water had been lower by
1st sale	☐ %
If 2nd sale	☐ %
If 3rd sale	☐ %

- **<u>If you are not involved in irrigated farming, please write comments at the last page, and finish.</u>**

8 **If <u>prices for your products</u> had been higher than the prevailing prices, at the time you sold water (by the percentages shown below), what would have been your decision about selling water?**

If prices were higher by	**Your decision to sell water**		
5%	◯ sell	◯ not sell	◯ buy more water
10%	◯ sell	◯ not sell	◯ buy more water
20%	◯ sell	◯ not sell	◯ buy more water
50%	◯ sell	◯ not sell	◯ buy more water

<u>Questions 9 - 14</u> are similar to questions 8 - 13 in A2.1 (Permanent Water Entitlement Purchasing)

<u>Questions 15 - 22</u> are similar to questions 15 - 22 in A2.1 (Permanent Water Entitlement Purchasing)

Your comments:

Thank you very much for your cooperation

Appendix 3

Statistical Analysis to Test the Validity of Responses of the Mail Survey for Permanent Water Transfers

A3.1 Introduction

A major problem associated with the analysis of mail survey responses is the effect of non-respondents. In other words, it is necessary to prove that the sample is representative of the population. In this regard, the number of responses received, as a percentage of the total number of questionnaires mailed out is an important factor. It is also possible to test variables for which data are available for the total population. If the statistical analysis shows that population data for such variables are not different from those of respondents (respondents to first letter or reminder letters) and non-respondents (those who have never responded), it is reasonable to assume that responses are representative of the population (Aaker and Day, 1986).

However, data are available for a limited number of variables for the total population. To overcome this problem, Aaker and Day (1986) suggest that the analysis could be performed for variables for which data are available from the first responses (responses for the first letter) and follow up responses (responses to reminder letters). If respondents represent the population, there should not be a significant difference between variables considered for two groups. Implicit in this is the assumption that a person who responds to a reminder letter is more similar to a non-respondent.

In this study, both of above methods are used to analyze whether respondents represent the population. Two variables, property area and water entitlement attached to property are tested for respondents and non-respondents. The variables, farm type and size of the transfer are analysed for responses to the first and follow up letters. Separate analyses were carried out for buyers of permanent water entitlements, sellers, and both buyers and sellers combined.

Another important consideration is whether the distribution of responses is geographically biased. In other words, it is important to verify whether the responses returned are homogeneous for all the areas within the scheme by applying a homogeneity test.

A3.2 Survey Responses

Several authors discuss satisfactory return rates for mail surveys (Aaker and day, 1986; Bjornlund, 2000). A 25% - 30% rate of return is in general considered satisfactory. Two mail surveys similar to this have previously been conducted in the study area. A survey conducted by H. Bjornlund in 1994 received response rate of 62% (Bjornlund, 2000). This questionnaire comprised 20 general and specific questions. A survey conducted by Tisdell *et al*. (2000) in June 2000 received 27% response rate. The present survey comprised questions and sub-questions that are mostly specific in nature. Details of the number of responses received are shown in Table A3.1.

Table A3.1. Details of Responses Received for the Mail Survey - Permanent Water Transfers

Description	Purchase of water entitlements		Sale of water entitlements		Both purchase and sale of water entitlements	
	No.	%	No.	%	No.	%
Participants to the survey	140	100	175	100	315	100
Questionnaires returned due to wrong address	0	0	8	5	8	3
Questionnaires received by participants	140	100	167	100	307	100
Valid responses	48	34	49	29	97	32
Invalid responses	1	1	10	6	11	3

Table A3.1 shows that rates of responses are well within the acceptable range for a mail survey (Aaker and Day, 1986). However valid response rate for sellers is comparatively lower than that of buyers. It is understandable that there might be low enthusiasm among sellers. After selling water entitlements, some of sellers have quit irrigated agriculture and have no further interest for water use. Therefore they may not be keen to participate in this type of survey.

A3.3 Geographical Distribution of Responses

The Chi-squared homogeneity test as suggested by Walpole and Myers (1989) was used to test the geographical distribution of responses. In the test, homogeneity between number of respondents and number of non-respondents in irrigation zones was tested. The test results are shown in Table A3.2.

Although there are 11 trading zones defined within the study area, the number of zones has been reduced to seven by amalgamating several zones with similar water transfers features in the past. This is to satisfy the minimum cell-frequency requirements for the Chi-squared test.

Table A.3.2 shows that no significant difference exists between zones with regard to received responses. Therefore it can be concluded that the distribution of responses is not geographically biased.

A3.4 Analysis of Responses for Respondents and Non-Respondents

The variables considered for the analysis of respondents and non-respondents are property area and water entitlement attached to the property. These two variables have been selected because data are available for the population. Both variables can be treated as continuous variables.

Property Area

Descriptive statistics of the property area for respondents and the population of water entitlement buyers, sellers, and both buyers and sellers together are tabulated in Table A3.3.

Table A3.3 does not provide sufficient evidence for a particular behavior of property area for the categories considered. Therefore the Kolmogorov-Smirnov (KS) test, and Shapiro-Wilk (SW) test were applied to test the assumption of normality of distribution. When a sample size is less than 50, the SW test is more suitable than the KS test. Test results are tabulated in Table A3.4.

Table A3.4 suggests that none of the categories of the variable: property area is normally distributed at 0.05 significance level. Also, based on frequency diagrams, it was observed that distributions of data are not symmetrical. Therefore, it is not possible to apply the t-test to analyse whether respondents and non-respondents have the same mean for the variables concerned. In this situation, the variable needs to be re-coded as a categorical variable so that the Chi-squared test can be applied.

Property areas for respondents and non-respondents for three categories: buyers of water entitlement, sellers, and both buyers and sellers combined were re-coded as a categorical variable. The Chi-squared test was then applied to determine whether respondents and non-respondents are equally represented in each category. Test results are shown in Table A3.5.

Table A3.2. Chi-squared Test Results for the Homogeneity of Responses on Geographical Basis

Description	Buyers of water entitlements	Sellers of water entitlements	Buyers and sellers combined
Significance	0.60	0.32	0.14
Degree of Freedom	6	6	6
Critical Value	12.59	12.59	12.59
Value of the Test	4.59	6.88	9.56

Table A3.3. Descriptive Statistics for the Property Area of Water Traders

Description	Purchase of water entitlements		Sale of water entitlements		Purchases and sales combined	
	Respondents	Population	Respondents	Population	Respondents	Population
Number	48	140	49	175	97	315
Minimum	0	0	0d	0	0	0
Maximum	1130	1130	2834	2834	2834	2834
Mean	110.3	101.3	211.2	94.6	158.4	96.9
Std.error of the mean	31.1	14.0	68.0	19.6	36.4	12.5
Standard deviation	210.8	166.2	440.4	256.3	342.0	220.1
Skewness	3.17	3.64	5.40	7.98	5.95	7.60
Kurtosis	12.0	16.75	32.33	79.00	43.95	81.75

Table A3.4. Normality Test for Property Area

Description	Purchase of water entitlements		Sale of water entitlements		Both purchase and sale of water entitlements	
	Respondents	Population	Respondents	Population	Respondents	Population
Test	SW	KS	SW	KS	KS	KS
Statistic	0.59	0.29	0.43	0.35	0.32	0.33
DF	47	140	48	175	95	315
Significance	0.01*	0.00*	0.01*	0.00*	0.00*	0.00*

* Significant at 0.05 significance level
DF: degree of freedom

Table A3.5. Chi-squared Test Results for the Comparison of Re-coded Property Area for Respondents and Non-respondents

Description	Purchase of water entitlements	Sale of water entitlements	Both purchase and sale of water entitlements
Chi-squared test statistic	3.4	6.7	7.7
Critical Value	7.82	7.82	9.49
Degree of freedom	3	3	4
Significance	0.33	0.08	0.05

Table A3.5 shows that no significance difference exists between property area for respondents and non-respondents for all three categories.

Water Entitlements Attached

The same procedure applied for property area was used to analyse water entitlement attached to properties of respondents and the population of three categories: buyers, sellers and both buyers and sellers together. Descriptive statistics have been calculated, and KS and SW normality tests have been performed. None of them show normality or symmetric distribution of data for the variable. Therefore, water entitlement has been re-coded as a categorical variable before applying the Chi-squared test. The results of the Chi-squared test are shown in Table A3.6. Based on these results, it can be concluded that there exists no significant difference between respondents and non-respondents with regard to water entitlement attached to properties at 0.05 significance level.

A3.5 Analysis of Responses to the 1st and 2nd Letters Addressed to Participants

The variables farm type and size of the transfer were considered in the analysis of responses to the first and reminder survey letters. Farm type was treated as a categorical variable and size of the transfer as a continuous variable. The analysis to determine whether the sample in each farm type is representative is important because water availability desired by farmers for different farm types was analysed in the study.

Farm Type

The Chi-squared test has been used to analyse this variable. The survey included 6 farm types although the number was reduced to 4 to satisfy minimum cell frequency requirements for the test. The farm types with their respective notations are:

- 1 - Dairy
- 2 - Horticulture
- 5 - Cropping, grazing, and cropping and grazing
- 6 - Others (non-farming water transfers are also included).

Farm types 3 (cropping), and 4 (grazing) were combined with farm type 5. The purpose of the Chi-squared test is to analyse representativeness of each farm types in the responses to the two survey letters. The test was performed only for combined buyers and sellers. Separate tests for buyers and sellers were not possible to apply due to low cell frequencies nor was a meaningful amalgamation of farm types to increase cell frequencies. The test results are tabulated in Table A3.7. According to Table A3.7, it can be concluded that farm types are equally represented in responses for 1st and 2nd letters.

Table A3.6. Chi-squared Test Results for the Comparison of Re-coded Water Entitlement Attached to Properties for Respondents and Non-respondents

Description	Purchase of water entitlement	Sale of water entitlement	Purchase and sale combined
Chi-squared test statistic	2.75	5.65	8.63
Critical Value	9.49	5.99	12.59
Degree of freedom	4	2	6
Significance	0.59	0.23	0.07

Table A3.7. Chi-squared test Results for the Comparison of Farm Types Responses for 1st and 2nd Letters to Participants

Description	Buyers and sellers of water entitlements
Chi-squared test statistic	2.62
Critical Value	7.82
Degree of freedom	3
Significance	0.46

Size of the Water Transfer

Based on descriptive statistics and SW normality test, distributions of water entitlements traded are not normal or symmetrical for three categories: water buyers, sellers and both buyers and sellers together. The Mann Whitney U (MWU) test for equality of mean and KS two-sample test for distribution were used to test this variable. The null hypothesis: respondents to first and second letters have same mean and distribution of volume of water entitlement traded was used. In addition to this, the Chi-squared test was also applied by re-coding water entitlements traded into ranges, and defining it as a categorical variable. Test results are shown in Tables A3.8 and A3.9.

Both Table A3.8 and Table A3.9 show that there is no significant difference between volume of water entitlements traded by respondents to the first and second survey letters.

A3.6 Representation of Population by Responses

The preceding analysis included four variables, which were tested to determine whether the sample is a good representation of the population by considering the following variables:

- property area and water entitlement attached to properties analysed for respondents and non-respondents, and
- farm types and volume of water entitlements traded analysed for responses to the first and second survey letters.

In all cases it was found that there is no significant difference between the sample and the population statistics. It can thus be concluded that the survey responses constitute a good representation of their respective populations.

Table A3.8. Analysis of Volume of Water Entitlement Traded in Responses for 1st and 2nd Letters to Participants

Description	**Sample Size**	**MWU test**		**KS Two Sample Test**	
		Test Statistic	**Significance**	**Test Statistic (KS-Z)**	**Significance**
Water buyers	17, 30	216	0.39	0.98	0.29
Water sellers	24, 24	207.5	0.15	0.84	0.48
Buyers and sellers together	41, 54	945.5	0.28	1.09	0.19

Table A3.9. Chi-squared Test Results for the Comparison of Volume of Water Entitlement Traded for Responses to 1st and 2nd Letters

Description	**Water entitlements purchased**	**Water entitlements sold**	**Water purchases and sales combined**
Chi-squared test statistic	1.74	2.14	3.09
Critical Value	3.84	7.82	7.82
Degree of freedom	1	3	3
Significance	0.19	0.14	0.08

Appendix 4

Statistical Analysis to Test the Validity of Responses of the Mail Survey for Temporary Water Transfers

A4.1 Introduction

The survey of temporary water transfers comprised 283 randomly selected temporary water trades that took place in the 1999/2000 water-year. These were distributed in two water trading zones: Rochester (RO) and Swan Hill (SH).

The same statistical tests to test the representation of samples described for permanent water transfers (Appendix 3) was applied for temporary water transfers. Separate analyses were carried out for three categories of temporary water traders: Rochester, Swan Hill, and Rochester and Swan Hill together. The homogeneity of distribution of responses was also investigated by statistical tests that were applied on a geographical basis as well as for purchases and sales.

Sample representation of the population parameters was investigated by analysing data from the survey responses against the rest of the population for selected variables. The population of water traders for the analyses includes all temporary water traders in 1999/2000 water-year in a particular category. The rest of the population data includes those who have been invited to participate in the survey but did not respond and those who have not been included in the survey. Two variables, property area and water entitlements attached to properties, for which data are available for both respondents and population were selected for the analysis.

Since participants to the survey were randomly selected, it is hard to justify that respondents to follow up letters represents others in the population (water traders in the population excluding respondents for the first letter). Therefore analyses were not carried out for respondents for first letter against respondents for follow up letters.

A4.2 Survey Responses

The problem of rate of responses to mail surveys was already discussed for permanent water transfers. The same considerations are applicable to temporary water transfers. The mail survey for temporary water transfers comprised questions and sub-questions: 39 questions for water purchases and 37 questions for water sales, which are mostly specific in nature. Details of the received responses are shown in Table A4.1.

Table A4.1 shows that the rates of responses are within the acceptable range for a mail survey (Aaker and Day, 1986). The valid response rate for water traders in Swan Hill is slightly lower than that of water traders in Rochester. Rochester is basically a net importer of water whereas Swan Hill is a net exporter of water. Dairy farming, which consumes comparatively more

Table A4.1. Details of Responses Received for the Mail Survey - Temporary Water Transfers

Description		Geographical basis		Purchase/sale basis		Total
		Rochester	Swan Hill	Buyers	Sellers	
Total number of trades		863	245	577	531	1108
Total number of traders		535	168	356	347	703
Number of traders surveyed		150	133	133	150	283
Questionnaires returned due to wrong address		0	0	0	0	0
Questionnaires received by participants		150	133	133	150	283
Valid responses	Number	56	47	49	54	103
	%	37	35	37	36	36
Invalid responses	Number	3	4	2	5	7
	%	2.0	3.0	1.5	3.3	2.5

Note: Percentages of valid and invalid responses are based on number of questionnaires received by participants

water, is the predominant type of farm enterprise in Rochester while cropping and grazing is the main farm type in Swan Hill. These differences between two zones may have contributed to the relatively low response rate in Swan Hill. Rate of responses are slightly higher than those from permanent trading.

The rates of invalid responses are comparable to that of the overall responses for permanent trading. Furthermore, the differences in rates of invalid responses for different categories of temporary trading are not high. In the case of responses for permanent transfers, it was observed that the rates of invalid responses from buyers and sellers are 1% and 6% respectively. Unlike sellers of permanent water entitlements, temporary water traders whether buyers or sellers are continuing farmers. Therefore the same difference observed in the number of invalid responses between permanent buyers and sellers cannot be expected from temporary buyers and sellers.

A4.3 Homogeneity of Distribution

The Chi-squared test was used to investigate the geographical homogeneity of distribution of responses, and the homogeneity of buyers and sellers responded (Walpole and Myers, 1989). The test results are shown in Tables A4.2 and A4.3.

Tables A4.2 and A4.3 show that there is no significant difference between the numbers of responses on a geographical basis or between purchases and sales.

A4.4 Analysis of Responses

The variables included in the analysis of respondents and non-respondents are property area and water entitlements attached to properties. These two variables have been selected because population data are available. Both variables can be treated as continuous variables.

Table A4.2. Homogeneity of Responses on Geographical Basis - Chi-squared Test

Description	Degree of freedom	Significance
Buyers, between RO and SH	1	0.64
Sellers, between RO and SH	1	1.00
Buyers and sellers, between RO and SH	1	0.73

Note: Significance is compared at 0.05 significance level.

Table A4.3. Homogeneity of Responses on Purchase/sale Basis - Chi-squared Test

Description	Degree of freedom	Significance
RO, between buyers and sellers	1	0.74
SH, between buyers and sellers	1	0.86
Both zones, between buyers and sellers	1	0.89

Note: Significance is compared at 0.05 significance level.

Property Area

Descriptive statistics of property area for respondents and non-respondents of the mail survey of temporary water traders in Rochester, Swan Hill, and Rochester and Swan Hill combined together are tabulated in Table A4.4.

The results indicate that the variable property area is not normally distributed. The Kolmogorov-Smirnov (KS) test applied to sample size greater than 50 and the Shapiro-Wilk (SW) test applied to sample size less than 50, show that the null hypothesis: property area is normally distributed is rejected at 0.05 significance level for all categories. This precluded the use of parametric tests that are based on normality assumptions.

Although distributions are not normal, sample sizes are reasonably large for all categories. This allowed the t-test to be used in the analysis (Walpole and Myers, 1989). In addition to the t-test, MWU and KS non-parametric tests and Chi-squared test have been applied by re-coding the data. These test results are shown in Tables A4.5, A4.6, and A4.7.

Table A4.4. Descriptive Statistics for the Property Area for Respondents and Non-respondents

Description	Rochester		Swan Hill		Rochester and Swan Hill combined	
	Respondents	Non-respondents	Respondents	Non-respondents	Respondents	Non-respondents
Number of cases	54	440	45	120	99	560
Minimum	9	0	2	0	2	0
Maximum	379	81	533	733	533	805
Mean	101.2	117.3	101.1	62.6	101.2	105.3
Std.error of the mean	11.5	6.2	20.5	10.0	11.0	5.4
Standard deviation	84.9	131.0	137.6	110.5	109.7	128.7
Skewness	1.55	2.61	2.23	3.38	2.04	2.66
Std. error of skewness	0.37	0.12	0.44	0.217	0.29	0.10
Kurtosis	2.53	8.39	4.48	13.58	4.54	8.75
Std. error of skewness	0.73	0.23	0.86	0.43	0.56	0.21

Table A4.5. Statistics of t-test for the Property Area for Respondents and Non-respondents

Description	Sample Size	Levene's test for equality of variance		2-samples t-test significance	
		f-statistic	Significance	Equality of variances assumed	Equality of variances not assumed
Rochester	54, 440	1.29	0.26	0.43	0.29
Swan Hill	45, 120	1.34	0.25	0.11	0.17
Rochester and Swan Hill together	99, 560	0.44	0.51	0.80	0.77

Note: Significance is compared at 0.05 significance level.
Sample size - (respondents, non-respondents).

Tables A4.5, A4.6, and A4.7 suggest that the property area is not different between respondents and non-respondents for the categories considered at 0.05 significance level.

Water Entitlements Attached

The same procedure applied to property area was used to analyse water entitlements attached to respondents and non-respondents from three categories: Rochester, Swan Hill, and Rochester and Swan Hill combined. The descriptive statistics for these variables are shown in Table A4.8.

Table A4.6. MWU and KS Test Statistics for the Property Area for Respondents and Non-respondents

Description	Sample Size	MWU test		KS Two Sample Test	
		Test Statistic	Significance	Test Statistic (KS-Z)	Significance
Rochester	54, 440	9196.5	0.76	0.55	0.54
Swan Hill	45, 120	1308	0.04*	1.60	0.05
Rochester and Swan Hill together	99, 560	19688.5	0.82	0.37	0.99

Note: Significant at 0.05 significance level.
Sample size: (respondents, non-respondents)

Table A4.7. Chi-squared Test Statistics for the Comparison of Re-coded Property Area between Respondents and Non-respondents

Description	Degree of freedom	Significance
Rochester	3	0.51
Swan Hill	2	0.05
Rochester and Swan Hill together	3	0.76

Note: Significance is compared at 0.05 significance level.

Table A4.8. Descriptive Statistics for the Water Entitlement Attached for Respondents and Non-respondents

Description	Rochester		Swan Hill		Rochester and Swan Hill	
	Respondents	Non-respondents	Respondents	Non-respondents	Respondents	Non-respondents
Number of cases	54	440	45	120	99	560
Minimum	17	2	0	0	0	0
Maximum	2244	4698	942	2270	2244	4698
Mean	509.9	525.4	186.4	164.2	379.5	446.5
Std.error of the mean	76.2	35.3	30.3	31.8	47.8	29.1
Standard deviation	563.6	740.0	202.7	349.3	479.0	690.3
Skewness	1.740	3.15	2.17	5.01	2.29	3.39
Std. error of skewness	0.37	0.12	0.45	0.22	0.29	0.10
Kurtosis	2.41	11.76	6.51	26.83	5.26	13.89
Std. error of skewness	0.73	0.23	0.87	0.43	0.58	0.21

Table A4.8, along with normality tests (KS, SW), shows that the data are not normally distributed for all three categories. Therefore, the analytical procedure already applied for the property area has also been used for the water entitlement attached. Test results are shown in Tables A4.9, A4.10, and A4.11.

These test results show that there is no significant difference at 0.05 significance level between respondents and non-respondents with respect to water entitlements attached to properties.

A4.5 Representation of Population Parameters

In the preceding analysis the variables, property area and water entitlements attached to properties for both respondents and non-respondents were examined for how well they represent their respective populations. The results show that there is no significant difference between the two groups compared for Rochester, Swan Hill, and both Rochester and Swan Hill combined together. The conclusion can thus be drawn that the responses constitute a representative sample of their respective populations.

Table A4.9. Statistics of t-test for the Comparison of Means of Water Entitlement Attached for Respondents and Non-respondents

Description	Sample Size	Levene's test for equality of variance		2-samples t-test significance	
		f-statistic	Significance	Equality of variances assumed	Equality of variances not assumed
Rochester	54, 440	0.19	0.66	0.90	0.87
Swan Hill	45, 120	3.65	0.06	0.17	0.30
Rochester and Swan Hill together	99, 560	1.89	0.17	0.44	0.31

Note: Significance is compared at 0.05 significance level.
Sample size - (respondents, non-respondents).

Table A4.10. MWU and KS Test Statistics for the Water Entitlement Attached for Respondents and Non-respondents

Description	Sample Size	MWU test		KS Two Sample Test	
		Test Statistic	Significance	Test Statistic (KS-Z)	Significance
Rochester	54, 440	8510	0.73	0.54	0.94
Swan Hill	45, 120	1355.5	0.14	1.05	0.22
Rochester and Swan Hill together	99, 560	18545	0.82	0.50	0.96

Note: Significance is compared at 0.05 significance level.
Sample size - (respondents, non-respondents).

Table A4.11. Chi-squared Test Statistics for the Comparison of Re-coded Water Entitlements between Respondents and Non-respondents

Description	Degree of freedom	Significance
Rochester	4	0.77
Swan Hill	4	0.05
Rochester and Swan Hill together	4	0.71

Note: Significance is compared at 0.05 significance level.

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Established and supported under the Australian Government's Cooperative Research Centre Program